Insecticidal Activities and GC-MS Analysis of the Selected Family Members of Meliaceae Used Traditionally as Insecticides

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Abstract: The environmental and health risks associated with synthetic pesticides have increased the demand for botanical insecticides as safer and biodegradable alternatives to control insect pests in agriculture. Hence in this study, five Meliaceae species were evaluated for their insecticidal activities against the Spodoptera frugiperda and the Plutella xylostella larvae, as well as their chemical constituents. Repellence, feeding deterrence, and topical application bioassays were employed to evaluate their insecticidal activities. GC-MS analysis was performed to identify chemical compounds present in each plant. The repellence bioassay indicated that Melia azedarach extracts exhibited the highest repellence percentage against S. frugiperda (95%) and P. xylostella (90%). The feeding deterrence bioassay showed that M. azedarach and Trichilia dregeana extracts displayed excellent antifeeding activity against the S. frugiperda (deterrent coefficient, 83.95) and P. xylostella (deterrent coefficient, 112.25), respectively. The topical application bioassay demonstrated that Ekebergia capensis extracts had the highest larval mortality against S. frugiperda (LD$_{50}$ 0.14 mg/kg). Conversely, M. azedarach extracts showed the highest larval mortality against P. xylostella (LD$_{50}$ 0.14 mg/kg). GC-MS analysis revealed that all plant extracts had compounds belonging to the two noteworthy groups (phenols and terpenes), which possess insecticidal properties. Overall, this study lends scientific credence to the folkloric use of Meliaceae species as potential biocontrol agents against insect pests.

Keywords: antifeedants; botanical insecticides; insect pests; Meliaceae; synthetic pesticides

1. Introduction

The agricultural sector has always been faced with challenges due to insect pests and will continue to do so in the future [1]. These pests damage crops during the growing period, and they may also subsequently cause damage to the harvested products stored in storehouses [2]. Controlling insect pests remains a problem as the insects keep building resistance to common pesticides while, on the other hand, toxic pesticides are being removed from the markets [1]. Synthetic pesticides have been commonly used and are considered a highly effective means of controlling plant damage caused by insects [3], which leads to remarkable improvements in plant yield productivity [4]. However, the indiscriminate and haphazard usage of synthetic pesticides has adversely affected human health and the ecosystem as a whole [5].

The presence of pesticide residues in foods, fruits, vegetables, and even in breastfeeding mothers’ milk creates a threat to human health. In developing countries, nearly 3 million farmworkers experience severe pesticide poisoning, resulting in about 18,000 deaths, while 25 million workers suffer from mild pesticide poisoning each year [6]. The use of synthetic pesticides also raises several environmental concerns because over 5% of the sprayed synthetic pesticides do not reach their target insect pests; instead, they can be found in air, soil, and water streams [7]. As a result of these devastating occupational synthetic pesticides...
pesticide poisoning cases, research to find alternative methods that are environmentally friendly and cost-effective in controlling insect pests has increased [1].

Based on recent studies to find ways to mitigate problems caused by synthetic pesticides, natural bio-insecticides from medicinal plants can be an excellent alternative strategy to overcome pest resistance and environmental contamination [8]. This possibility is not surprising as plants are rich sources of bioactive chemicals, and botanical insecticides have been reported to have fewer adverse effects on the environment or human health [1].

Meliaceae is one of two flowering plant families that have gained considerable attention, whereby systematic investigations of its members for their insecticidal potential have been undertaken [9,10]. Chemicals extracted from members of the Meliaceae have received attention recently from applied entomologists due to their excellent properties as control agents for insects [11]. This knowledge has prompted the interest to assess other family members for their insecticidal and antifeedant properties in this study.

_Platypus xylostella_ (L.) (Lepidoptera: Plutellidae), commonly known as the diamondback moth (DBM) or the cabbage moth, is an economically important pest of cruciferous plants globally [12]. The Diamondback moth is an oligophagous insect that mainly feeds on cole crops, including broccoli, brussel sprouts, canola, cauliflower, and cabbage, which are of essential economic value [13]. The insect is important in agriculture as causes yield losses of as much as 100% [14]. In the 1970s, there was a major outbreak of DBM, mainly due to the development of resistance to synthetic insecticides [13]. It has been estimated that the yield losses and control associated with diamondback moth globally ranged between 4–5 US billion dollars yearly [14]. In sub-Saharan Africa, crop losses due to diamondback moths have been reported to be between 8–22% in the field [15].

_Spodoptera frugiperda_ (J.E. Smith) (Lepidoptera: Noctuidae), commonly known as the fall armyworm (FAW), is a polyphagous insect that is important in agriculture as it is difficult to control and, as a result, causes a lot of damage [16]. This migratory insect also causes enormous economic losses, mainly attacking crops that form part of the primary staple food [17], including rice, maize, forage grasses, sorghum, alfalfa, vegetable crops, and many others [16]. The first case to be reported in Africa of the fall armyworm was in late 2016, when it attacked most West African farms and subsequently spread throughout the continent rapidly and is now found in 44 African countries [18]. Environmentally friendly and effective methods to control fall armyworms are crucial as these insects are heavy foliage feeders [17] and can result in the total loss of crops. In sub-Saharan Africa, maize, rice, sorghum, and sugarcane crop damage is estimated to cause up to USD 13 billion yearly [19].

Ever since plant-derived products have gained increased attention from researchers to assess their insecticidal properties, more than 2000 plant species have been recorded to be used traditionally as insecticides [20]. However, many studies that attempted to validate these properties scientifically are incomplete; the bioassays procedures used were usually inappropriate or inadequate [21]. As a result, biological compounds that are potentially useful remain uninvestigated, undiscovered, underutilized, or undeveloped from this reservoir of unstudied plant materials [22]. Hence, in this study, four Meliaceae species that had previously not been evaluated extensively for their insecticidal and antifeedant properties against the test insects _S. frugiperda_ and _P. xylostella_ were selected. _Melia azedarach_ was chosen as a positive control as it is a well-known bioinsecticide plant. Water extracts were selected for extraction in this study because it is one of the simplest and safest (non-toxicity) solvents. In addition, aqueous plant extracts are traditionally used to control insect pests. Using aqueous extracts is fitting because the main purpose of this study is to identify safer, cost-effective, and renewable alternative methods to synthetic pesticides. Slightly polar acetone and ethanol extracts were selected because the main targeted compounds, limonoids (terpenes), were reported to have a higher solubility in polar solvents and alcohol [23].
2. Results
2.1. Antifeedant and Insecticidal Analysis
2.1.1. Repellence Test

Repellence Bioassay against *S. frugiperda* Larvae

Table 1 indicates the results of the repellence bioassay test of the five selected Meliaceae species against the *S. frugiperda*. Positive average percentage repulsion values exhibit repellence, and negative average percentage repulsion values exhibit attractancy. Plant extracts that are ranked in higher classes (i.e., III, IV, and V) are considered to have a high repellence against the larvae, and those that are ranked to lower classes (I and II) have partial repellence against the larvae. Aqueous and ethanolic extracts of *Melia azedarach* L. and *Trichilia dregeana* Harv. & Sond. acetone extracts were found to have strongly repelled the *S. frugiperda* larvae with repellence of 95%, 65%, and 71%, and they belonged to class V, IV, and IV, respectively. It is followed by aqueous extracts of *Turraea floribunda* Hochst. (49%) belonging to class III. Aqueous and ethanol extracts of *T. dregeana* and ethanolic extracts of *Turraea obtusifolia* Hochst. moderately repelled the *S. frugiperda* with repellence of 40%, 30%, and 30%, respectively. Aqueous and acetone extracts of *T. obtusifolia* were recorded to have the lowest repellency (3% and 5%) and were all assigned to the lowest class (I). Ethanolic extracts of *T. floribunda* (−55%) indicated *S. frugiperda* larvae stimulation.

**Table 1.** Average repellence of five Meliaceae species leaf extracts against *Spodoptera frugiperda* larvae using the treated filter paper test.

| Plant Species            | Extract   | Dose/Concentration (%) | Percentage Repulsion (PR) = 2 × (C − 50) in Hours | Average (PR) | Class |
|--------------------------|-----------|------------------------|--------------------------------------------------|--------------|-------|
|                          |           |                        | 1 H  2 H  3 H  4 H                              |              |       |
| 1. *Ekebergia capensis*  | Aqueous   | 0.5                    | 60  60  0  100                                   | 33           | II    |
|                          |           | 1.0                    | −20  20  20  20                                  | 15           | I     |
|                          | Aqueous   | 0.5                    | −20  20  20  20                                  | 10           | I     |
|                          | Acetone   | 0.5                    | 60  60  20  20                                  |              |       |
|                          |           | 1.0                    | −60  −20 20  20                                 |              |       |
| 2. *Melia azedarach* L.  | Aqueous   | 0.5                    | 100  100 100 100                                 | 95           | V     |
|                          |           | 1.0                    | 100  60  100 100                                 |              |       |
|                          | Acetone   | 0.5                    | 20  60  0 0                                     | 28           | II    |
|                          |           | 1.0                    | 60  −20 100 0                                   |              |       |
| 3. *Trichilia dregeana*  | Aqueous   | 0.5                    | 20  20  20  20                                  | 40           | II    |
| Harv. & Sond.            |           | 1.0                    | 20  60  60 100                                  |              |       |
|                          | Acetone   | 0.5                    | 60  60  50 0                                    | 71           | IV    |
|                          |           | 1.0                    | 100  100 100 100                                |              |       |
| 4. *Turraea floribunda*  | Aqueous   | 0.5                    | −60  100 100 100                                | 49           | III   |
| Hochst.                  |           | 1.0                    | 0  100  0 50                                    |              |       |
|                          | Acetone   | 0.5                    | 60  60  20 100                                  | 20           | I     |
|                          |           | 1.0                    | 100  −100 −60 −20                               | −55          |       |
|                          | Ethanol   | 0.5                    | −60  −60 −60 −60                                 |              |       |
|                          |           | 1.0                    | −60  −60 20 −20                                 |              |       |
Table 1. Cont.

| Plant Species | Extract | Dose/Concentration (%) | Percentage Repulsion (PR) = 2 × (C − 50) in Hours | Average (PR) | Class |
|---------------|---------|------------------------|---------------------------------------------------|--------------|-------|
|               |         | 1 H       | 2 H       | 3 H       | 4 H       |
| 5. *Turracea obtusifolia* Hochst. | Aqueous | 0.5 | 0 | 0 | 5 | 0 | 3 | 1 |
|               |         | 1.0 | −20 | −20 | 20 | 20 | 5 | 1 |
|               | Acetone | 0.5 | 60 | −20 | 60 | −20 | 20 | 20 | 30 | II |
|               |         | 1.0 | −20 | −20 | −20 | −20 | 20 | 20 | 30 | II |
|               | Ethanol | 0.5 | −20 | 20 | 20 | 20 | 20 | 30 | II |
|               |         | 1.0 | 20 | 60 | 60 | 60 | 60 | 30 | II |

Repellence Bioassay against *P. xylostella* Larvae

Table 2 indicates the average percentage repulsion for the five Meliaceae species screened for their repellence activity against *P. xylostella* larvae. The overall highest percentage repulsion against the *P. xylostella* larvae was recorded for the aqueous (90%) and ethanol (80%) extracts of *Melia azedarach*, meaning that they exhibited excellent repellent activity, hence they were assigned to classes V and IV, respectively. Good repellent activity against *P. xylostella* was also recorded for acetone (65%) and ethanol (65%) extracts of *T. dregeana*, and they were assigned to class IV. Extracts of *E. capensis* moderately repelled *P. xylostella* larvae with repellence of 60% (aqueous), 50% (acetone), and 50% (ethanol), assigned to class III. All extracts of *T. obtusifolia*, i.e., aqueous (15%), acetone (30%), and ethanol (31%), recorded the lowest repellent activities against *P. xylostella*. Ethanolic extracts of *T. floribunda* (−10%) indicated the *P. xylostella* larvae stimulation.

Table 2. Average repellence of five Meliaceae species leaf extracts against *Plutella xylostella* larvae using the treated filter paper test.
2.1.2. Feeding Deterrence Test

Feeding Deterrence Activity of *S. frugiperda* Larvae

Table 3 indicates the feeding deterrent activity coefficients of Meliaceae species against the fall armyworm larvae. All extracts exhibited feeding activity against the larvae to a certain extent, except for the ethanolic extracts of *T. floribunda*, which were found to have inert antifeedant compounds against the *S. frugiperda* larvae with a feeding deterrent coefficient of −12.89. Of all the tested extracts, aqueous extracts of *M. azedarach* (83.92) and aqueous (68.44) and ethanol (67.29) extracts of *T. obtusifolia* recorded the highest coefficient of deterrence, indicating a good feeding deterrence activity. Aqueous extracts of *T. floribunda* and aqueous extracts of *T. dregeana* moderately caused larvae fertility, with feeding coefficient of 66.96 and 62.02, respectively, ranked ++. Furthermore, ethanolic extracts of *E. capensis* and acetone extracts of *T. floribunda* were the least effective feeding deterrents against the *S. frugiperda* larvae.

