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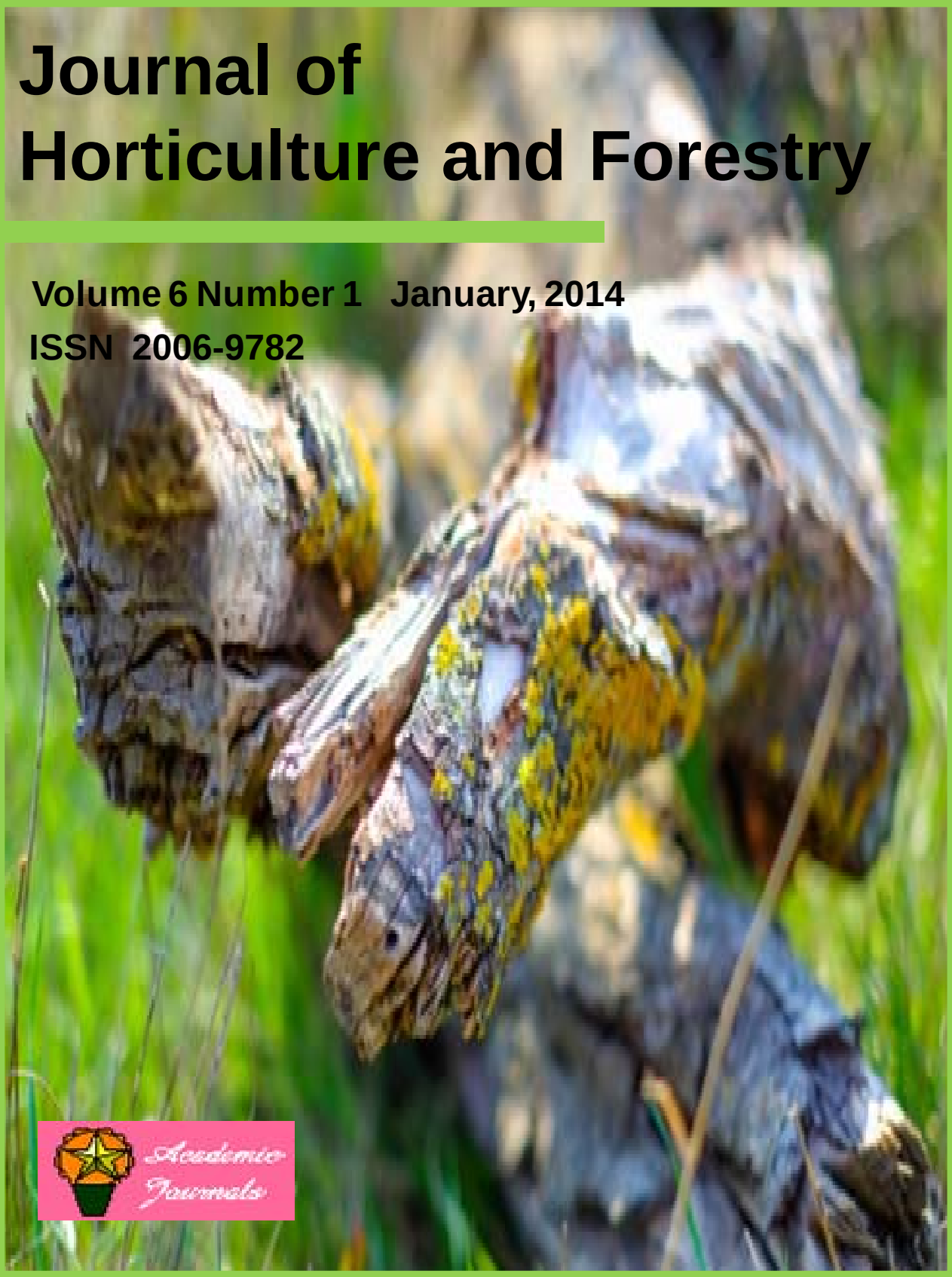

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Pitout JDD, Church DL, Gregson DB, Chow BL, McCracken M, Mulvey M, Laupland KB (2007). Molecular epidemiology of CTXM-producing Escherichia coli in the Calgary Health Region: emergence of CTX-M-15-producing isolates. Antimicrob. Agents Chemother. 51: 1281-1286.