Feeding Deterrence Activity of *P. xylostella* Larvae

Table 4 indicates the feeding deterrent activities of the studied Meliaceae species against the diamondback moth larvae. All plant extracts exhibited noteworthy deterrence against the *P. xylostella* larvae. All extracts of *T. dregeana* showed exceptionally high feeding deterrent activities, with acetone recording a 112.25 deterrence coefficient ranked ++++, ethan (99.39, +++), and aqueous (98.77, ++). Aqueous extracts of *T. obtusifolia* and ethanolic extracts of *E. capensis* moderately caused feeding deterrence of the larvae, with feeding coefficients of 86.74 and 85.79, respectively, both ranked ++. Meanwhile, aqueous (13.95, +) and acetone (25.93, +) extracts of *T. floribunda* were the least effective feeding deterrents against *P. xylostella* larvae.
Table 3. Feeding deterrent activity coefficient of five Meliaceae species leaf extracts against *Spodoptera frugiperda*.

| Plant Species        | Extract  | Coefficient of Deterrence | Efficacy of Extract |
|----------------------|----------|---------------------------|---------------------|
|                      |          | Absolute (A) | Relative (R) | Total (T) |                      |
| 1. *Ekebergia capensis* | Aqueous  | 21.66 | 26.61 | 48.27 | +                     |
|                      | Acetone  | 25.14 | 19.97 | 45.11 | +                     |
|                      | Ethanol  | -10.77 | 28.55 | 17.78 | +                     |
| 2. *Melia azedarach*  | Aqueous  | 48.04 | 35.88 | 83.92 | ++                    |
|                      | Acetone  | 58.14 | 3.43 | 61.57 | ++                    |
|                      | Ethanol  | 28.96 | 8.39 | 37.35 | +                     |
| 3. *Trichilia dregeana* | Aqueous | 29.95 | 32.07 | 62.02 | ++                    |
|                      | Acetone  | 29.01 | 23.84 | 52.85 | ++                    |
|                      | Ethanol  | 14.30 | 31.99 | 46.29 | +                     |
| 4. *Turraea floribunda* | Aqueous | 24.40 | 42.56 | 66.96 | ++                    |
|                      | Acetone  | 17.86 | 3.04 | 20.90 | +                     |
|                      | Ethanol  | 3.04 | -15.93 | -12.89 | 0                     |
| 5. *Turraea obtusifolia* | Aqueous | 40.91 | 26.38 | 67.29 | ++                    |
|                      | Acetone  | 17.51 | 17.17 | 34.65 | +                     |
|                      | Ethanol  | 27.06 | 41.38 | 68.44 | ++                    |

Table 4. Feeding deterrent activity coefficient of five Meliaceae species leaves extracts against *Plutella xylostella* larvae.

| Plant Species        | Extract  | Coefficient of Deterrence | Efficacy of Extract |
|----------------------|----------|---------------------------|---------------------|
|                      |          | Absolute (A) | Relative (R) | Total (T) |                      |
| 1. *Ekebergia capensis* | Aqueous  | 27.65 | 3.61 | 31.26 | +                     |
|                      | Acetone  | 50.60 | 2.57 | 53.17 | ++                    |
|                      | Ethanol  | 40.39 | 45.40 | 85.79 | ++                    |
| 2. *Melia azedarach*  | Aqueous  | 34.79 | 3.34 | 38.13 | +                     |
|                      | Acetone  | 32.89 | 13.55 | 46.44 | +                     |
|                      | Ethanol  | 56.13 | 4.13 | 60.26 | ++                    |
| 3. *Trichilia dregeana* | Aqueous | 45.85 | 52.92 | 98.77 | ++                    |
|                      | Acetone  | 62.37 | 49.88 | 112.25 | +++                   |
|                      | Ethanol  | 63.52 | 35.87 | 99.39 | ++                    |
| 4. *Turraea floribunda* | Aqueous | 34.70 | -20.75 | 13.95 | +                     |
|                      | Acetone  | 49.41 | -23.48 | 25.93 | +                     |
|                      | Ethanol  | 49.65 | -5.43 | 44.22 | +                     |
| 5. *Turraea obtusifolia* | Aqueous | 42.24 | 44.50 | 86.74 | ++                    |
|                      | Acetone  | 38.94 | 0.94 | 39.88 | +                     |
|                      | Ethanol  | 55.43 | -1.06 | 54.37 | ++                    |
2.1.3. Topical Application Test
Contact Toxicity against *S. frugiperda* Larvae

Table 5 shows the direct contact toxicity of the Meliaceae plant extracts to the *S. frugiperda* larvae using different concentrations. Aqueous extracts of *T. dregeana* and *M. azedarach* exhibited a positive correlation, where the least concentrated extracts [0.5] showed less toxicity than the more concentrated extracts [1.0]. At [0.5], extracts recorded a 20% mortality rate, while [1.0] recorded an 80% mortality rate. The negative correlation between the concentration of extracts and the rate of mortality observed was recorded for *E. capensis* (acetone), *M. azedarach* (acetone and ethanol), and *T. floribunda* (acetone), where at [0.5] 20%, the mortality rate and at [1.0] mortality rate was 80%. Extracts that did not show any correlation and had constant mortality rates were aqueous extracts of *E. capensis* where, at [0.5] and [1.0], 80% of the larvae died, aqueous extracts of *T. floribunda* at [0.5] and [1.0] caused 60% mortality, and ethanolic extracts of *T. floribunda* at [0.5] and [1.0] caused 20% larval mortality. Probability unit (Probit) analysis showed that aqueous extracts of *E. capensis* (LD$_{50}$ value of 0.14 mg/kg) and *T. floribunda* (LD$_{50}$ value of 0.56 mg/kg) were more toxic to the *S. frugiperda* larvae. Probit analysis also indicated that ethanolic extracts of *E. capensis* were the least toxic to the fall armyworm, with LD$_{50}$ values of 851.14 mg/kg.

Contact Toxicity against *P. xylostella* Larvae

Results of the direct contact toxicity of the Meliaceae plant extracts to the *P. xylostella* larvae using different concentrations are outlined in Table 6. All extracts of *M. azedarach* at 500 ppm and 1000 ppm concentrations showed excellent results, as they killed 80% of the *P. xylostella* larvae. The Probit analysis further supported this and indicated that all three different extracts of *M. azedarach* were the most toxic to *P. xylostella*, with LDL$_{50}$ of 0.14 mg/kg. Results for acetone extracts of *E. capensis* and ethanolic extracts of *T. floribunda* showed a positive correlation between the concentration of extracts and mortality rates recorded. At [0.5], *E. capensis* and *T. floribunda* recorded a mortality of 20%, and at [1.0], they recorded an 80% mortality rate. The negative correlation between the concentration of extracts and the rate of mortality observed was recorded for acetone extracts of *T. dregeana* and aqueous extracts of *T. floribunda*. At [0.5], both extracts killed 80% of the larvae; at [1.0], *T. dregeana* killed 20%, while *T. floribunda* killed 40% of the larvae. Extracts that did not show any correlation and had constant mortality rate were aqueous extracts of *T. obtusifolia* because, at [0.5] and [1.0], the extracts killed 40% of the *P. xylostella* larvae. Probit analysis indicated that only the aqueous extract of *T. obtusifolia* was the second most toxic to the *P. xylostella* larvae, with an LDL$_{50}$ value of 1.78 mg/kg. Meanwhile, all other plant extracts displayed insignificant toxicity to the *P. xylostella*, with acetone and ethanol extracts of *T. obtusifolia* recording the highest LDL$_{50}$ value of 1318.26 mg/kg.

2.2. GC-HRT-MS Analyses

The presence of chemical compounds in plants is important as they may be responsible for their biological activities, antifeedant and insecticidal properties. Tables 7–14 indicate active compounds present in each Meliaceae species using GC-MS analyses, with their retention time (RT), observed mass to charge ion ratio (m/z), molecular formula (MF), metabolite class (MC), and fold change (FC, the average of the peak area values obtained at the different injections of the same compound). In *E. capensis* acetone extracts, thirty-three compounds were identified (Table 7), most of which are triterpenoids (five), alkanes (three), esters (three), sesquiterpenoids (three), diterpenoids (two), methyl esters (two), and two compounds were unclassified. Ethanolic extracts of *E. capensis* in Table 8 identified fifty compounds, of which most are sesquiterpenoids (eight), fatty acids (five), diterpenoids (three), methyl esters (three), triterpenoids (three), benzofurans (two), esters (two), fatty amides (two), and one compound was unclassified.
Table 5. Toxicity of five Meliaceae species leaf extracts applied topically to *Spodoptera frugiperda* larvae.

| Plant Species | Extracts | Concentration (ppm) | log10 (Concentration) | % Dead | Probit | LD₅₀ (mg/kg) |
|---------------|----------|---------------------|-----------------------|--------|--------|--------------|
| 1. *Ekebergia capensis* | Aqueous  | 500 | 2.70 | 80 | 5.84 | 0.14 |
|  | 1000 | 3.00 | 80 | 5.84 |
|  | Acetone | 500 | 2.70 | 80 | 5.84 | 707.95 |
|  | 1000 | 3.00 | 20 | 4.16 | 851.14 |
|  | Ethanol | 500 | 2.70 | 20 | 4.16 | |
|  | 1000 | 3.00 | 60 | 5.25 |
| 2. *Melia azedarach* | Aqueous  | 500 | 2.70 | 20 | 4.16 | 707.95 |
|  | 1000 | 3.00 | 80 | 5.84 | 707.95 |
|  | Acetone | 500 | 2.70 | 80 | 5.84 | 707.95 |
|  | 1000 | 3.00 | 20 | 4.16 | 707.95 |
|  | Ethanol | 500 | 2.70 | 80 | 5.84 | 707.95 |
|  | 1000 | 3.00 | 20 | 4.16 | 707.95 |
| 3. *Trichilia dregeana* | Aqueous  | 500 | 2.70 | 20 | 4.16 | 707.95 |
|  | 1000 | 3.00 | 80 | 5.84 | 707.95 |
|  | Acetone | 500 | 2.70 | 60 | 5.25 | 707.95 |
|  | 1000 | 3.00 | 40 | 4.75 | 588.84 |
|  | Ethanol | 500 | 2.70 | 40 | 4.75 | |
|  | 1000 | 3.00 | 80 | 5.84 |
| 4. *Turraea floribunda* | Aqueous  | 500 | 2.70 | 60 | 5.25 | 0.56 |
|  | 1000 | 3.00 | 60 | 5.25 | 707.95 |
|  | Acetone | 500 | 2.70 | 80 | 5.84 | 707.95 |
|  | 1000 | 3.00 | 20 | 4.16 | 6.92 |
|  | Ethanol | 500 | 2.70 | 20 | 4.16 | |
|  | 1000 | 3.00 | 20 | 4.16 | |
| 5. *Turraea obtusifolia* | Aqueous  | 500 | 2.70 | 60 | 5.25 | 371.54 |
|  | 1000 | 3.00 | 80 | 5.84 | 707.95 |
|  | Acetone | 500 | 2.70 | 40 | 4.75 | 371.54 |
|  | 1000 | 3.00 | 60 | 5.25 | 707.95 |
|  | Ethanol | 500 | 2.70 | 60 | 5.25 | 371.54 |
| Plant Species | Extracts     | Concentration (ppm) | log10 (Concentration) | % Dead | Probit | LD\(_{50}\) (mg/kg) |
|---------------|--------------|---------------------|-----------------------|--------|--------|-------------------|
| 1. Ekebergia capensis | Aqueous      | 500                 | 2.70                  | 40     | 4.75   | 691.83            |
|               |              | 1000                | 3.00                  | 60     | 5.25   | 707.95            |
|               | Acetone      | 500                 | 2.70                  | 20     | 4.16   | 707.95            |
|               |              | 1000                | 3.00                  | 80     | 5.84   | 691.83            |
|               | Ethanol      | 500                 | 2.70                  | 40     | 4.75   | 691.83            |
|               |              | 1000                | 3.00                  | 60     | 5.25   | 707.95            |
| 2. Melia azedarach | Aqueous     | 500                 | 2.70                  | 80     | 5.84   | 0.14              |
|               |              | 1000                | 3.00                  | 80     | 5.84   | 0.14              |
|               | Acetone      | 500                 | 2.70                  | 80     | 5.84   | 0.14              |
|               |              | 1000                | 3.00                  | 80     | 5.84   | 0.14              |
|               | Ethanol      | 500                 | 2.70                  | 80     | 5.84   | 0.14              |
|               |              | 1000                | 3.00                  | 80     | 5.84   | 0.14              |
| 3. Trichilia dregeana | Aqueous   | 500                 | 2.70                  | 40     | 4.75   | 691.83            |
|               |              | 1000                | 3.00                  | 60     | 5.25   | 707.95            |
|               | Acetone      | 500                 | 2.70                  | 80     | 5.84   | 691.83            |
|               |              | 1000                | 3.00                  | 20     | 4.16   | 707.95            |
|               | Ethanol      | 500                 | 2.70                  | 60     | 5.25   | 691.83            |
|               |              | 1000                | 3.00                  | 40     | 4.75   | 691.83            |
| 4. Turraea floribunda | Aqueous    | 500                 | 2.70                  | 80     | 5.84   | 851.14            |
|               |              | 1000                | 3.00                  | 40     | 4.75   | 851.14            |
|               | Acetone      | 500                 | 2.70                  | 20     | 4.16   | 707.95            |
|               |              | 1000                | 3.00                  | 60     | 5.25   | 707.95            |
|               | Ethanol      | 500                 | 2.70                  | 20     | 4.16   | 707.95            |
|               |              | 1000                | 3.00                  | 80     | 5.84   | 707.95            |
| 5. Turraea obtusifolia | Aqueous   | 500                 | 2.70                  | 40     | 4.75   | 1.78              |
|               |              | 1000                | 3.00                  | 40     | 4.75   | 1318.26           |
|               | Acetone      | 500                 | 2.70                  | 20     | 4.16   | 1318.26           |
|               |              | 1000                | 3.00                  | 40     | 4.75   | 1318.26           |
|               | Ethanol      | 500                 | 2.70                  | 80     | 5.84   | 1318.26           |
|               |              | 1000                | 3.00                  | 60     | 5.25   | 1318.26           |
Table 7. Compounds identified in leaf acetone extracts of *Ekebergia capensis*.

| RT (min) | Observed Ion m/z | MF         | Name                                                                 | MC            | FC            |
|----------|------------------|------------|----------------------------------------------------------------------|---------------|---------------|
| 1.       | 13.95            | C15H24O    | (1R,3E,7E,11R)-1,5,5,8-Tetramethyl-12-oxabicyclo[9.1.0]dodeca-3,7-diene Epoxide | 26,6925.50    |               |
| 2.       | 29.96            | C13H20N2SSi| 1,2-Benzisothiazol-3-amine, TBDMS derivative Sugar                  | 18,674.71     |               |
| 3.       | 13.45            | C13H22     | 1,8-Cyclopentadecadiyne Sesquiterpenoid                            | 115,106.00    |               |
| 4.       | 12.71            | C11H16O2   | 2(4H)-Benzofuranone, 5,6,7,7a-tetrahydro-4,4,7a-trimethyl-            | 132,297.50    |               |
| 5.       | 16.78            | C13H26O    | 2-Undecanone, 6,10-dimethyl-                                        | 204,579.33    |               |
| 6.       | 30.25            | C24H36O2Si2| 4-Methyl-2,4-bis(p-hydroxyphenyl)pent-1-ene, 2TMS derivative Bisphenol A | 25,467.00     |               |
| 7.       | 18.36            | C20H40     | 5-Eicosene, (E)-                                                   | 70,769.00     |               |
| 8.       | 21.85            | C19H35NO   | 9-Octadecenamide, (Z)-                                            | 448,270.50    |               |
| 9.       | 20.26            | C11H16FNO3 | Benzeneethanamine, 2-fluoro-β,3,4-trihydroxy-N-isopropyl-            | 173,648.67    |               |
| 10.      | 24.10            | C20H26O4   | Bis[2-(cinnamoyloxy)-1-naphthyl]methane                             | 10,127.50     |               |
| 11.      | 13.56            | C15H24O    | Caryophyllene oxide Sesquiterpenoid                                | 411,365.67    |               |
| 12.      | 27.33            | C27H44O    | Cholesta-4,6-dien-3-ol, (3β)-                                     | 108,829.33    |               |
| 13.      | 28.04            | C46H35O3Si3| Cyclotrisiloxane, hexamethyl-                                      | 24,262.25     |               |
| 14.      | 22.87            | C27H36     | Heptacosane                                                        | 215,283.20    |               |
| 15.      | 13.54            | C16H34     | Hexadecane                                                        | 729,031.09    |               |
| 16.      | 2.59             | H4N2       | Hydrazine                                                          | 12,709.83     |               |
| 17.      | 29.62            | C36H50O    | Lupeol                                                             | 84,095.50     |               |
| 18.      | 2.96             | CH3O       | Methyl Alcohol                                                     | 2773,625.86   |               |
| 19.      | 18.18            | C14H22O2   | n-Hexadecanoic acid Fatty acid                                     | 829,242.33    |               |
| 20.      | 16.70            | C20H38     | Neophytadiene                                                      | 202,795.80    |               |
Table 7. Cont.

| RT (min) | Observed Ion m/z | MF     | Name                                           | MC    | FC      |
|----------|------------------|--------|------------------------------------------------|-------|---------|
| 21       | 21.89            | 154.1226 | C₉H₁₀NO | Nonanamide                                    | Amide | 349,356.50 |
| 22       | 24.39            | 218.7771 | C₂₈H₆₈   | Octacosane                                    | Alkane | 171,462.67 |
| 23       | 29.30            | 408.3768 | C₃₂H₅₂O₂ | Olean-12-en-3-ol, acetate, (3β)-              | Triterpenoid | 210,758.00 |
| 24       | 17.09            | 224.0999 | C₂₂H₂₁NO₄| Phthalic acid, 4-cyanophenyl heptyl ester     | Ester | 454,868.00 |
| 25       | 23.33            | 218.8161 | C₂₅H₅₀O₁ | Phthalic acid, heptyl 3-methylbutyl ester     | Ester | 4577,088.00 |
| 26       | 16.70            | 218.8513 | C₂₀H₄₀O | Phytol                                        | Diterpenoid | 202,160.25 |
| 27       | 14.32            | 218.8335 | C₁₈H₂₄O | Tetracyclo[6.3.2.0(2,5).0(1,8)]tridecan-9-ol, 4,4-dimethyl-| No records | 91,373.50 |
| 28       | 17.65            | 227.2006 | C₁₄H₂₆O₂ | Tridecanoic acid, methyl ester                | Methyl ester | 380,039.50 |
| 29       | 30.36            | 283.8030 | C₁₆H₄₅AsO₃Si₃| Tris(tert-butylmethyldisilyloxy)arsane             | Ester | 29,655.00 |
| 30       | 19.68            | 199.1691 | C₁₂H₂₄O₂ | Undecanoic acid, methyl ester                 | Methyl ester | 74,944.00 |
| 31       | 14.46            | 200.1558 | C₁₅H₃₀ | α-Calacorene                                   | Sesquiterpenoid | 49,402.00 |
| 32       | 27.58            | 431.3842 | C₃₁H₅₂O₃ | α-Tocopheryl acetate                          | Triterpenoid | 183,414.80 |
| 33       | 28.36            | 401.3731 | C₃₁H₅₂O₂ | β-Sitosterol acetate                          | Triterpenoid | 696,117.67 |

Table 8. Compounds identified in leaf ethanol extracts of *Ekebergia capensis*.

| RT (min) | Observed Ion m/z | MF     | Name                                           | MC    | FC      |
|----------|------------------|--------|------------------------------------------------|-------|---------|
| 1        | 13.49            | 218.9559 | C₁₅H₂₄O | (-)-Spathulenol                                | Sesquiterpenoid | 225,729.33 |
| 2        | 23.93            | 150.1032 | C₁₂H₁₅ClN₂ | (1R,2R,4S)-2-(6-Chloropyridin-3-yl)-7-methyl-7-azabicyclo[2.2.1]heptane | Epibatidine analogues | 148,243.33 |
| 3        | 13.98            | 220.1821 | C₁₅H₂₄O | (1R,3E,7E,11R)-1,5,5,8-Tetramethyl-12-oxabicyclo[9.1.0]dodeca-3,7-diene | Epoxide | 499,685.75 |
| 4        | 29.29            | 263.9630 | C₁₃H₂₀N₂Si | 1,2-Benzisothiazol-3-amine, TBDMS derivative | Sugar | 23,401.00 |
| 5        | 14.34            | 218.7645 | C₁₃H₂₀O | 10,10-Dimethyl-2,6-dimethylenebicyclo[7.2.0]undecan-5β-ol | Epoxide | 193,820.25 |
| 6        | 19.99            | 265.2496 | C₂₁H₃₆O₂ | 11,14,17-Eicosatrienoic acid, methyl ester    | Methyl ester | 815,008.50 |
| 7        | 12.74            | 180.1142 | C₁₁H₁₆O₂ | 2(4H)-Benzofuranone, 5,6,7,7a-tetrahydro-4,4,7a-trimethyl- | Benzofuran | 260,204.00 |
| RT (min) | Observed Ion m/z | MF. | Name | MC | FC |
|---------|------------------|-----|------|----|----|
| 8. 4.15 | 110.0360 C6H6O2 | 2-Furancarboxaldehyde, 5-methyl- | Aryl-aldehyde | 76,995.50 |
| 9. 4.59 | 112.0154 C5H4O3 | 2H-Pyran-2,6(3H)-dione | Valerolactone | 166,899.00 |
| 10. 8.89 | 150.0679 C4H10O2 | 2-Methoxy-4-vinylphenol | Ketone | 215,229.67 |
| 11. 5.13 | 102.0550 C6H12NO | 2-Pyrrolidinemethanol, 1-methyl- | Proline | 1586,572.00 |
| 12. 16.80 | 193.1957 C13H26O | 2-Undecanone, 6,10-dimethyl- | Fatty aldehyde | 441,117.67 |
| 13. 17.00 | 278.2967 C20H40O | 3,7,11,15-Tetramethyl-2-hexadecen-1-ol | Diterpenoid | 321,637.00 |
| 14. 14.96 | 218.7685 C20H12FO | 3-Fluorobenzoic acid, tridec-2-ynyl ester | Organofluorine compound | 255,232.00 |
| 15. 6.58 | 144.0415 C6H6O4 | 4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl- | Fatty acid | 1257,832.00 |
| 16. 13.21 | 200.1558 C15H20 | 4-Isopropyl-6-methyl-1-methylene-1,2,3,4-tetrahydronaphthalene | Sesquiterpenoid | 67,046.83 |
| 17. 28.47 | 340.8050 C24H36O2Si2 | 4-Methyl-2,4-bis(p-hydroxyphenyl)pent-1-ene, 2TMS derivative | Bisphenol A | 17,941.50 |
| 18. 15.56 | 218.8078 C15H20O2 | 6,6-Dimethyl-2-(3-oxobutyl)bicyclo[3.1.1]heptan-3-one | Oxepane | 360,494.00 |
| 19. 16.14 | 196.1090 C11H14O3 | 6-Hydroxy-4,4,7a-trimethyl-5,6,7,7a-tetrahydrobenzofuran-2(4H)-one | Benzofuran | 480,778.00 |
| 20. 15.70 | 180.0778 C12H26O2 | 7-Acetyl-2-hydroxy-2-methyl-5-isopropylbicyclo[4.3.0]nonane | Sesquiterpenoid | 296,149.33 |
| 21. 21.89 | 282.2742 C18H18NO | 9-Octadecanamide, (Z)- | Fatty amide | 875,563.20 |
| 22. 10.36 | 122.0361 C7H6O2 | Benzaldehyde, 4-hydroxy- | Hydroxybenzaldehyde | 78,283.50 |
| 23. 28.39 | 400.3717 C28H46O | Campsterol | Ergosterol | 683,575.33 |
| 24. 14.80 | 218.9483 C12H24O | Caryophylla-4(12),8(13)-dien-5α-ol | Sesquiterpenoid | 309,195.00 |
| 25. 13.60 | 220.1821 C15H24O | Caryophyllene oxide | Sesquiterpenoid | 768,061.33 |
| 26. 8.55 | 110.0361 C6H6O2 | Catechol | Catechol | 198,727.00 |
| 27. 27.36 | 379.3372 C27H44O | Cholesta-4,6-dien-3-ol, (3β)- | Cholesterol | 293,677.67 |
| 28. 13.34 | 218.7878 C12H2Cl3O4 | Fumaric acid, ethyl pentachlorophenyl ester | Ester | 166,528.00 |
Table 8. Cont.

| RT (min) | Observed Ion m/z | MF. | Name | MC | FC |
|----------|------------------|-----|------|----|----|
| 29.      | 3.38             | C_6H_8O_4 | Glycolaldehyde dimer | Pentose | 8,931.50 |
| 30.      | 20.31            | C_16H_33NO | Hexadecanamide | Fatty amide | 594,910.67 |
| 31.      | 23.05            | C_18H_38O_4 | Hexadecanoic acid, 2-hydroxy-1-(hydroxymethyl)ethyl ester | 1-monoacylglycerol | 184,585.67 |
| 32.      | 2.60             | H_3N_2 | Hydrazine | Non-metal compound | 24,186.67 |
| 33.      | 2.97             | CH_4O | Methyl Alcohol | Alcohol | 1931,798.17 |
| 34.      | 14.84            | C_15H_18 | Naphthalene, 1,6-dimethyl-4-(1-methylethyl)- | Sesquiterpenoid | 72,764.67 |
| 35.      | 16.72            | C_20H_38 | Neophytadiene | Diterpenoid | 454,427.18 |
| 36.      | 18.26            | C_16H_32O_2 | n-Hexadecanoic acid | Fatty acid | 2543,102.33 |
| 37.      | 6.28             | C_6H_13NO | N-Methyl-L-prolinol | Amino acid | 957,665.00 |
| 38.      | 20.13            | C_18H_36O_2 | Octadecanoic acid | Fatty acid | 650,507.00 |
| 39.      | 12.24            | C_14H_22O | Phenol, 3,5-bis(1,1-dimethylethyl)- | Sesquiterpenoid | 100,587.50 |
| 40.      | 18.16            | C_20H_40O_4 | Phthalic acid, heptyl penty l ester | Ester | 7104,005.33 |
| 41.      | 19.61            | C_20H_40O | Phytol | Diterpenoid | 714,988.60 |
| 42.      | 28.60            | C_26H_48O | Stigmasterol | Steroid | 825,673.33 |
| 43.      | 15.83            | C_14H_28O_2 | Tetradecanoic acid | Fatty acid | 274,646.67 |
| 44.      | 18.28            | C_16H_30O_2 | Tridecanoic acid | Fatty acid | 5679,271.50 |
| 45.      | 17.67            | C_14H_26O_2 | Tridecanoic acid, methyl ester | Methyl ester | 307,666.00 |
| 46.      | 17.69            | C_12H_22O_2 | Undecanoic acid, methyl ester | Methyl ester | 255,331.00 |
| 47.      | 12.89            | C_15H_30 | α-Calacorene | Sesquiterpenoid | 60,816.33 |
| 48.      | 27.60            | C_31H_52O_3 | α-Tocopheryl acetate | Triterpenoid | 681,154.00 |
| 49.      | 29.34            | C_30H_50O | β-Amyrin | Triterpenoid | 390,576.00 |
| 50.      | 29.01            | C_20H_50O | β-Sitosterol | Triterpenoid | 1529,284.00 |
### Table 9. Compounds identified in leaf acetone extracts of Melia azedarach.

| RT (min) | Observed Ion m/z | MF                                      | Name                                                                 | MC          | FC        |
|---------|------------------|-----------------------------------------|----------------------------------------------------------------------|-------------|-----------|
| 1.      | 30.53            | C$_{14}$H$_{22}$O$_x$                  | 1,2,4-Benzene|triscarboxylic acid, 1,2-dimethyl ester | Benzoic acid | 21,666.00 |
| 2.      | 30.13            | C$_{13}$H$_{18}$N$_2$Si                  | 1,2-Benzothiazol-3-amino, TBDMS derivative                            | Sugar       | 23,300.33 |
| 3.      | 28.24            | C$_{13}$H$_{22}$Si$_2$                  | 1,2-Bis(trimethylsilyl)benzene                                        | Organosilicon | 11,527.50 |
| 4.      | 16.78            | C$_{15}$H$_{19}$O                      | 2-Tetradecanone                                                       | Ketone      | 182,214.50 |
| 5.      | 21.78            | C$_{21}$H$_{40}$O                      | 4,8,12,16-Tetramethylhexadecan-4-olide                               | Beta-diketone | 73,950.50 |
| 6.      | 30.24            | C$_{24}$H$_{36}$O$_2$Si$_2$             | 4-Methyl-2,4-bis(3-hydroxyphenyl)pent-1-ene, 2TMS derivative         | Bisphenol A  | 56,309.00 |
| 7.      | 14.92            | C$_{18}$H$_{30}$O$_2$                   | 8-(2-Acetoxypiperidin-2-yl)-6,6-dimethyloct-3,4-dien-2-one            | Fatty alcohol ester | 151,894.00 |
| 8.      | 23.33            | C$_{12}$H$_{16}$O$_4$                  | Bis(2-ethylhexyl)phthalate                                           | Ester       | 54,139.00 |
| 9.      | 28.57            | C$_{20}$H$_{46}$                       | Cholesterol                                                          | Cholesterol | 449,205.00 |
| 10.     | 28.25            | C$_{15}$H$_{30}$O$_2$Si$_2$             | Cyclohexanone, hexamethyl-                                           | Organosilicon | 22,319.83 |
| 11.     | 20.34            | C$_{27}$H$_{56}$                       | Heptacosane                                                          | Alkane      | 136,232.20 |
| 12.     | 18.43            | C$_{16}$H$_{34}$                       | Hexadecane                                                           | Alkane      | 461,468.60 |
| 13.     | 2.59             | C$_{12}$H$_{24}$O$_2$                  | Hydrazine                                                            | Non-metal compound | 31,792.00 |
| 14.     | 2.93             | C$_{18}$H$_{34}$NO                     | Hydroxylamine                                                        | Amine       | 687,694.00 |
| 15.     | 24.40            | C$_{20}$H$_{40}$O$_2$                  | Isobutyl hexadecyl ether                                             | Ether       | 99,861.00 |
| 16.     | 15.46            | C$_{10}$H$_{18}$F$_2$O$_4$             | Isophthalic acid, 3,5-difluoroethyl pentyl ester                     | Ester       | 9,181.00 |
| 17.     | 2.97             | C$_{12}$H$_{24}$O$_2$                  | Methyl Alcohol                                                       | Methyl alcohol | 2893,853.89 |
| 18.     | 16.70            | C$_{20}$H$_{38}$                       | Neophytadiene                                                        | Diterpenoid | 212,138.00 |
| 19.     | 20.24            | C$_{18}$H$_{30}$NO                     | Nonanamide                                                           | Amide       | 100,542.80 |
| 20.     | 19.59            | C$_{19}$H$_{40}$O$_2$                  | Phytol                                                               | Diterpenoid | 354,182.00 |
| 21.     | 17.66            | C$_{12}$H$_{24}$O$_2$                  | Tridecanoic acid, methyl ester                                       | Methyl ester | 263,243.33 |
| 22.     | 30.06            | C$_{20}$H$_{40}$AsO$_x$Si$_3$          | Tris(tert-butyl)dimethylsilyloxy)arsane                              | Ester       | 21,078.67 |
| 23.     | 19.68            | C$_{20}$H$_{42}$O$_2$                  | Undecanoic acid, methyl ester                                        | Methyl ester | 67,474.00 |
| 24.     | 29.63            | C$_{12}$H$_{24}$O$_2$                  | α-Tocopheryl acetate                                                | Triterpenoid | 222,825.33 |
| 25.     | 28.37            | C$_{13}$H$_{26}$O$_2$                  | β-Sitosterol acetate                                                | Triterpenoid | 548,590.25 |