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Journal of Horticulture and Forestry

Full Length Research Paper

Comparative evaluation of the essential oil composition from the leaves and flowers of *Hyssopus officinalis* L.

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Accepted 17 September, 2013

The chemical constituents of essential oil were obtained from the fresh leaves and flowers of *Hyssopus officinalis* L. (Lamiaceae) by hydro distillation method analyzed by gas chromatography and gas chromatography mass spectrometry. Hydro distillation method was used to extract the essential oil. Thirty-five compounds were identified, accounting for 92.13% of the total oil with 0.75% (v/w) oil yield in the essential oil of the leaves. The main constituents of the essential oil were Iso pinocamphone (38.47%), Pinocomphone (13.32%), n-decane (8.67%) and Pinocarvone (5.34%). Thirty-six compounds were identified, accounting for 98.68% of the total oil with 1.38% (v/w) oil yield in the essential oil of the flowers. The main constituents of the essential oil were Iso pinocamphone (40.25%), Pinocomphone (14.92%), n-decane (8.63%) and Pinocarvone (6.76%).

Key words: *Hyssopus officinalis* L., iso pinocamphone, volatile oil, gas chromatography mass spectrometry (GC/MS).

INTRODUCTION

Hyssop (*Hyssopus officinalis*, synonym *Hyssopus decumbens*) is a herbaceous plant of the genus Hyssopus native to Southern Europe, the Middle East, and the region surrounding the Caspian Sea. *H. officinalis* L. is an evergreen Shrub growing to 0.6 m (2ft) by 0.6 m (2ft in). This plant can be grown for ground cover when spaced about 45 cm apart each way. It is hardy to zone 7. It is in leaf 12-January. It is the in flower of July to September, and its seeds ripen from August to October. The flowers are hermaphrodite (have both male and female organs) and are pollinated by Bees. Hyssop is a brightly colored shrub or subshrub that ranges from 30 to 60 cm in height. The stem is woody at the base, a number of straight branches are grown from it. Its leaves are lanceolate, dark green in color, and from 2 to 2.5 cm long. During the summer, the plant produces bunches of pink, blue, or, more rarely, white fragrant flowers. These give rise to small oblong achenes. The species as a whole is resistant to drought, and tolerant of chalky, sandy soils. It thrives in full sun and warm climates. The plant is commonly used by beekeepers to produce a rich and aromatic honey. Herb hyssop leaves are used as an aromatic condiment. The leaves have a lightly bitter taste due to its tannins, and an intense minty aroma. It is used moderately in cooking due to its intensity. The herb is also used to flavor liqueur, and is part of the official formulation of Chartreuse. The plant also includes the chemicals thujone and phenol, which give it antiseptic properties (Van Wyk and Michael, 2004). A strongly aromatic flavor, somewhat like a cross between sage and mint, it has fallen out of flavor in the recent years. It has a positive effect when used to treat bronchitis and respiratory infections, especially where there is excessive mucous production (Chevallier, 2001). Hyssop can irritate the mucous membranes, so it is the best given after an infection has peaked, when the herb's tonic action

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encourages a general recovery (Chiej, 1984). The leaves and flowering tops are antiseptic, antitussive, astringent, carminative, diaphoretic, emmenagogue, expectorant, pectoral, sedative, stimulant, stomachic, tonic and vasodilator. It is commonly used as an aromatic herb and medicinal plant (Mills and Bone, 2005). The plant can be harvested when in full flower and dried for later use. A tea made from the leaves is used in the treatment of flatulence, stomach-aches, upper respiratory tract infections, coughs in children etc. A poultice made from the fresh herb is used to heal wounds. The essential oil is used in aromatherapy. This oil should not be used on the people who are highly strung as it can cause epileptic symptoms. The essential oil should not be used internally except under professional supervision.