### Table 10. Compounds identified in leaf ethanol extracts of Melia azedarach.

| RT (min) | Observed Ion m/z | MF                                      | Name                                                                 | MC          | FC        |
|---------|------------------|-----------------------------------------|----------------------------------------------------------------------|-------------|-----------|
| 1.      | 14.94            | C$_{13}$H$_{24}$O$_2$                  | 1,6,6-Trimethyl-7-(3-oxobut-1-etyl)-3,8-dioxaspiro[5.1.0](2,4)octan-5-one | Ketone      | 208,378.00 |
| 2.      | 17.00            | C$_{16}$H$_{30}$                       | 1-Hexadecyne                                                        | Hydrocarbon | 146,746.50 |
| 3.      | 17.00            | C$_{16}$H$_{30}$                       | 1-Octadecyne                                                        | Hydrocarbon | 182,460.00 |
| RT (min) | Observed Ion m/z | MF       | Name                                           | MC               | FC    |
|---------|------------------|----------|------------------------------------------------|------------------|-------|
| 4.      | 2.77             | 43.0049  | C₇H₈ClO | 2-Chloroethanol                                | Chloroethanol    | 10,825.00 |
| 5.      | 12.38            | 155.0941 | C₅H₁₃NO₂ | 2-Hydroxy-1-(1′-pyrrolidyl)-1-buten-3-one      | No record       | 163,420.00 |
| 6.      | 16.79            | 218.8744 | C₆H₁₂O   | 2-Tetradecanone                                | Ketone           | 191,685.50 |
| 7.      | 16.79            | 218.8549 | C₁₂H₂₆O  | 2-Undecanone, 6,10-dimethyl-                   | Fatty aldehyde   | 177,821.00 |
| 8.      | 16.94            | 49.9534  | C₃H₄N₂  | 3-Methyl-1,2-diazirine                         | No record       | 10,163.33  |
| 9.      | 16.30            | 144.0416 | C₆H₁₄O   | 4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl- | Fatty acid        | 419,184.67 |
| 10.     | 21.87            | 218.9503 | C₁₂H₂₅NO | 9-Octodecanamide, (Z)-                         | Fatty amide      | 368,824.25 |
| 11.     | 12.30            | 220.1819 | C₁₃H₂₆O  | Butylated Hydroxytoluene                      | Phenylpropane    | 26,415.67  |
| 12.     | 28.39            | 405.0388 | C₁₈H₃₅NO | 9-Octadecenamide, (Z)-                         | Fatty amide      | 107,671.50 |
| 13.     | 29.66            | 430.3826 | C₁₉H₃₂O  | dl-α-F                                        | Resorcinol       | 505,469.00 |
| 14.     | 20.27            | 130.0692 | C₁₀H₂₅NO | Dodecanamid                                    | Fatty amide      | 74,969.00  |
| 15.     | 13.24            | 128.0426 | C₁₈H₃₇O₄ | Fumaric acid, ethyl pentachlorophenyl ester    | Ester            | 90,985.50  |
| 16.     | 20.27            | 130.9721 | C₁₀H₂₀NO | Hexadecanamide                                 | Fatty amide      | 163,949.33 |
| 17.     | 2.90             | 32.0228  | CH₄O    | Methyl Alcohol                                 | Alcohol          | 1607,627.00 |
| 18.     | 13.03            | 157.1220 | C₁₂H₂₅O₂ | n-Decanoic acid                                | Fatty acid       | 86,722.40  |
| 19.     | 18.19            | 124.0390 | C₁₀H₁₈  | Neophytadiene                                  | Diterpenoid      | 454,350.71 |
| 20.     | 17.21            | 256.2401 | C₁₂H₂₀O₂ | n-Hexadecanoic acid                           | Fatty acid       | 163,949.33 |
| 21.     | 17.21            | 154.1226 | C₁₀H₂₅NO | Nonanamide                                     | Amide            | 223,305.67 |
| 22.     | 22.39            | 340.2390 | C₁₀H₂₅O₂ | Phenol, 2,2′-methylenebis[(1,1-dimethyl-4-methyl)- | Diterpenoid      | 40,545.33  |
| 23.     | 12.23            | 206.1636 | C₁₀H₁₂O  | Phenol, 2,5-bis[(1,1-dimethyl)-]               | Sesquiterpenoid  | 29,976.67 |
| 24.     | 18.16            | 278.1512 | C₁₀H₂₀O₄ | Phthalic acid, heptyl pentyl ester             | Ester            | 4299,525.00 |
| 25.     | 17.11            | 223.0966 | C₁₂H₂₅NO₃| Phthalic acid, monoamidate, N-ethyl-N-(3-methylphenyl)-, isoamidinyl ester | Ester            | 197,285.67 |
| 26.     | 19.62            | 278.2864 | C₁₂H₁₆O  | Phytol                                         | Diterpenoid      | 658,472.67 |
| 27.     | 29.10            | 331.0578 | C₁₄H₁₆O  | Stigmasta-5,24(28)-dien-3-ol, (3β,24Z)-       | Steroid          | 57,701.00  |
| 28.     | 28.61            | 412.3719 | C₁₂H₁₆O  | Stigmasterol                                   | Steroid          | 701,624.67 |
| 29.     | 21.80            | 130.8943 | C₁₀H₁₄O₂ | Tetrahydrofuran-2-one, 3-[2-phenyl]-4-methyl- | Fatty acid ester | 65,973.00 |
| 30.     | 19.56            | 85.0280  | C₃H₅O₂   | Tetrahydrofuran Z-10-dodecanoate               | Ester            | 18,107.50  |
| 31.     | 17.68            | 218.9267 | C₁₂H₂₅O₂ | Tridecanolic acid, methyl ester                | Methyl ester     | 119,263.00 |
| 32.     | 27.60            | 431.3843 | C₁₀H₂₀O  | α-Tocopheryl acetate                          | Triterpenoid     | 70,903.00  |
| 33.     | 29.01            | 414.3875 | C₁₀H₁₄O  | β-Sitosterol                                   | Triterpenoid     | 1380,935.00 |
Table 11. Compounds identified in leaf acetone extracts of *Trichilia dregeana*.

| RT (min) | Observed Ion m/z | MF     | Name                                                                 | MC       | FC          |
|---------|-------------------|--------|----------------------------------------------------------------------|----------|-------------|
| 1.      | 20.94             | 272.2504 | C_{20}H_{32} (R,1E,5E,9E)-1,5,9-Trimethyl-12-(prop-1-en-2-yl)cycloketetradeca-1,5,9-triene | Diterpenoid | 661,369.50  |
| 2.      | 29.36             | 263.7976 | C_{13}H_{20}N_{2}Si | 1,2-Benzisothiazol-3-amine, TBDMS derivative | Sugar     | 24,657.75   |
| 3.      | 5.25              | 109.1014 | C_{6}H_{14} 1,6-Heptadiene, 2-methyl- | Alkadiene | 241,431.50  |
| 4.      | 18.65             | 277.2445 | C_{20}H_{34}O 1H-Naphtho[2,1-b]pyran, 3-ethenylidodecahydro-3,4a,7,7,10a-pentamethyl- | Triterpenoid | 254,957.50  |
| 5.      | 21.38             | 218.9118 | C_{15}H_{26}O 1-Naphthalenemethanol, 1,4,4a,5,6,7,8,8a-octahydro-2,5,5,8a-tetramethyl- | Sesquiterpenoid | 910,101.00  |
| 6.      | 22.82             | 292.1670 | C_{17}H_{34}O_{4} 2-Hydroxy-4-methoxy-7-methyl- | Gingerdione | 53,596.00   |
| 7.      | 16.78             | 180.1858 | C_{15}H_{26}O 2-Undecanone, 6,10-dimethyl- | Fatty aldehyde | 498,290.33  |
| 8.      | 21.78             | 263.8585 | C_{21}H_{40}O_{2} 4,8,12,16-Tetramethylheptadecan-4-olide | Beta-diketone | 288,631.33  |
| 9.      | 29.60             | 281.9882 | C_{17}H_{30}OSi 4-tet-Octylphenol, TMS derivative | Alkylbenzene | 32,218.33   |
| 10.     | 21.69             | 270.2347 | C_{20}H_{30} Bicyclo[3.1.1]hept-2-ene, 2,2′-(1,2-ethanediyl)bis[6,6-dimethyl- | Diterpenoid | 205,660.50  |
| 11.     | 23.33             | 218.8484 | C_{24}H_{38}O_{4} Bis(2-ethylhexyl) phthalate | Ester     | 105,403.33  |
| 12.     | 21.69             | 289.2480 | C_{26}H_{40}O_{2} Butyl 4,7,10,13,16,19-docosahexaenoate | Fatty acid | 286,373.50  |
| 13.     | 20.88             | 263.9540 | C_{20}H_{40}O_{2} Butyric acid, hexadecyl ester | Fatty acid | 180,132.50  |
| 14.     | 28.14             | 226.1588 | C_{6}H_{13}O_{3}Si_{3} Cyclotrisiloxane, hexamethyl- | Organosilicon | 21,468.33   |
| 15.     | 18.15             | 278.1513 | C_{16}H_{22}O_{4} Dibutyl phthalate | Ester     | 5113,869.00 |
| 16.     | 15.29             | 87.0440  | C_{13}H_{20}O_{2} Dodecanoic acid, 2-methyl- | Ester     | 161,611.50  |
| 17.     | 18.47             | 263.8584 | C_{20}H_{42} Eicosane | Alkane | 491,217.33  |
| 18.     | 28.36             | 417.0340 | C_{30}H_{50}O_{2} Ergost-5-en-3-ol, acetate, (3β,24R)- | Triterpenoid | 303,607.00  |
| 19.     | 20.35             | 218.8367 | C_{27}H_{56} Heptacosane | Alkane | 179,363.50  |
| 20.     | 13.54             | 130.8832 | C_{16}H_{34} Hexadecane | Alkane | 578,509.80  |
| 21.     | 20.96             | 263.8346 | C_{21}H_{44}O Hexadecyl pentyl ether | Ether     | 415,977.00  |
| 22.     | 2.58              | 32.0175  | H_{2}N_{2} Hydrazine | Non-metal compound | 195,016.33 |
| 23.     | 21.06             | 272.2508 | C_{20}H_{32} Kaur-15-ene | Diterpenoid | 464,961.67  |
| 24.     | 2.89              | 32.0474  | CH_{4}O Methyl Alcohol | Alcohol | 3486,357.33 |
| 25.     | 16.70             | 218.8848 | C_{20}H_{38} Neophytadiene | Diterpenoid | 115,963.50  |
| 26.     | 20.27             | 130.9004 | C_{8}H_{10}NO Nonanamide | Amide | 132,986.33  |
### Table 11. Cont.

| RT (min) | Observed Ion m/z | MF     | Name                                                                                                               | MC     | FC       |
|----------|------------------|--------|-------------------------------------------------------------------------------------------------------------------|--------|----------|
| 27.      | 18.37            | C_{20}H_{32} | Phenanthrene, 7-ethenyl-1,2,3,4,4a,4b,5,6,7,9,10a-dodecahydro-1,1,4a,7-tetramethyl-, [4aS-(4aa,4bb,7b,10aβ)]-   |        | 728,659.00 |
| 28.      | 17.09            | C_{22}H_{32}NO_{4} | Phthalic acid, 4-cyanophenyl heptyl ester                        | Ester  | 230,352.00 |
| 29.      | 19.58            | C_{20}H_{40}O | Phytol                                                             | Steroid| 308,190.00 |
| 30.      | 28.57            | C_{20}H_{40}O | Alkylthiol                                                       |        | 687,016.50 |
| 31.      | 17.67            | C_{14}H_{28}O_{2} | Tridecanoic acid, methyl ester                                   | Fatty ester | 219,513.33 |
| 32.      | 18.43            | C_{15}H_{24}O_{2} | 1,2-Benzenediol, α-chloroacetyl-α'-cyclopropanecarbonyl-   | 7-hydroxycoumarin | 82,416.00 |
| 33.      | 27.58            | C_{31}H_{30}O_{3} | α-Tocopheryl acetate                                            | Triterpenoid | 186,539.25 |
| 34.      | 28.99            | C_{29}H_{50}O | γ-Sitostenone                                                    | Steroid  | 519,588.00 |

### Table 12. Compounds identified in leaf ethanol extracts of *Trichilia dregeana*.

| RT (min) | Observed Ion m/z | MF     | Name                                                                                                               | MC     | FC       |
|----------|------------------|--------|-------------------------------------------------------------------------------------------------------------------|--------|----------|
| 1.       | 13.97            | C_{15}H_{24}O | (1R,3E,7E,11R)-1,5,5,8-Tetramethyl-12-oxabicyclo[9.1.0]dodeca-3,7-diene                                        |        | 100,323.50 |
| 2.       | 20.96            | C_{20}H_{34}O | (E)-3-Methyl-5-((1R,4aR,8aR)-5,5,8a-trimethyl-2-methylenedecahydronaphthalen-1-yl)pent-2-en-1-ol             | Diterpenoid | 545,931.00 |
| 3.       | 22.71            | C_{12}H_{16}Cl_{2}O_{4} | 1,2-Benzisothiazol-3-amine, TBDMS derivative                  |        | 9,766.00  |
| 4.       | 23.14            | C_{20}H_{32}O_{2} | 2,6,10-Dodecatrien-1-ol, 3,7,11-trimethyl-, (E,E)-                 |        | 136,124.67 |
| 5.       | 12.49            | C_{15}H_{24}O | 2,6,10-Dodecatrien-1-ol, 3,7,11-trimethyl-                         | Sesquiterpenoid | 136,124.67 |
| 6.       | 20.84            | C_{17}H_{24}O_{4} | 2-Hydroxy-4-methoxy-7-methyl-7,8,9,10,11,12,13,14-octahydro-6-oxazabicyclododecen-5-one |        | 45,244.00  |
Table 12. Cont.

| RT (min) | Observed Ion m/z | MF | Name | MC | FC |
|----------|------------------|----|------|----|----|
| 11.      | 16.80 179.1786 C12H26O | 2-Undecanone, 6,10-dimethyl- | Fatty aldehyde | 393,929.33 |
| 12.      | 20.91 263.8061 C14H28O3 | 3-Hydroxymyristic acid | Fatty acid | 161,204.00 |
| 13.      | 21.21 274.2300 C19H30O | 4,14-Dimethyl-11-isopropyltricyclo[7.5.0.0(10,14)]tetradec-4-en-8-one | Androgen | 101,356.00 |
| 14.      | 21.80 263.9405 C21H40O2 | 4,8,12,16-Tetramethylheptadecan-4-olide | Beta-diketone | 269,254.50 |
| 15.      | 11.17 130.8733 C7H12O | 4-Hepten-2-one, (E)- | Organoxygen compound | 136,106.00 |
| 16.      | 21.88 263.8605 C18H35NO | 9-Octadecanamide, (Z)- | Fatty amide | 708,408.50 |
| 17.      | 21.71 289.2489 C26H40O2 | Butyl 4,7,10,13,16,19-docosahexaenoate | Fatty acid | 318,610.00 |
| 18.      | 12.29 220.1824 C15H24O | Butylated Hydroxytoluene | Phenylpropane | 27,910.67 |
| 19.      | 2.88 41.0132 CH6N4O | Carbohydrazide | Carbohydrazide | 151,106.00 |
| 20.      | 23.54 257.2272 C12H25NO | Dodecanamide | Fatty amide | 55,399.50 |
| 21.      | 17.69 227.2003 C13H26O2 | Dodecanoic acid, methyl ester | Methyl ester | 127,277.00 |
| 22.      | 2.62 31.0644 C2H4Cl2O | Ethanol, 2,2-dichloro- | Alcohol | 12,654.00 |
| 23.      | 21.41 218.8306 C15H26O | Humulane-1,6-dien-3-ol | Sesquiterpenoid | 1117,231.00 |
| 24.      | 11.43 130.9770 C16H24 | Humulene | Sesquiterpenoid | 33,834.00 |
| 25.      | 2.86 32.0543 H4N2 | Hydrazine | Non-metal compound | 29,779.50 |
| 26.      | 21.08 272.2510 C20H32 | Kaur-15-ene | Diterpenoid | 494,925.33 |
| 27.      | 2.65 31.9949 CH4O | Methyl Alcohol | Alcohol | 1822,640.42 |
| 28.      | 15.82 171.1382 C10H20O2 | n-Decanoic acid | Fatty acid | 115,234.67 |
| 29.      | 16.72 137.1327 C20H38 | Neophytadiene | Diterpenoid | 139,113.50 |
| 30.      | 18.22 256.2398 C16H32O2 | n-Hexadecanoic acid | Fatty acid | 1293,680.33 |
| 31.      | 18.39 272.2504 C20H32 | Phenanthrene, 7-ethylbenz| Diterpenoid | 807,281.67 |
| 32.      | 22.39 340.2411 C23H32O2 | Phenol, 2,2′-methylenebis[6-(1,1-dimethyl)-4-methyl]- | Diterpenoid | 67,053.50 |
| 33.      | 12.22 206.1663 C14H22O | Phenol, 2,5-bis(1,1-dimethylethyl)- | Sesquiterpenoid | 41,210.00 |
| 34.      | 15.89 218.9111 C5F9P | Phosphine, tris(trifluoromethyl)- | Organofluorine | 14,308.25 |
| 35.      | 18.17 278.1507 C20H30O4 | Phthalic acid, heptyl pentyl ester | Ester | 3770,875.00 |
| RT (min) | Observed Ion m/z | MF     | Name                                                                 | MC     | FC    |
|---------|-----------------|--------|----------------------------------------------------------------------|--------|-------|
| 36.     | 17.11           | 223.0962 | C_{21}H_{25}NO_{3} Phthalic acid, monoamide, N-ethyl-N-(3-methylphenyl)-, isobutyl ester | Ester  | 244,482.50 |
| 37.     | 19.61           | 137.1326 | C_{26}H_{40}O Phytol Diterpenoid                                       | Diterpenoid | 223,292.75 |
| 38.     | 28.34           | 380.3446 | C_{26}H_{46}O Stigmaster-5,24(28)-dien-3-ol, (3β,24Z)-                 | Steroid | 234,342.50 |
| 39.     | 25.42           | 218.9552 | C_{30}H_{50} Supraene Triterpenoid                                      | Triterpenoid | 565,315.33 |
| 40.     | 27.60           | 431.3852 | C_{31}H_{46}O\_{3} a-Tocopherol acetate                               | Triterpenoid | 264,498.80 |
| 41.     | 29.01           | 414.3875 | C_{29}H_{50}O\_{β} β-Sitosterol                                       | Triterpenoid | 1371,309.00 |
| 42.     | 30.00           | 412.3724 | C_{28}H_{48}O\_{γ} γ-Sitostenone                                        | Steroid | 540,348.67 |
| 43.     | 27.05           | 416.3666 | C_{28}H_{46}O\_{γ} γ-Tocopherol                                       | Steroid | 121,387.50 |

Table 13. Compounds identified in leaf acetone extracts of *Turraea floribunda*.

| RT (min) | Observed Ion m/z | MF     | Name                                                                 | MC     | FC    |
|---------|-----------------|--------|----------------------------------------------------------------------|--------|-------|
| 1.      | 15.00           | 220.1822 | C_{15}H_{24}O ((4aS,8S,8aR)-8-Isopropyl-5-methyl-3,4,4a,7,8,8a-hexahydrornaphthalen-2-yl)methanol | Sesquiterpenoid | 171,920.00 |
| 2.      | 19.57           | 201.1638 | C_{15}H_{24} (1R,4S,5S)-1,8-Dimethyl-4-(prop-1-en-2-yl)spiro[4.5]dec-7-ene | Hydrocarbon | 192,589.50 |
| 3.      | 26.14           | 263.8413 | C_{20}H_{32} (E,E,E)-3,7,11,15-Tetramethylhexadeca-1,3,6,10-pentaene  | Diterpenoid | 480,221.00 |
| 4.      | 21.84           | 273.2215 | C_{20}H_{32} 1,3,6,10-Cyclotetradecaetraene, 3,7,11-trimethyl-14-(1-methylpentyl)-, [S-(E,Z,E,E)]- | Diterpenoid | 484,433.00 |
| 5.      | 20.78           | 201.1639 | C_{13}H_{22} 1,3,7,11-Cyclotetradecaetraene, 2-methyl-                |         | 902,135.00 |
| 6.      | 18.80           | 263.7967 | C_{20}H_{34}O 1,6,10,14-Hexadecatetraen-3-ol, 3,7,11,15-tetramethyl-, (E,E)- | Diterpenoid | 650,540.67 |
| 7.      | 13.56           | 202.1714 | C_{15}H_{26} 1H-3a,7-Methanoazulene, octahydro-1,4,9,9-tetramethyl-   | Sesquiterpenoid | 128,891.33 |
| 8.      | 8.68            | 142.0775 | C_{11}H_{10} 1H-Indene, 1-ethylidene-                                 | Hydrocarbon | 28,659.00 |
| 9.      | 12.71           | 161.1324 | C_{11}H_{16}O_{2} 2(4H)-Benzofuranone, 5,6,7a-tetrahydro-4,4,7a-trimethyl-, (R)- | Benzoferan | 135,928.67 |
| 10.     | 26.14           | 280.9475 | C_{22}H_{30}O_{2} 2,6,10,14-Hexadecatetraen-1-ol, 3,7,11,15-tetramethyl-, acetate, (E,E,E)- | Fatty alcohol | 176,010.50 |
| 11.     | 15.19           | 210.1614 | C_{13}H_{22}O_{2} 2-Cyclohexen-1-one, 4-(3-hydroxybutyl)-3,5,5-trimethyl- | Apocarotenoid | 82,345.33 |
| 12.     | 16.79           | 263.8863 | C_{16}H_{30}O 2-Pentadecanone, 6,10,14-trimethyl-                     | Ketone   | 1520,735.33 |
| 13.     | 16.97           | 263.7692 | C_{20}H_{40} 3,7,11,15-Tetramethyl-2-hexadecen-1-ol                     | Diterpenoid | 19,984.50 |
| 14.     | 25.67           | 218.8406 | C_{15}H_{23}N 3-Cyano-3-octyl-1,4-cyclohexadiene                       |         | 98,440.00 |
| 15.     | 5.24            | 105.0696 | C_{8}H_{14} 4-Methyl-1,5-Heptadiene                                    | Alkene   | 238,594.00 |
| 16.     | 12.47           | 221.1901 | C_{15}H_{24}O 6,10-Dodecadien-1-yn-3-ol, 3,7,11-trimethyl-            | Fatty alcohol | 132,884.67 |
| RT (min) | Observed Ion m/z | MF | Name | MC | FC |
|----------|------------------|----|------|----|----|
| 17.      | 20.45            | 263.8287 | C_{21}H_{30}O_{4} | 9,12,15-Octadecatrienoic acid, 2,3-dihydroxypropyl ester, (Z,Z,Z)- | Lineolic acid | 24,402.00 |
| 18.      | 21.75            | 288.2451 | C_{32}H_{54}O_{2} | 9,19-Cyclolanostan-3-ol, acetate, (3β)- | Cycloartanol | 185,601.00 |
| 19.      | 3.21             | 43.0106 | C_{2}H_{4}N_{2}O | Acetic acid, hydrazide | N-nitroso compound | 9,648.50 |
| 20.      | 3.40             | 130.9333 | C_{2}H_{4}O | Acetic acid, hydroxy- | Hydroxy acid | 16,192.00 |
| 21.      | 8.01             | 136.0518 | C_{6}H_{12}O_{2} | Benzeneacetic acid | Benzene | 823,393.50 |
| 22.      | 20.33            | 218.8824 | C_{11}H_{16}FNO_{3} | Benzeneethanamine, 2-fluoro-β,3,4-trihydroxy-N-isopropyl- | Organofluorine compound | 461,586.67 |
| 23.      | 21.65            | 274.2253 | C_{20}H_{34}O_{2} | Butyric acid, 6,9,12-hexadecatrienoate | No records | 120,874.00 |
| 24.      | 20.40            | 263.7774 | C_{20}H_{30}O_{2} | cis-5,8,11,14,17-Eicosapentaenoic acid | Fatty acid | 67,970.33 |
| 25.      | 14.77            | 218.7973 | C_{15}H_{24}O | cis-Z-α-Bisabolene epoxide | Sesquiterpenoid | 163,987.00 |
| 26.      | 29.61            | 224.8923 | C_{6}H_{12}O_{3}Si_{3} | Cyclotrisiloxane, hexamethyl- | Organosilicon | 37,777.00 |
| 27.      | 6.10             | 130.9737 | C_{10}H_{11}N_{2}O | dl-7-Azatryptophan | L-alpha-amino acid | 5,636.50 |
| 28.      | 27.58            | 430.3826 | C_{20}H_{40}O_{2} | dl-α-Tocopherol | Resorcinol | 308,112.50 |
| 29.      | 18.43            | 218.9230 | C_{20}H_{42} | Eicosane | Alkane | 773,942.50 |
| 30.      | 28.37            | 401.3748 | C_{30}H_{50}O_{2} | Ergost-5-en-3-ol, acetate, (3β,24R)- | Triterpenoid | 400,755.50 |
| 31.      | 16.60            | 134.1088 | C_{12}H_{18} | Geijerene | Monoterpenoid | 506,492.50 |
| 32.      | 4.79             | 68.9660 | C_{3}H_{6}O_{3} | Glycerin | Sugar alcohol | 1247,390.50 |
| 33.      | 20.35            | 263.9279 | C_{25}H_{56} | Heptacosane | Alkane | 459,191.00 |
| 34.      | 13.54            | 154.1719 | C_{16}H_{34} | Hexadecane | Alkane | 887,579.50 |
| 35.      | 2.58             | 32.0644 | H_{2}N_{2} | Hydrazine | Non-metal compound | 16,395.00 |
| 36.      | 21.65            | 218.9095 | C_{15}H_{24}O | Isoaromadendrene epoxide | Sesquiterpenoid | 87,763.50 |
| 37.      | 17.91            | 278.2969 | C_{22}H_{46}O | Isophytol | Diterpenoid | 581,608.33 |
| 38.      | 21.36            | 263.8432 | C_{22}H_{34}O_{2} | Methyl 6,9,12,15,18-heneicosapentenoate | Methyl ester | 222,155.00 |
| 39.      | 19.47            | 263.8150 | C_{18}H_{30}O_{2} | Methyl 8,11,14-heptadecatrienoate | Methyl ester | 143,481.00 |
| 40.      | 2.63             | 32.0319 | CH_{4}O | Methyl Alcohol | Alcohol | 2542,812.29 |
| 41.      | 16.70            | 218.9458 | C_{20}H_{38} | Neophytadiene | Diterpenoid | 455,672.53 |
| 42.      | 17.92            | 218.9160 | C_{16}H_{36}O | Octadecanal | Fatty aldehyde | 7,428.50 |
| 43.      | 22.38            | 340.2405 | C_{23}H_{32}O_{2} | Phenol, 2,2'-methylenebis[6-(1,1-dimethyllethyl)-4-methyl- | Diterpenoid | 98,778.00 |
Table 13. Cont.

| RT (min) | Observed Ion m/z | MF        | Name                                             | MC                    | FC        |
|---------|------------------|-----------|--------------------------------------------------|-----------------------|-----------|
| 44.     | 12.20            | 206.1665  | C_{14}H_{22}O                                    | Phenol, 2,6-bis(1,1-dimethylethyl)- | Sesquiterpenoid | 26,409.00 |
| 45.     | 17.09            | 263.7937  | C_{22}H_{31}NO_{4}                               | Phthalic acid, 4-cyanophenyl heptyl ester | Ester     | 863,842.00 |
| 46.     | 23.33            | 279.1599  | C_{33}H_{50}O_{4}                               | Phthalic acid, heptadecyl 2-propylpentyl ester | Ester     | 192,600.50 |
| 47.     | 18.14            | 279.1561  | C_{20}H_{30}O_{4}                               | Phthalic acid, heptyl pentyl ester     | Ester     | 7570,367.00 |
| 48.     | 2.96             | 31.4619   | H_{4}Si                                          | Silane                 | Non-metal compound | 14,625.00 |
| 49.     | 29.96            | 412.3726  | C_{29}H_{48}O                                   | Stigmast-4-en-3-one    | Steroid   | 315,755.67 |
| 50.     | 25.39            | 231.2112  | C_{30}H_{50}                                    | Supraene               | Triterpenoid | 784,372.00 |
| 51.     | 15.80            | 218.9575  | C_{14}H_{22}O_{2}                               | Tetradecanoic acid     | Fatty acid | 201,837.50 |
| 52.     | 7.28             | 86.0223   | C_{4}H_{7}S                                     | Thiophene, 2,3-dihydro-| Dihydrothiophene | 156,903.67 |
| 53.     | 13.54            | 218.8948  | C_{13}H_{28}                                     | Tridecane              | Alkane    | 208,627.00 |
| 54.     | 17.65            | 228.2039  | C_{14}H_{22}O_{2}                               | Tridecanoic acid, methyl ester | Methyl ester | 395,572.00 |
| 55.     | 12.99            | 157.1222  | C_{11}H_{22}O_{2}                               | Undecanoic acid        | Methyl ester | 51,909.00  |
| 56.     | 12.87            | 157.1011  | C_{15}H_{20}                                     | α-Calacorene           | Sesquiterpenoid | 30,917.33 |
| 57.     | 29.63            | 431.3858  | C_{31}H_{52}O_{3}                               | α-Tocopheryl acetate   | Triterpenoid | 199,285.00 |
| 58.     | 21.51            | 218.7617  | C_{15}H_{24}O                                   | β-Santalol             | Triterpenoid | 80,032.50  |
| 59.     | 28.98            | 414.3873  | C_{20}H_{30}O                                   | β-Sitosterol           | Triterpenoid | 833,435.33 |