Hyssop can be grown as a dwarf hedge, it responds well to trimming in the spring. The growing plant attracts cabbage white butterflies away from brassicas. Another report says that hyssop attracts cabbage white butterflies and should not be grown near cabbages. An essential oil from the leaves is antiseptic and also used in perfumery and as a food flavoring (Huxley, 1992). It has a particularly fine odor and is much valued by perfumers. Average yield of the oil is about 0.6%. Yields from the blue-flowered variety are circa 1 to 1.5% of essential oil, the red-flowered variety yields about 0.8%, whilst the white-flowered form yields 0.5% of essential oil. The plant was formerly used as a strewing herb (Huxley, 1992) and is also used in pot-pourri. A tea made from the leaves is useful for controlling bacterial plant diseases. The essential oil of hyssop is widely used for food, pharmaceutical and cosmetic industries throughout the world. Therefore, it is very important to know the chemical characteristics of the oil for economic use and enhanced performance of the end products. This study was carried out to determine the essential oil of *H. officinalis* (L.) (Lamiaceae) collected from wild in the Khalkhal, Southeast Ardabil Province in Iran. The essential oil of *H. officinalis* plant has been studied in Iran and other countries but the chemical composition of the essential oil of *H. officinalis* has not been determined in Khalkhal, Iran. In the present work we have analyzed the chemical composition of the leaves and the flowers of *H. officinalis* L. that grow in Khalkhal and then the results were compared with various origins in other countries.

MATERIALS AND METHODS

Plant material collection and isolation of their essential oil

The leaves and flowers of *H. officinalis* were obtained from Khalkhal in Ardabil Province from 1843 m height, at full flowering stage in June 2012. The samples were cleaned in the shade condition to prevent volatility of the plant material constituents and to keep the natural color of the sample fixed. Then they were air-dried and powdered using a milling machine and kept in a cool dry place until ready for extraction of the essential oil. Afterwards, essential oil was extracted from 150 g of t he powdered sample using hydro-distillation method with the help of Clevenger set for three hours. Following, the oil samples were dried using anhydrous sodium sulfate and kept in sterile sample tubes in refrigerator. The oil yields of leaves and flowers were calculated.

Analysis of essential oil

Gas chromatography

GC analysis was performed using a model of HP-439 gas chromatograph equipped with column CP Sil. 5CB in 25 meters length, internal diameter of 0.25 mm and film thickness 0.39 µm. Oven temperature was between 60 and 220°C at a rate of 7°C slope per minute. The injector temperature was 280°C and detector (FID) temperature was 270°C while the carrier gas was helium.

Gas chromatography/mass mass spectrometry

The chromatograph gas set was attached to a Mass Spectrometry to analyze and identify the combinations forming the essential oil, Model Hewlett Packard-5973 was used for this purpose. The conditions of analysis and specifications of the GC/MC set were as follows: Capillary column HP 5MS in 60 meters length, internal diameter of 0.25 mm and layer thickness of 0.25 µm, thermal program of oven (3 min) in 60°C, then 60 to 220°C with a 6°C slope per minute, then 3 min in 220°C, the temperature of place of injection 280°C, gas conveying helium, the speed of gas move 1.0 milliliter per minute, the ratio of fission 1 to 43, the rate of injection 0.1 µl, temperature of the reservoir of ionization 230°C, ionization mode EI, with an Ionization energy of 70eV. The series of normal Alkans C8-C17 were also injected to the set under the same condition with that of essential oil injection to calculate Restrictive Index (RI) of components of essential oil. The RI of components of the sample was calculated by using a computerized program. Finally, the components of essential oil were identified by comparing the mass spectrums obtained using the existing standard mass spectrums at electronic library of Wiley 2000 existing in Absolution software of GC/Ms set and calculation of standard RI in accordance with C_8-C_{17} Alkanes and by comparing them with the existing standard figures in references (Adams, 2001).

RESULTS AND DISCUSSION

The identified combinations of essential oil, RI, and quantitative percentage of the compounds from seeds and flowers are listed in Table 1. The study of the analysis of *H. officinalis* L. essential oil under investigation showed that thirty-five compounds, accounting for 92.13% of the total oil with 0.75% (v/w) oil yield were identified in the essential oil of the leaves. The main constituents of the essential oil were *Iso* pinocamphone (38.47%), Pinocomphone (13.32%), n-decane (8.67%) and Pinocarvone (5.34%) with 65.8% constituting the highest percentage of essential oil. Also from thirty-six compounds, accounting for 98.68% of the total oil was identified in the essential oil of the flowers with 1.38% (v/w) oil yields. The main constituents of the essential oil were *Iso* pinocamphone (40.25%), Pinocomphone (14.92%), n-decane (8.63%) and Pinocarvone (6.76%) with 70.56% constituting the highest

Table 1. Combinations identified in the essential oil of *Hyssopus officinalis* L.

Compound name	(RI)	Leave (%)	Flower (%)
α-thujene	928	0.32	0.59
α-pinene	935	1.14	1.27
Sabinene	978	0.97	0.28
β-pinene	987	1.78	1.64
Myrcene	992	-	0.61
n-decane	997	8.67	8.63
δ-3-carene	1012	0.85	1.23
P-cymene	1029	0.45	0.68
Limonene	1035	0.47	0.33
1,8-cineole	1038	0.56	1.69
(Z)-β-ocimene	1045	1.27	0.95
(E)-β-ocimene	1054	0.75	0.48
Linalool	1107	0.53	0.67
Camphor	1136	0.65	0.42
Pinocomphone	1158	13.32	14.92
Pinocarvone	1165	5.34	6.76
Iso pinocamphone	1178	38.47	40.25
Terpinen-4-ol	1192	1.78	1.89
α-terpineol	1203	0.25	0.34
Myrtenol	1212	1.75	1.65
Carvon	1236	0.27	0.44
Cumin aldehyde	1245	0.68	0.45
Piperitone	1263	1.65	1.34
Thymol	1289	0.45	0.89
Carvacrol	1306	2.54	2.97
Eugenol	1348	0.89	0.54
β-bourbonene	1375	1.63	1.27
Methyl eugenol	1396	0.21	0.46
α-gurjunene	1417	0.39	0.34
β-caryophyllene	1425	0.32	0.41
α-humulene	1466	0.18	-
Allo aromadendrene	1467	0.67	0.24
Germacrene D	1482	0.57	0.68
Elemol	1537	0.53	0.78
Spathulenol	1568	-	0.16
Caryophyllene oxide	1582	0.48	0.67
α-bisabolol	1675	1.35	1.76
Total		92.13	98.68

The indexes of restrictive have been calculated by injecting the mixture of normal hydrocarbons (C8-C17) to HP-5MS column.

percentage of essential oil. The quality and quantity of the materials forming *H. officinalis* L. essential oil had some differences and similarities with the cases reported in other regions. The studies of essential oils ingredients for botanical populations with ecological and genetic differences can be of great importance in identifying the variety of essential oils inside the population of species. It seems that the geographical origin of *H. officinalis* L. greatly influences the oil quality. The essential oil of *H. officinalis* L. plant has been widely studied in Iran and other countries but the chemical composition of the essential oil of *H. officinalis* grown in Ardabil province is yet to be determined. The present study, results showed the major oil constituents of the leaves and the flowers of *H. officinalis* L. from Ardabil province, Iran were *Iso* pinocamphone and Pinocomphone. In a study they were the chemical compositions of essential oil of aerial part of *H. officinalis* obtained from the hydrodistillation. The chemical composition of essential oil was determined using gas chromatography/mass spectrometry (GC/ MS).

Thirty nine components were identified in *H. officinalis* oil that include thymol (18.95%), fl-bisabolol (10.62%), carvacrol (7.73%), n–Dodecan (5.23%), caryophyllene (4.96%), ortho–acetanisol (4.72%), camphor (3.47%), cumin aldehyde (3.22%) and spathulenol (3.02%) as major components in essential oil (Dehghanzadeh et al., 2012). In a research the plants of *H. officinalis* ssp. *officinalis* genotype raised through seeds sown in early December 1997 flowered in May 1998. The essential oil yields obtained upon hydrodistillation of above ground parts, harvested in May, were 0.25% on fresh herbage weight basis and 1.18% on dry herbage weight basis.

The GC and GC–MS analysis of the essential oil led to the identification of 21 compounds representing 95.6% of the oil, having seven monoterpene hydrocarbons (32.3%), five oxygenated monoterpenes (60.5%) one phenol (0.2%) and six sesquiterpene hydrocarbons (0.35%). The major constituents of the camphorous odoured oil were pinocamphone (49.1%) >β-pinene (18.4%) >isopinocamphone (9.7%) (Garg et al., 1999). The oil obtained by hydrodistillation from the aerial parts of *H. officinalis* L. subsp. *angustifolius* (Bieb.) Arcangeli from Turkey was analyzed by GC–MS. Thirty-four components were characterized, representing 91.0% of the total components detected. The major constituents were identified as pinocarvone (36.3%), pinocamphone (19.6%), *β*-pinene (10.6%), 1,8-cineole (7.2%) and isopinocamphone (5.3%) (Ozer et al., 2005). The essential oil from *H. officinalis* grown in Spain was examined by GC and GC/MS. The oil was characterized by a high content of 1,8-cineole (52.89%) and β-pinene (16.82%) as the main components (Vallejo et al., 1995).