Table 14. Compounds identified in leaf ethanol extracts of Turraea floribunda.

| RT (min) | Observed Ion m/z | MF.             | Name                                             | MC                    | FC        |
|---------|------------------|-----------------|--------------------------------------------------|-----------------------|-----------|
| 1.      | 28.27            | 218.8544        | C_{13}H_{20}N_{2}Si                               | 1,2-Benzisothiazol-3-amine, TBDMS derivative | Sugar     | 21,941.25  |
| 2.      | 16.77            | 130.9077        | C_{16}H_{30}O_{2}                                 | 2,15-Hexadecanedione  | Fatty acid | 8,739.00   |
| 3.      | 2.79             | 42.9883         | C_{2}H_{5}ClO                                    | 2-Chloroethanol        | Chloroethanol | 17,013.50 |
| 4.      | 17.66            | 218.9181        | C_{8}H_{16}BrNO                                  | 2-Piperidinone, N-[4-bromo-n-butyl]- | Delta-lactam | 212,874.00 |
| 5.      | 16.78            | 218.8178        | C_{13}H_{26}O                                   | 2-Undecanone, 6,10-dimethyl- | Fatty aldehyde | 331,058.75 |
| 6.      | 30.93            | 250.8218        | C_{28}H_{46}O_{2}                                | 4,4′-bi-4H-pyran, 2,2′,6,6′-tetrakis(1,1-dimethylethyl)-4,4′-dimethyl- | 13,508.50 |
| 7.      | 27.65            | 206.9513        | C_{24}H_{36}O_{2}Si                              | 4-Methyl-2,4-bis(p-hydroxyphenyl)pent-1-ene, 2TMS derivative | Bisphenol A | 25,492.75  |
| 8.      | 28.52            | 207.8478        | C_{17}H_{30}OSi                                  | 4-tert-Octylphenol, TMS derivative | Alkylbenzene | 23,331.67  |
Table 14. Cont.

| RT (min) | Observed Ion m/z | MF. Name                      | MC             | FC             |
|----------|------------------|-------------------------------|----------------|----------------|
| 9.       | 6.56             | C₆H₄O₄ 4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl- | Fatty acid     | 123,337.50     |
| 10.      | 28.19            | C₉H₂AsO₂Si₃ Arsenous acid, tris(trimethylsilyl) ester | Trialkylheterosilane | 17,467.00     |
| 11.      | 21.85            | C₁₁H₁₆FNO₃ Benzenethanamine, 2-fluoro-β,3,4-trihydroxy-N-isopropyl- | Organosilicone | 197,067.50     |
| 12.      | 28.20            | C₉H₁₈O₂Si₃ Cyclotrisiloxane, hexamethyl- | Organosilicon | 10,533.67      |
| 13.      | 18.93            | C₁₀H₁₁N₂O₂ dl-7-Azatryptophan | L-alpha-amino acid | 13,803.00     |
| 14.      | 2.87             | H₄N₂ Hydrazine | Non-metal compound | 29,112.33     |
| 15.      | 2.89             | H₃NO Hydroxylamine | Amine | 19,833.67      |
| 16.      | 17.92            | C₂₀H₄₀O Isophytol | Diterpenoid | 126,936.00     |
| 17.      | 2.59             | CH₄O Methyl Alcohol | Alcohol | 3945,937.00    |
| 18.      | 15.78            | C₁₀H₂₀O₂ n-Decanoic acid | Fatty acid | 56,292.00      |
| 19.      | 18.17            | C₁₆H₃₂O₂ n-Hexadecanoic acid | Fatty acid | 1236,320.33    |
| 20.      | 8.69             | C₁₁H₁₀ Naphthalene, 2-methyl- | Naphthalene | 16,237.00      |
| 21.      | 16.71            | C₂₀H₃₈ Neophytadiene | Diterpenoid | 212,701.60     |
| 22.      | 20.27            | C₉H₁₉NO Nonanamide | Amide | 135,588.33     |
| 23.      | 18.14            | C₂₀H₃₀O₄ Phthalic acid, heptyl pentyl ester | Ester | 4220,463.00    |
| 24.      | 19.59            | C₂₀H₄₀O Phytol | Diterpenoid | 332,925.75     |
| 25.      | 28.57            | C₂₀H₄₀O Stigmasterol | Steroid | 263,092.00     |
| 26.      | 19.68            | C₁₄H₂₈O₂ Tridecanoic acid, methyl ester | Methyl ester | 162,963.00     |
| 27.      | 28.28            | C₁₆H₄₅AsO₃Si₃ Tris(tert-butyldimethylsilylox)arsane | Ester | 23,852.50      |
| 28.      | 17.66            | C₁₂H₂₄O₂ Undecanoic acid, methyl ester | Methyl ester | 230,369.50     |
| 29.      | 28.97            | C₃₁H₅₂O₂ β-Sitosterol acetate | Triterpenoid | 330,908.00     |

Table 9 shows the results of acetone extracts of *M. azedarach*; twenty-six compounds were identified. Of these, two are classified as esters, alkanes (three), diterpenoids (two), methyl esters (two), non-metal compounds (two), organosilicons (two), and triterpenoids (two). Thirty-three compounds were identified in ethanolic extracts of *M. azedarach*, shown in Table 10. Four compounds are classified as esters, diterpenoids (three), fatty acids (three), fatty amides (three), hydrocarbons (two), ketones (two), steroids (two), triterpenoids (two), and three compounds were unclassified.

Thirty-nine compounds were identified in acetone extracts of *T. dregeana* (Table 11), most of which are diterpenoids (six), esters (four), triterpenoids (four), alkanes (three), fatty acids (two), non-metal compounds (two), steroids (two), and one compound was unclassified. Forty-three compounds were identified in ethanolic extracts of *T. dregeana* (Table 12),
with most of the compounds in the classes: diterpenoids (seven), sesquiterpenoids (five), fatty acids (four), triterpenoids (four), steroids (three), alcohols (two), fatty amides (two), and one compound was unclassified.

Acetone leaf extracts of *T. floribunda* (Table 13) had sixty compounds, of which seven are diterpenoids (seven), sesquiterpenoids (seven), alkanes (four), methyl esters (four), triterpenoids (four), non-metal compounds (three), esters (three), fatty acids (two), fatty alcohols (two), hydrocarbons (two), and three compounds were unclassified. Table 14 shows thirty compounds identified in ethanol extracts of *T. floribunda*; most of the chemical compounds belong to the chemical classes: fatty acids (four), diterpenoids (three), esters (two), methyl esters (two), non-metal compounds (two), and one compound was unclassified.

Table 15 shows forty-four compounds identified in acetone extracts of *T. obtusifolia*; chemical classes with the most chemical compounds are: fatty acids (six), sesquiterpenoids (five), alkanes (three), diterpenoids (three), triterpenoids (three), esters (two), non-metal compounds (two), steroids (two), and two compounds were unclassified. There were forty-six compounds identified in ethanolic extracts of *T. obtusifolia* (Table 16), chemical classes with the most chemical compounds: sesquiterpenoids (seven), diterpenoids (five), fatty acids (five), methyl esters (three), steroids (three), fatty alcohols (two), resorcinols (two), and five compounds were unclassified.

Table 15. Compounds identified in leaf acetone extracts of *Turraea obtusifolia*.

| RT (min) | Observed Ion m/z | MF      | Name                                                                 | MC       | FC        |
|---------|------------------|---------|----------------------------------------------------------------------|----------|-----------|
| 1.      | 15.00            | 220.182 | C_{10}H_{16}O           | (1R,2R,4S,6S,7S,8S)-8-Isopropyl-1-methyl-3-methyleneoctadecan-4-ol | Sesquiterpenoid | 126,668.00 |
| 2.      | 15.10            | 263.826 | C_{10}H_{16}O           | 1,3-Bis-(2-cyclopropyl,2-methylcyclopropyl)-but-2-en-1-one       | 2-benzopyran  | 92,518.50  |
| 3.      | 14.33            | 218.965 | C_{10}H_{16}O           | 10,10-Dimethyl-2,6-dimethylenebicyclo[7.2.0]undecan-5β-ol        | 219,693.33  |
| 4.      | 8.86             | 130.968 | C_{10}H_{16}O           | 2,4-Decadienal                                                 | Aldehyde    | 75,217.75  |
| 5.      | 16.78            | 179.1793| C_{10}H_{16}O           | 2-Undecanone, 6,10-dimethyl-                                    | Fatty aldehyde | 255,603.50 |
| 6.      | 11.98            | 202.173 | C_{10}H_{16}O           | 3,5,11-Eicosatriene                                            | Sesquiterpenoid | 56,152.67  |
| 7.      | 21.79            | 263.864 | C_{10}H_{16}O           | 8,12,16-Tetramethylheptadecan-4-ol                             | Beta-diketone | 410,582.00 |
| 8.      | 30.47            | 281.821 | C_{10}H_{16}O           | 4-tert-Octylphenol, TMS derivative                               | Alkylbenzene | 27,817.50  |
| 9.      | 14.78            | 218.8204| C_{10}H_{16}O           | 6,10-Dodecadien-1-yne-3-ol, 3,7,11-trimethyl-                  | Fatty alcohol | 206,334.00 |
| 10.     | 15.85            | 218.167 | C_{10}H_{16}O           | 7-Isopropenyl-1,4a-dimethyl-4,4a,5,6,7,8-hexahydro-3H-naphthalen-2-one | Fatty alcohol | 186,966.33 |
| 11.     | 20.00            | 263.9515| C_{10}H_{16}O           | 8,11,14-Eicosenoic acid, (Z,Z,Z)-                              | Fatty acid   | 13,480.00  |
| 12.     | 19.94            | 280.2397| C_{10}H_{16}O           | 9,12-Octadecadienoic acid, (Z,Z)-                              | Fatty acid   | 44,571.00  |
| 13.     | 29.97            | 422.3973| C_{10}H_{16}O           | 9,19-Cycloergost-24(28)-en-3-ol, 4,14-dimethyl-, acetate, (3β,4α,5α)- | Triterpenoid | 182,421.67 |
| 14.     | 16.95            | 263.819 | C_{10}H_{16}O           | Andrographolide                                                 | Butyro lactone | 235,288.00 |
| 15.     | 21.37            | 204.1875| C_{10}H_{16}O           | Azulene, 1,2,3,5,6,7,8,8a-octahydro-1,4-dimethyl-7-((1-methyljethenyl)-[1S-(1α,7α,8β,8a)]- | Sesquiterpenoid | 17,979.50  |
| 16.     | 8.67             | 142.077 | C_{10}H_{16}O           | Benzocycloheptatriene                                          | Benzenoid    | 17,979.50  |
Table 15. Cont.

| RT (min) | Observed Ion m/z | MF       | Name                                | MC          | FC          |
|----------|-----------------|----------|-------------------------------------|-------------|-------------|
| 17       | 27.85           | 218.8211 | C_{27}H_{50}O_{12}                   | Cyclotrisiloxane, hexamethyl- | Organosilicon | 19,618.33   |
| 18       | 10.01           | 130.9654 | C_{10}H_{14}N_{2}O_{2}              | dl-7-Azatryptophan | L-alpha-amino acid | 12,483.25   |
| 19       | 13.94           | 218.8738 | C_{22}H_{36}O_{2}                   | Docosene    | Fatty acid   | 40,765.00    |
| 20       | 18.43           | 263.7630 | C_{22}H_{44}                        | Eicosane    | Alkane       | 644,244.67   |
| 21       | 11.70           | 202.1715 | C_{15}H_{22}                        | Eudesmen-2,4,11-triene | Sesquiterpenoid | 186,595.60   |
| 22       | 20.31           | 263.9065 | C_{16}H_{33}NO                     | Hexadecanamide | Fatty amide | 235,968.00   |
| 23       | 20.35           | 218.7788 | C_{16}H_{34}                        | Hexadecane  | Alkane       | 444,080.00   |
| 24       | 2.59            | 32.0455  | H_{2}N_{2}                           | Hydrazine   | Non-metal compound | 27,402.00    |
| 25       | 17.91           | 263.7523 | C_{20}H_{40}O                       | Isophytol   | Diterpenoid  | 180,211.33   |
| 26       | 14.93           | 220.1819 | C_{15}H_{26}O                       | Ledene oxide-(II) | Sesquiterpenoid | 165,643.67   |
| 27       | 2.86            | 32.0231  | CH_{4}O                              | Methyl Alcohol | Alcohol   | 3308,314.78  |
| 28       | 16.70           | 218.9564 | C_{20}H_{38}                        | Neophytiadiene | Diterpenoid | 239,419.44   |
| 29       | 18.21           | 256.2402 | C_{16}H_{32}O_{2}                   | n-Hexadecanoic acid | Fatty acid | 1312,119.00  |
| 30       | 16.22           | 218.7640 | C_{21}H_{42}                        | Pentadecane | Alkane       | 703,400.00   |
| 31       | 6.40            | 130.9444 | C_{6}H_{12}O_{3}                    | Pentanoic acid, 2-hydroxy-3-methyl- | Fatty acid | 374,290.67   |
| 32       | 17.09           | 263.7686 | C_{21}H_{21}NO_{3}                  | Phthalic acid, heptyl 4-nitrophenyl ester | Ester | 403,612.00   |
| 33       | 18.14           | 279.1556 | C_{20}H_{32}O_{4}                   | Phthalic acid, heptyl pentyl ester | Ester | 4790,918.75  |
| 34       | 19.59           | 279.2999 | C_{20}H_{40}O                       | Phytol      | Diterpenoid  | 423,228.75   |
| 35       | 28.57           | 412.3719 | C_{29}H_{46}O                       | Stigmasterol | Steroid     | 467,141.50   |
| 36       | 15.79           | 185.1536 | C_{14}H_{28}O_{2}                   | Tetradecanoic acid | Fatty acid | 105,645.50   |
| 37       | 3.07            | 70.0287  | C_{2}H_{4}OS                        | Thioaetic acid | Alkylthiol | 27,616.00    |
| 38       | 17.66           | 227.2008 | C_{14}H_{30}O_{2}                   | Tridecanoic acid, methyl ester | Fatty acid ester | 449,472.00   |
| 39       | 19.68           | 218.8289 | C_{12}H_{24}O_{2}                   | Undecanoic acid, methyl ester | Methyl ester | 180,225.75   |
| 40       | 27.58           | 430.3823 | C_{20}H_{40}O                       | Vitamin E   | Resorcinol   | 262,653.50   |
| 41       | 25.67           | 420.0371 | C_{20}H_{50}O                       | α-Tocopheryl acetate | Triterpenoid | 295,293.67   |
| 42       | 29.64           | 432.3904 | C_{20}H_{50}O                       | α-Tocopherol A | Steroid | 141,624.33   |
| 43       | 28.98           | 414.3868 | C_{20}H_{50}O                       | β-Sitosterol | Triterpenoid | 999,333.33   |
Table 16. Compounds identified in leaf ethanol extracts of *Turraea obtusifolia*.