In a comparison study of Hyssop (*H. officinalis* L.), native to the Caucasus, North Western Iran, Turkish North Eastern Black Sea region, and Southern Anatolia, it is a highly valued medicinal plant. The experiment was conducted to find the effect of harvesting at different blooming stages of the plant on fresh and dry herbage yield, dry leaf yield, essential oil content, and essential oil components.

In total, twenty-nine components were identified in hyssop essential oil by GC/MS. Isopinocamphone was the dominating component (47.9 to 51.4%) in all analyzed oil samples. The results clearly demonstrated that oil contents are seriously affected by the environmental conditions and stage of blooming, with the highest oil yield and oil contents at the post-blooming stage (Kizil et al., 2008). In a study the essential oil was obtained (0.66%) from the aerial plant parts of wild *H. officinalis* L., collected around Petnjica (Montenegro). It was examined by a combination of GC and GC/MS. Fifty-seven constituents were found, out of which the major ones were methyl eugenol (38.3%), limonene (37.4%) and β-pinene (9.6%) (Gorunovic et al., 1995). In a research the essential oils were obtained from wild growing *H. officinalis* L. ssp. *aristatus* (Godr.) Briq. At two stages of development, they are found to be very similar in composition with 1,8-cineole (48.2 and 39.6%), isopinocamphone (16.3 and 29.2%) and β-pinene (11.4 and 39.6%) as major constituents. The essential oil obtained commercially from cultivated *H. officinalis* contains larger amounts of isopinocamphone (40.2%), pinocamphone (10.3%), and β-pinene (14.2%), but no traces of 1,8-cineole (Tsankova et al., 1993). The essential oils from different parts of hyssop (*H. officinalis* L.) were investigated by means of GC and GC-MS at three developmental stages of plant. 15 other terpenes were detected besides the main components pinocamphone, camphor and β-pinene, that included isopinocamphone, α and β-phellandrene, germacrene D, and some derivatives of myrtenol. The sesquiterpene alcohol hedycaryol was found to be converted to elemol during GC and MS analysis. As compared with the essential oil content (0.03 to 0.16% of the fresh plant material), the glycosidic bound volatiles were present in lower concentrations (0.01 to 0.06%).

The glycosidic fraction was hydrolysed by means of Pectinol C and β-glucosidase yielding among others octan-3-ol, linalol, cis-nerolidol, benzyl alcohol, phenylethanol, eugenol and o-vanillin. The bicyclic terpenes myrtenol and verbenol could only be detected in small amounts as glycosides of the leaves. This fact gives reason for doubt about a direct connection between the glycosidic bound volatiles and the biogenesis of the essential oil components in hyssop (Schulz and Stahl-Biskup, 1991). Three forms of hyssop *H. officinalis* L., f. *cyaneus* Alef. f. *ruber* Mill, and f. *albus* Alef. exist in the wild of Yugoslavia that were multiplied and cultivated. The *cyaneus* form, characterized by its blue flowers, yielded between 4.9 and 5.8 tonnes of fresh plant material per hectare, and essential oil in yields ranging from 0.65 to 0.75%. The pink-flowered *ruber* form and the white flowered *albus*, respectively, yielded 3.9 to 5.1 tonnes/ha and 4.5 to 6.5 tonnes/ha of fresh plant material in yields of 0.7 to 1.1% and 0.6 to 1.0%. The chemical analysis of different batches of oils produced shows that they are mainly composed of *cis* and *trans*-pinocamphone, and pinocarvone, together with lesser amounts of germacrene D, bicyclogermacrene, elemol and spathulenol (Chalchat et al., 2001). Three Italian strains of hyssop wildly grown in different natural habitats of the Abruzzi region (Central Italy) and classified as *H. officinalis* L. subsp. *aristatus*, were characterized on the basis of their essential oil composition. The oils were obtained by steam distillation of the fresh aerial parts of the plants and analyzed by GC and GC/MS. Thirty-three compounds were identified in this connection. Relevant differences in the quantitative composition were observed among the oils so that the existence of three different chemotypes could be realized.

In particular, one of the strains was characterized by high contents of myrtenol (32.6%) and β-pinene (193%), another contained β-pinene (24.7%) and 1,8-cineole (231%) as the main components, while the third was very rich of methyl eugenol (439%) and limonene (15.9%).

Whereas the latter two strains were similar in composition of oils from Spain and Montenegro, respectively, the former possessed a very unusual oil composition (Piccaglia et al., 1999).

In a study the leaves gathered near Khandiza (Uzbek SSR) in 1986 yielded 0.34% essential oil, that is, only half of the quantity expected by literature. Its composition was investigated by GC and chromato-mass spectrometry, and is tabulated in comparison with that of Zotov (1974). The main constituents were identified as pinocamphone (71%), β-pinene (8.6%) and 1,8-cineole (6.4%). Sabinene content was only 1.3%, with no limonene or isopinocamphone (respectively 16.3, 13.8 and 12.1% according to Zotov) (Dzhumaev et al., 1990). The chemical composition of *H. officinalis* (Lamiaceae) essential oil grown in southeastern Spain was analyzed by GC-MS.

The study is focused on chemical heterogeneity of different oil batches and their extraction yield due to the high relevance of this species in the world market, cultivated under irrigation and non-irrigation conditions and with different harvesting dates.

All essential oil samples have two main terpene compounds which are pinocamphone and *iso*-pinocamphone, accounting for approximately 35 to 40% of the total oil contents. Other relevant compounds were identified, with *β*-pinene, which accounted for 10 to 17% contribution to the total composition, standing out. Significant differences between their volatile compositions have been observed between treatments, being limonene, (E)-*β*-ocimene, pinocarveol, *α*-pinene and *β*-phellandrene the compounds that contributed most to discrimination.

It was also observed that the irrigation period is the most favorable for the cultivation of hyssop in this region, especially for batch 7 which gives the highest extraction yield and the best EO quality (Moro et al., 2011). A study was carried out to determine the essential oil of *H. officinalis* (L.) (*Lamiaceae*) collected from the wild of Southeast Anatolian, Turkey.

Chemical compositions of hydrodistilled essential oils obtained from hyssop leaves were analyzed by GC-MS. It was determined that hyssop essential oil contained *iso*pinocamphone (57.27%), (-)-β-pinene (7.23%), (-)-terpinen-4-ol (7.13%), pinocarvone (6.49%), carvacrol (3.02%), *p*-cymene (2.81%) and myrtenal (2.32%) as its major components (Kizil et al., 2010). The composition of *H. officinalis* L. essential oil was analyzed by GC and GC/MS. The main components of the oil were cis-pinocamphone (42.9%), trans-pinocamphone (14.1%), germacrene-D-11-ol (5.7%) and elemol (5.6%) (Mitic and Dordevic, 2000).

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REFERENCES

Adams RP (2001). Identification of essential oil components by gas chromatography mass spectroscopy. Illinois Allured Publication Corporation.

Chalchat JC, Adamovic D, Gorunovic MS (2001). Composition of Oils of Three Cultivated Forms of *Hyssopus officinalis* Endemic in Yugoslavia: f. albus Alef. f. cyaneus Alef. And f. ruber Mill. J. Essent. Oil Res. 13(6):419-421.

Chevallier A (2001). Encyclopedia of Medicinal Plants. Dorling Kindersley Publishing Australia. 336 p.

Chiej R (1984). The Macdonald Encyclopedia of Medicinal Plants. London, Macdonald & Co., P. 274.

Dehghanzadeh N, Ketabchi S, Alizadeh A (2012). Essential Oil Composition and Antibacterial Activity of *Hyssopus officinalis* L. Grown in Iran. Asian J. Exp. Biol. Sci. 3(4):767-771.

Dzhumaev KhK, Zenkevich IG, Tkachenko KG, Tsibul'skaya IA (1990). Essential oil of the leaves of *Hyssopus seravschanicus* from South Uzbekistan. Chem. Nat. Comp. 26(1):101-102.