| RT (min) | Observed Ion m/z | MF | Name | MC | FC |
|---------|------------------|----|------|----|----|
| 1       | 13.98            | C_{15}H_{24}O | (1R,3E,7E,11R)-1,5,5,8-Tetramethyl-12-oxabicyclo[9.1.0]dodeca-3,7-diene Epoxide | 360.103.67 |
| 2       | 20.96            | C_{20}H_{34}O | (E)-3-Methyl-5-(1R,4aR,8aR)-5,5,8a-trimethyl-2-methylenedeacydrophenanthalene-1-ylpent-2-en-1-ol Diterpenoid | 115.266.00 |
| 3       | 21.30            | C_{15}H_{22}O | (R)-(-)-14-Methyl-8-hexadecyn-1-ol Fatty alcohol | 73.991.50 |
| 4       | 14.35            | C_{10}H_{20}O | 10,10-Dimethyl-2,6-dimethylenebicyclo[7.2.0]undecan-5β-ol | 385.059.67 |
| 5       | 17.93            | C_{20}H_{40}O | 1-Hexadecen-3-ol, 3,5,11,15-tetramethyl- Diterpenoid | 315.859.50 |
| 6       | 12.74            | C_{11}H_{16}O | 2(4H)-Benzofuranone, 5,6,7,7a-tetrahydro-4,4,7a-trimethyl- | 93.776.33 |
| 7       | 12.38            | C_{6}H_{14}O | 2-Hydroxy-1-(1′-pyrrolidiyl)-1-buten-3-one | 99.138.00 |
| 8       | 16.80            | C_{15}H_{24}O | 3,5,11-Eudesmatriene Sesquiterpenoid | 84,655.00 |
| 9       | 11.99            | C_{20}H_{40}O | 3,7,11,15-Tetramethyl-2-hexadecen-1-ol Diterpenoid | 23,305.00 |
| 10      | 12.38            | C_{21}H_{40}O | 4,8,12,16-Tetramethylheptadecan-4-olide Beta-diketone | 348,560.00 |
| 11      | 21.81            | C_{15}H_{22}O | 2-Hydroxy-1-(1′-pyrrolidiyl)-1-buten-3-one | 99,138.00 |
| 12      | 6.57             | C_{6}H_{12}O | 4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl- Fatty acid | 842,545.00 |
| 13      | 28.80            | C_{17}H_{30}O | 4-tert-Octylphenol, TMS derivative Alkylbenzene | 31,758.67 |
| 14      | 28.39            | C_{19}H_{32}O | 5-Cholestene-3-ol, 24-methyl- Steroid | 548,943.50 |
| 15      | 15.88            | C_{15}H_{24}O | 6,10-Dodecadien-1-yn-3-ol, 3,7,11-trimethyl- Fatty alcohol | 153,763.25 |
| 16      | 15.88            | C_{15}H_{24}O | 7-Isopropenyl-1,4a-dimethyl-4,4a,5,6,7,8-hexahydro-3H-naphthalen-2-one | 307,202.33 |
| 17      | 20.97            | C_{14}H_{30}O | 9,12,15-Octadecatrienoic acid, (Z,Z,Z)- Methyl ester | 923,805.50 |
| 18      | 19.49            | C_{14}H_{32}O | 9,12,15-Octadecatrienoic acid, methyl ester, (Z,Z,Z)- Methyl ester | 152,852.00 |
| 19      | 19.88            | C_{6}H_{18}O | 4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl- Fatty acid | 153,763.25 |
| 20      | 2.95             | C_{6}H_{12}O | Acetic acid, hydroxy- Hydroxy acid | 8,158.50 |
| 21      | 13.85            | C_{15}H_{24}O | Bergamotol, Z-α-trans- Monoterpenoid | 48,437.33 |
| 22      | 13.60            | C_{15}H_{24}O | Caryophyllene-oxide Sesquiterpenoid | 487,571.00 |
| 23      | 14.61            | C_{15}H_{30}O | cis-Z-α-Bisabolene epoxide Sesquiterpenoid | 177,591.67 |
| 24      | 21.81            | C_{15}H_{30}O | Cyclooctadecane, hexamethyl- Organosilicon | 22,405.75 |
| 25      | 21.81            | C_{15}H_{30}O | 2-Hydroxy-1-(1′-pyrrolidiyl)-1-buten-3-one | 99,138.00 |
| 26      | 17.67            | C_{15}H_{30}O | Dodecanoic acid, methyl ester Methyl ester | 353,733.33 |
| 27      | 11.72            | C_{15}H_{24}O | Eudesma-2,4,11-triene Sesquiterpenoid | 160,053.60 |
| 28      | 13.27            | C_{15}H_{30}O | Fumaric acid, ethyl 3,4,5-trichlorophenyl ester | 53,322.00 |
| 29      | 3.46             | C_{6}H_{10}O | Glycolaldehyde dimer Pentaose | 11,108.50 |
| 30      | 14.96            | C_{15}H_{24}O | Ledene oxide-(II) Sesquiterpenoid | 335,514.67 |
Table 16. Cont.

| RT (min) | Observed Ion m/z | MF        | Name                                           | MC    | FC               |
|---------|------------------|-----------|------------------------------------------------|-------|------------------|
| 31.     | 14.61            | 263.9254  | C_{11}H_{22}O_{6}       | Methyl 2-hydroxy-octadeca-9,12,15-trienoate | Fatty acid | 365,830.00       |
| 32.     | 2.97             | 32.0260   | CH_{3}O                | Methyl Alcohol | Alcohol        | 3178,893.00      |
| 33.     | 16.72            | 221.1896  | C_{19}H_{38}O_{3}      | Neophytadiene | Diterpenoid     | 260,778.86       |
| 34.     | 18.26            | 256.1901  | C_{16}H_{32}O_{2}      | n-Hexadecanoic acid | Fatty acid | 5461,473.67      |
| 35.     | 20.34            | 156.0941  | C_{20}H_{38}NO         | Nonanamide | Amide           | 370,402.80       |
| 36.     | 12.24            | 206.1660  | C_{14}H_{32}O          | Phenol, 2,6-bis(1,1-dimethylethyl)- | Sesquiterpenoid | 60,234.00       |
| 37.     | 18.16            | 278.1520  | C_{20}H_{40}O_{4}      | Phthalic acid, heptyl pentyl ester | Ester       | 7217,745.00      |
| 38.     | 19.61            | 278.2960  | C_{20}H_{40}O          | Phytol     | Diterpenoid     | 507,674.67       |
| 39.     | 7.29             | 130.9626  | C_{13}H_{30}NO_{2}     | Pyrrolidin-1-propionic acid | Proline    | 87,679.50        |
| 40.     | 7.28             | 133.1012  | C_{6}H_{12}ClN         | Pyrrolidine, 1-(2-chloromethyl)- | Haloalkyl  | 88,402.00        |
| 41.     | 28.60            | 412.3717  | C_{29}H_{50}O          | Stigmasterol | Steroid        | 585,313.00       |
| 42.     | 20.16            | 227.2011  | C_{14}H_{28}O_{2}      | Tetradecanoic acid | Fatty acid | 200,040.00       |
| 43.     | 14.81            | 219.9886  | C_{15}H_{30}O          | trans-Z-α-Bisabolene epoxide | Sesquiterpenoid | 242,292.25     |
| 44.     | 27.60            | 430.3830  | C_{29}H_{50}O          | Vitamin E | Resorcinol      | 309,983.50       |
| 45.     | 25.67            | 421.3605  | C_{29}H_{50}O_{4}      | α-Tocosphoro A | Steroid       | 220,431.00       |
| 46.     | 29.01            | 414.3884  | C_{29}H_{50}O_{4}      | β-Sitostanol | Triterpenoid    | 1141,657.00      |

3. Discussion

Most of the botanical extracts tested for their insecticidal activities proved to be effective repellents, feeding deterrents, and contact toxic against the *S. frugiperda* and *P. xylostella* larvae. Repellence, feeding deterrence, and contact toxicity of *E. capensis*, *T. dregeana*, *Turraea floribunda*, and *T. obtusifolia* extracts are recorded for the first time in this study. *Melia azedarach* was used as a positive control in this study as it is a well-known insecticidal plant in the Meliaceae family. The species has been proven to be an excellent insecticide against *S. frugiperda* [24–31]. In addition, *M. azedarach* extracts were found to be an effective botanical insecticide against *P. xylostella* in studies by Charleston et al. [32], Charleston et al. [12], Chen et al. [33], Chen et al. [34], Defagó et al. [35], Dilawari et al. [36], Dilawaxi et al. [37], Kumar et al. [38], Patil and Goud [39], Qiu et al. [40], Rani et al. [41], Sharma et al. [42], and Singh et al. [43].

Plant extracts with repellent activities are those with compounds that have irritating effects, causing insects to move away from them [44]. All plant extracts evaluated had repellence against the *S. frugiperda* and *P. xylostella* larvae, except for the ethanolic extracts of *T. floribunda* that had attractancy against the two tested larvae. However, there were interspecific differences as the botanical extracts were more susceptible as repellents to the *P. xylostella* larvae than to the *S. frugiperda* larvae (Tables 1 and 2). Accordingly, seven extracts displayed repellency against *P. xylostella* larvae as follows: one in class V, three in IV, and five in III. In comparison, extracts displayed repellency against *S. frugiperda* according to the following level of activity: one in class V, two in IV, and one in III. It is not surprising that *M. azedarach* extracts were found to have the highest repellent activity against both *S. frugiperda* and *P. xylostella* larvae in this study, as this plant is known to have excellent repellent and insecticidal properties against several insect pests in several studies. Interestingly, *T. dregeana* recorded the same repellence activity as *M. azedarach* against both
S. frugiperda and P. xylostella larvae. Against S. frugiperda, acetone extracts repelled 71% of the larvae (Table 1); meanwhile, against P. xylostella, acetone and ethanol extracts repelled 65% of the larvae (Table 2). Trichilia dregeana extracts in the study by Adinew [45] were found to have a highly positive protectant ability against Sitophilus zeami Motschulsky (Maize weevil), which is also a major pest of maize similar to S. frugiperda. Extracts of T. floribunda moderately repelled the S. frugiperda larvae, while E. capensis and T. obtusifolia extracts recorded the lowest repellence activity.

Plants with antifeeding activities have compounds that, once consumed, cause the insects to stop feeding and eventually die due to starvation [44]. A study by Farag et al. [46] suggested that the plant extracts with feeding deterrence activity act as a stomach poison when ingested by insects. These feeding deterrent compounds could help reduce crop damage [18]. Melia azedarach aqueous extracts, followed by T. obtusifolia (aqueous and ethanol) and T. floribunda aqueous extracts, recorded the highest feeding deterrence activity against the S. frugiperda larvae. It does not come as a surprise that Turraea species recorded high feeding deterrence activity as in the study by Chimbe and Galley [47], another species of the genus, Turraea nitolica Kotschy & Peyr., was found to be effective against Sitophilus oryzae (rice weevil) larvae. Several studies also evaluated other species of the genus Trichilia for antifeedant properties. Trichilia elegans A.Juss. [48], T. pallens C.DC. [49], T. pallida Sw. [49], and T. roka (Forskk.) Chiov. [50] were found to have antifeedant activities against S. frugiperda larvae. Surprisingly, all T. dregeana extracts used in this study inhibited more P. xylostella larval feeding than M. azedarach extracts. This is contrary to the studies by Charleston et al. [52] and Dilawari et al. [36], where M. azedarach extracts recorded the highest antifeedant properties against the P. xylostella larvae. In this study, aqueous extracts of T. obtusifolia and ethanolic extracts of E. capensis also recorded high feeding deterrence activity against the P. xylostella larvae, with feeding deterrence coefficients of 86.74 and 85.79, respectively. The repellence activity of E. capensis coincides with that in the study by Champagne [51], in which the extracts acted as growth inhibitors and were toxic to Peridroma saucia Hübner (variegated cutworm) larvae. Trichilia silvatica C.DC. extracts were reported as good antifeedants against P. xylostella larvae [52].

Aqueous extracts of E. capensis and T. floribunda caused the highest S. frugiperda larval mortality, with recorded LC50 values of 0.14 mg/kg and 0.56 mg/kg, respectively. In the current study, all extracts of M. azedarach were less toxic to the S. frugiperda larvae (with an LC50 of 707.95 mg/kg). These results are contrary to the results obtained in the study by Bullangpoti et al. [26], where M. azedarach ethanolic extracts caused high mortality against the S. frugiperda with a recorded a lower LC50 value of 1.4 g L−1. Ekebergia capensis and T. dregeana extracts caused the least mortality to the larvae. However, in the study by Rioba and Stevenson [53], two members of the genus Trichilia, T. pallens C.DC., and T. pallida Sw., were found to cause high larval mortality against the S. frugiperda larvae. Trichilia trijuga Vell. extracts were found to be toxic to the Crocidolomia binotalis (cabbage cluster caterpillar) larvae [54] and T. americana (Sessé & Moc.) T.D.Penn. was toxic to the Trichoplusia ni (cabbage looper) and Pseudaelia unipuncta (armyworm moth) larvae [10]. On the other hand, all three extracts of M. azedarach and aqueous extracts of T. obtusifolia were more lethal to the P. xylostella larvae, with LC50 values of 0.14 mg/kg and 1.78 mg/kg, respectively. Ekebergia capensis, T. dregeana, and T. floribunda extracts caused insignificant toxicity against the P. xylostella larvae. This is contrary to this present study, as higher levels (LC50 value of 691.83 and 707.95 mg/kg) of the extracts of T. dregeana were needed to kill 50% of the larvae. Trichilia emetica methanol extracts resulted in high P. xylostella larval mortality with a recorded LC50 value of 0.94 mg.m−1 in the study by Munyemana and Alberto [55]. There may be a relationship between the toxicity against the P. xylostella of Turraea species screened in this study with the study of Essoung et al. [36] and Essoung et al. [57], where T. floribunda and other Turraea species T. abyssinica Hochst., T. nitolica Kotschy & Peyr., and T. wakefieldii Oliv. extracts were toxic to Tuta absoluta (tomato leafminer) larvae. Growth inhibitory and toxicity activity of eight Trichilia species T. americana (Sesse & Mocino) Pennington, T. connaroides (Wright & Am.), T. glabra L., T. havanensis Jacq., T. hirta L., T. martiana C.DC, T.
pleeana (A. Juss.) C.DC, and *T. quadrijuga* subsp. *cinerascens* (C.DC) Pennington extracts were evaluated on *Peridroma saucia* (variegated cutworm) and *Spodoptera litura* (cotton leafworm).