Garg SN, Naqvi AA, Singh A, Ram G, Kumar S (1999). Composition of essential oil from an annual crop of *Hyssopus officinalis* grown in Indian plains. Flav. Fragr. J. 14(3):170-172.

Gorunovic MS, Bogavac PM, Chalchat JC, Chabard JL (1995). Essential Oil of *Hyssopus officinalis* L., Lamiaceae of Montenegro Origin. J. Essent. Oil Res. 7(1):39-43.

Huxley A (1992). The New RHS Dictionary of Gardening.

Kizil S, Hasimi N, Tolan V, Kilinc E, Hakan Karatas H (2010). Chemical Composition, Antimicrobial and Antioxidant Activities of Hyssop (*Hyssopus officinalis* L.) Essential Oil. Not. Bot. Hort. Agrobot. Cluj. 38(3):99-103.

Kizil S, Toncer O, Ipek A, Arslan N, Saglam S, Saglam KhM (2008). Blooming stages of Turkish hyssop (*Hyssopus officinalis* L.) affect essential oil composition. Acta Agric. Scand. 58(3):273-279.

Mills S, Bone K (2005). The Essential Guide to Herbal Safety. Philadelphia, Elsevier Churchill Livingstone. P. 376.

Mitic V, Dordevic S (2000). Essential oil composition of *Hyssopus officinalis* L. cultivated in Serbia. Facta universitatis. Phys. Chem. Technol. 2(2):105-108.

Moro A, Zalacain A, Mendoza JH, Carmona M (2011). Effects of Agronomic Practices on Volatile Composition of *Hyssopus officinalis* L. Essential Oils. Mole. 16(5):4131-4139.

Ozer H, Sahin F, Kilic H, Gulluce M (2005). Essential oil composition of Hyssopus officinalis L. subsp. angustifolius (Bieb.) Arcangeli from Turkey . Flav. Fragr. J. 20(1):42-44.

Piccaglia R, Pace L, Tammaro F (1999). Characterization of essential oils from three Italian ecotypes of Hyssop [*Hyssopus officinalis* L. subsp. aristatus (Gordron Briq.]. J. Essent. Oil Res. 11(6):693-699.

Schulz G, Stahl-Biskup E (1991). Essential oils and glycosidic bound volatiles from leaves, stems, flowers and roots of *Hyssopus officinalis* L. (lamiaceae). Flav. Fragr. J. 6(1):69-73.

Tsankova ET, Konaktchiev AN, Genova EM (1993). Chemical Composition of the Essential Oils of Two *Hyssopus officinalis* Taxa. J. Essent. Oil Res. 5(6):609-611.

Vallejo MCG, Herraiz JG, Pérez-Alonso MJ, Velasco-Negueruela A (1995). Volatile Oil of *Hyssopus officinalis* L. from Spain. J. Essent. Oil Res. 7(5):567-568.

Van Wyk V, Michael W (2004). Medicinal Plants of the World. P. 177.

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Effectiveness of botanical formulations in vegetable production and bio-diversity preservation in Ondo State, Nigeria

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The study was conducted in the farming communities of Akure North and South Local Government Areas of Ondo State, Nigeria using pre-tested questionnaire/interview schedule, Key Informant Interview (KII), Focus Group Discussions (FGDs) and observation technique to generate data on: the types of vegetables grown, the major pest species, farmers control method in the field with emphasis on plant-based formulations and farmers' perceived efficacy of the plant botanical formulation on field crop pests. The data were analysed and results presented with descriptive statistics. Results indicate that *Telferia occidentale* (Ugwu) ranked first among vegetable grown for food (85%) and income generation followed by *Amaranthus hybridus* (African spinach) and Okra in that order. The major field pests identified were leaf borers (*Dysdercus superstitiosus*), webbers (*Sylepta derogate*), leaf hoppers (*Zonocerus variegatus*), sting bug (*Aspavia armigera*), weevils, leaf caterpillar (*Psara bipunctalis*) and flea beetles (*Podagrica* spp.). The most prominent among the materials used in the preparation of some of the identified botanical formulations are *Azadirachta indica* (Neem) leaves, *Piper guineense* (Black pepper), and *Nicotiana tobaccum* (tobacco). These plants were combined together in the preparation of botanical formulations to prevent and/or control pest in the field. It was ascertained from our FGDs that 75.8% of the farmers were of the opinion that indigenous control methods were as effective as synthetic pesticides. Vegetable farmers in the study area were found to create habitat for insect/bird predators as insect pest control strategy. It is evident from the result that the critical challenge of almost all the farmers was inability to estimate what proportion the ingredients used in plant-based formulations should be combined. As a result, standardized techniques of preparation, bio-safety and environmental guideline for efficacy should form important consideration in formulating botanicals for pest control methods.