In the present work, ethanol extracts yielded the highest number of chemical compounds except for *T. floribunda*, where acetone extracts yielded 60 compounds, whereas ethanol yielded 30 compounds. This coincides with the antifeedant results, as ethanol extracts had better repellence, feeding deterrence, and contact toxicity than acetone extracts. Four chemical compounds were present in acetone and ethanol extracts of all five Meliaceae species studied: methyl alcohol, neophytadiene, phytol, and β-sitosterol. The tridecanoic acid methyl ester was present in all plant extracts except in ethanolic extracts of *T. dregena*. The terpene derivatives phytol (present in all plant extracts in the current study) have been reported to have insecticidal [58] and pesticidal activities [59]. After all the chemical compounds identified in GC-MS analysis of plant extracts were classified, it was found that eight classes were common in all ethanol extracts. These were alcohols, diterpenoids, esters, fatty acids, fatty aldehydes, methyl esters, steroids, and triterpenoids. The five species’ most common classes in acetone extracts were alcohol, alkane, diterpenoid, ester, non-metal compound, organosilicon, and triterpenoid. All five plant species evaluated (either aqueous, acetone, or ethanol extracts) had repellence, feeding deterrence, and contact toxicity activity against *S. frugiperda* and *P. xylostella* larvae to some extent. The GC-MS analysis results strongly support these results as the two most well-known groups, phenols, and terpenes, known to have insecticidal and antifeedant properties, were present in all the plant extracts. *Trichilia dregena* extracts exhibited excellent repellence activity and feeding deterrence against the two test larvae as the positive control, *M. azedarach* extracts. GC-MS analysis revealed that ethanol extracts of *T. dregena* contained a high number of chemical classes that are terpenes (i.e., diterpenoid, sesquiterpenoid, triterpenoid, and steroid) and phenols (i.e., gingerdione). In acetone extracts of *T. dregena*, four terpenes were identified (i.e., diterpenoid, sesquiterpenoid, triterpenoid, and steroid), as well as four phenols (i.e., 7-hydroxycoumarin, alkylbenzene, gingerdione, and resorcinol). Chemical compound phenol, 2,2′-methylenebis[6-(1,1-dimethylethyl)-4-methyl- identified in ethanolic extracts of *T. dregena* was reported to have repellent, larvicidal, adulticidal, and oviposition deterrence activities against insects in a study by Chen et al. [60]. In studies by Curcino-Vieira et al. [61] and Tan and Luo [62], chemical compounds such as coumarins, diterpenes, flavonoids, glycosylated lignans, limonoids, monoterpenes, sesquiterpenes, steroids, and triterpenes isolated from the genus *Trichilia* were found to have insect feeding activities [63–65], and they may be toxic to insects [66,67]. *Ekebergia capensis* extracts exhibited good repellence, feeding deterrence, and contact toxicity against the test insects. GC-MS analysis revealed that ethanol extracts of *E. capensis* contained 50 compounds, of which 16 are terpenes belonging to diterpenoid, ergosterol, sesquiterpenoid, and steroid chemical classes. Conversely, acetone extracts identified thirty-three compounds, of which nine are terpenes (belonging to classes diterpenoid, sesquiterpenoid, and triterpenoid), and one is a phenol (cholesterol). The two members of the genus *Turraea, T. floribunda,* and *T. obtusifolia*, recorded minor activities in the antifeedant testing against the test insects. The presence of different chemical classes of compounds such as diterpenoids, flavonoids, limonoids, and terpenoids in some *Turraea* spp. have been associated with insecticidal activities in previous studies by Essoung et al. [56]; Ndung’u et al. [68]; Udenigwe et al. [69]; Yuan et al. [70]; Xu et al. [71]; and Zanin et al. [72]. Chemical groups other than phenols and terpenes, which have been recorded to have insecticidal, antifeedant, and insect repellent activities, have also been identified in the current study. For example, 9,12-octadecadienoic acid (Z,Z)- present in all *T. obtusifolia* extracts was reported to have insect-repellent properties in the study by Paulpriya et al. [59].
4. Materials and Methods

4.1. Antifeedant and Insecticidal Analysis

4.1.1. Sample Preparations

Leaves were dried under shade at room temperature (25 °C), then ground into a fine powder using an electric grinder. Extraction was carried out according to the procedures of Warthen et al. [73], with some slight modifications. Ten grams of each powdered sample were extracted in 100 mL of water, acetone, and ethanol separately for 72 h at room temperature. After extraction, the solutions were filtered through Whatman No.40 filter paper, and the solvents were removed using a rotary evaporator. Methanol was used to dissolve the organic residues, where 0.5% and 1.0% solutions were prepared for each sample.

4.1.2. Insects Selection and Rearing

*S. frugiperda* and *P. xylostella* second instar larvae strains (between 3 to 7 days old) were obtained from the Agricultural Research Council- Vegetable and Ornamental Plants (ARC- VOPI) in Pretoria, where they were reared, and the information on their age was also obtained.

4.1.3. Repellence Bioassay

The repellence bioassay of the plant samples was assessed using Standard Method Number 3, described by McDonald et al. [74], with some modifications. Repellence tests were conducted using Whatman No.40 filter papers as opposed to the strips of aluminum foil laminated to 40 lb. kaft paper, as described in the study by McDonald et al. [74]. The substrata were prepared by cutting a filter paper in half and placing it in 0.5% and 1.0% solutions of the plant extracts for 1 min, and then allowing it to air dry at room temperature overnight. Each half of the treated disk was attached lengthwise, edge to edge, to an untreated half-disk of the filter paper with cellulose tape and placed in a petri dish (Figure 1A,B). To avoid cannibalism in a petri dish, five larvae of each insect were placed in the middle of each filter paper circle and covered. For five hours, at hourly intervals, individuals that settled on each half of the filter paper disk were counted, and the experimental design was run once. The average of the counts was converted to express the percentage repulsion (PR) as follows:

\[
PR = 2 \times (C - 50)
\]  

where \( C \) is the percentage of insects on the untreated half of the disk. Positive percentage repulsion values expressed repellence, and negative percentage repulsion values expressed attractancy. The averages of the percentage repulsion were then assigned different classes using the scale as follows [75] (Table 17):

| Class | Percentage Repulsion |
|-------|-----------------------|
| 0     | >0.01 to <0.1         |
| I     | 0.1–20                |
| II    | 20.1–40               |
| III   | 40.1–60               |
| IV    | 60.1–80               |
| V     | 80.1–100              |

Table 17. Scale used to assign different classes of percentage repulsion values [75].
4.1.4. Feeding Deterrence Test

The potency of the feeding deterrence effect of plant leaf extracts against *S. frugiperda* and *P. xylostella* was determined by using the leaf disk bioassay. Maize and cabbage leaves were used as the test food for *S. frugiperda* and *P. xylostella*, respectively. The leaves were soaked in either water only (control leaf disks K) or in a 1% plant extract solution of aqueous, acetone, and ethanol separately (treated leaf disks E). The leaf disks (Figure 2A,B) were allowed to air dry at room temperature for about 30 min and weighed before they were presented to the larvae in petri dishes for 24 h, during which they were serving as the sole food source. The feeding behaviour of the larvae was recorded under three different conditions: (1) pure food, which comprised two control leaves (KK) (control test); (2) food with one control leaf (K) and one treated leaf (E) (choice test); and (3) food with two treated leaves (EE) (no choice test). After 24 h, the remaining leaves were reweighed, and mean percentages of feeding deterrence (FD) were calculated for each plant extract based on the weight of leaves before and after the tests. FD was calculated as follows:

\[
FD = \frac{(C - T)}{C + T} \times 100
\]  

(2)

\(C = \text{weight of control leaves; } T = \text{weight of treated leaves.}\)

After the FD values were calculated, three coefficients for the feeding deterrent activity from all three tests for each plant extract were calculated as follows [75]:

1. Absolute deterrence coefficient

\[
A = \frac{(KK - EE)}{KK + EE} \times 100
\]  

(3)

2. Relative deterrence coefficient

\[
R = \frac{(K - E)}{K + E} \times 100
\]  

(4)

3. Total deterrence coefficient

\[
T = A + R
\]  

(5)

Values of the total deterrence coefficient (A) served as an index of the feeding deterrence activity which was expressed on a scale between 0 and 200. Plant extracts with a total deterrence coefficient of between 150–200 were marked ++++; 100–150, +++; 50–100, ++, and 0–50 + [75].

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Figure 1. (A) Treated half and untreated half of filter paper with *S. frugiperda* larvae. (B) Treated half and untreated half of filter paper with *P. xylostella* larvae.
A

B

Figure 2. (A) Maize leaf disk for the feeding deterrence assay against S. frugiperda after 24 h. (B) Cabbage leaf disk for the feeding deterrence assay against P. xylostella after 24 h.

4.1.5. Topical Application Bioassay

The topical treatment assay tested the direct contact toxicity of the plant extracts, using Standard Method Number 1 described by McDonald et al. [74] with some modifications. Plant extract solutions of 0.5% and 1% were used for this test. Larvae were chilled for 10 min instead of being anesthetized with carbon dioxide in a Buchner funnel for about 5 min, as described in the study by McDonald et al. [74]. The immobilized larvae were picked up individually with forceps. Ten microliters of each plant extract solution were applied to the dorsum of each larva. Five larvae were treated at each dose and then transferred to a petri dish. After 24 h, the larvae were examined, and those that did not respond to gentle touch were considered dead. The number of dead larvae was recorded, and corrected mortality rates were calculated using the formula:

\[
\text{Percent larval mortality} = \left( \frac{\text{number of dead larvae}}{\text{total number of treated larvae}} \right) \times 100
\]

Probit analysis [76] was used to analyse concentration-mortality data.

4.2. Gas Chromatography-Mass Spectrometry (GC-MS) Analysis

GC-MS analysis was used to identify chemical compounds present in all five selected Meliaceae species. The patterns of the mass spectra fragmentation and their retention indices were compared with the ones stored in the computer library to identify the chemical components found in the plant extracts [77].

4.2.1. Sample Preparation

One gram of powdered samples was extracted in acetone and ethanol for 24 h at room temperature. The extracts were centrifuged at 13,000 \( \times g \) rpm for 10 min at 10 °C. Whatman No.1 filter paper was used to filter the solutions, and a rotary evaporator was used to evaporate or concentrate the solvents. One milliliter of methanol was used to dissolve the organic residues. The solutions were transferred into dark amber vials using syringe filters.

4.2.2. Gas Chromatography-High-Resolution-Time-of-Flight Mass Spectrometry (GC-HRTOF- MS) Analyses

The samples were analysed on the GC-HRTOF- MS system equipped with an Agilent 7890A gas chromatograph (Agilent Technologies, Inc., Wilmington, DE, USA). This system operates in high-resolution, equipped with a Gerstel MPS multipurpose autosampler (Gerstel Inc., Germany) and capillary column (Rxi- 5 ms- 30 m × 0.25 mm ID × 0.25 µm). For each plant extract, a volume of 1 µL was injected in a spitless mode. The program was started at 70 °C, held for 0.5 min, ramped at 10 °C/min to 150 °C, held for 2 min, ramped...
at 10 °C/min to 330 °C, and held for 3 min for the column to bake out. The samples were analysed at an MS data acquisition rate of 13 spectra/s, m/z range of 30–1000, electron ionization at 70 eV, ion source temperature was set at 250 °C, and the system extraction frequency was set at 1.25 kHz. Solvent blanks were also used to observe for contamination and impurities. Compounds were identified by matching the generated spectra with the NIST, Mainlib, and Feihn reference library databases on ChromaTOF-HRT® (LECO Corporation, St. Joseph, MI, USA). Subsequent retention time alignment, matched filtration, peak picking, detection, and matching were conducted on a data station equipped with the ChromaTOF-HRT® software (LECO Corporation, St. Joseph, MI, USA). Parameters adopted for processing included a signal-to-noise ratio (S/N) of 100, a similarity match above 70%, and data presented in Tables 7–16 representing only compounds occurring at least twice in triplicate injections. The collected GC-HRTOF-MS dataset was converted to mzML format using the LECO ChromaTOF-HRT software and then processed (peak picking and alignment) on the XCMS open-source tool.

5. Conclusions

Meliaceae species are abundant large tree species, so they would be suitable to supply very large-scale production of botanical insecticides; thus, their potential use in controlling insect pests is promising. This study provides potential evidence that further confirms the findings of many previous reports that Meliaceae members can be used as repellents, insecticides, and antifeedants to control S. frugiperda and P. xylostella insects, two of the most important agricultural pests that mostly attack crops which form part of the primary staple food. All extracts of the five evaluated species indicated repellence to the S. frugiperda and P. xylostella larvae, except for the ethanolic extracts of T. floribunda, which showed attraction to both the larvae. All extracts evaluated exhibited feeding deterrence to the S. frugiperda and P. xylostella larvae, except for the ethanol extracts of T. floribunda, which had inert antifeeding compounds. Aqueous extracts of E. capensis and T. floribunda were more toxic to the S. frugiperda larvae, and all extracts of M. azedarach were more toxic to the P. xylostella larvae. The GC-MS analysis results strongly support the insecticidal activities of the evaluated extracts as the two most well-known groups, phenols and terpenes, known to have insecticidal and antifeedant properties, were present in all the plant extracts. Therefore, this further corroborates the recorded traditional uses of these plants as insecticides and antifeedants. Plants that have indicated the most promising results are E. capensis, T. floribunda, and T. obtusifolia. These plants should be subjected to further quantitative phytochemical studies focusing on isolating and identifying active compounds rather than simply screening the plant extracts for insecticidal and antifeedant activity, as plant extracts may contain many compounds along with those that may cause negative side effects and toxicity. Further research should also be conducted regarding their safe use and non-target effects, and to determine if they can maintain yield at comparable levels to synthetic pesticides. Field trial evaluations of insecticidal and antifeedant plant extracts may also need to be undertaken to assess their impact on crop yield and damage and evaluate insect resistance issues in comparison to synthetic pesticides. This study’s results are significant as they will generate new and alternative natural products that can help improve biological effectiveness, lower residuals, increase nontoxic agricultural products, and decrease their presence in foods.

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