Key words: Indigenous knowledge, vegetables, insect pests, botanical formulations, farmers.

INTRODUCTION

Vegetables are of invaluable nutritional value with considerable potentials for ameliorating some of the world's most widespread and debilitating nutritional disorders, birth deters, mental and physical retardation, weakened immune systems and blindness if sufficient quantities are available to the people in the right form, place and price (Ijarotimi et al., 2003). In addition to health significance of vegetable consumption, income

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earned from vegetable production has been identified as important contributor to household welfare, especially female headed households in Nigeria. Akinrinola (2009) stated that vegetable production contributed between 33 and 37% of family income among peri-urban vegetable farmers in 2008 production season and is a veritable source of consumption smoothening during off-season.

Vegetable production in Nigeria is predominantly subsistence and is characterized by cyclic deficits and poverty prompted by unreliable rainfall patterns, declining soil fertility and pest disease infestation (DFID, 2002). The latter however, constitutes one of the greatest challenges to increased vegetable production. In specific terms, insect pest infestations accounts for 20 to 60% pre-harvest vegetable losses (Sithanntham et al., 2003).

Although, the use of synthetic pesticides have been promoted in the Nigerian agriculture for the past 2 decades, vegetable farmers are yet to align the practice into their pest management system, owing to the subsistence nature of production and high poverty levels (Okunlola, 2007). They depend mainly on indigenous knowledge through the use of plant botanical formulations to mitigate the effect of insect pest damage on the farm (Perrin and Phillips, 2006). The indigenous knowledge system (IKS) is very important to the rural poor, vulnerable and marginalized population. More importantly, the high costs of synthetic pesticides and associated toxicity risks discourage vegetable farmers to integrate it into their pest management system (Schwab et al., 1995; Theunissen, 1995; Canhilal et al., 2006).

The fact that subsistence farmers in the tropics use indigenous knowledge (IK) methods to manage insect-pest infestation and the noble promise for the development of suitable, simple, natural and environmental friendly pesticide products call for scientific improvement and packaging of existing IK base and practices. Despite the enormous potential inherent in plant based indigenous pest control, the practices have remained largely under investigated with limited intervention and resources committed.

Studies in Nigeria have identified several indigenous plant based pest management options used for the control of field and storage pest. Adedire and Lajide (1999) studied the effect of some plant extracts on the toxicity and oviposition deterrence of cowpea storage pest *Corymbia maculate.*

Onifade (2000) examined the antifungal effect of *Azadirachta indica* on *Colletrichum lindemuthianum* Aduloju (2000) focused on the use of aqueous plant extracts in the control of field insect pest and Ofuya et al. (2005) affirmed that powders of Eugenia aromatic controlled the pest of stored cowpea seeds.

In another twist, Ofuya and Olowo (2006) investigated the fumigant toxicity of four volatile botanical oils to *Callosobrunchus maculatus* and submitted that it effectively controlled the pest their findings were corroborated by Okunlola (2007) and Ofuya and Longe (2009) when they separately reported that the botanical formulations effectively controlled both stored and field insect pests.

In sum, these findings showed that botanical formulations reduced pest infestations by ≥ 50% and increased crop yield by ≥ 60% compared to orthodox control (Okuku, 2002; Aduloju, 2000; Folorunso, 2004; Ogunjobi and Ofuya, 2007). Thus, in order to enhance improved vegetable production (thereby enhancing consumption of adequate quantity of micro nutrients) and alleviate poverty among rural poor in the peri-urban centers, the plant based IK of insect pest management have to be properly documented, scientifically rationalized standardized, for registration at a later date. It is against this backdrop that this research was conducted as an inventory study to document farmers' IK on management of key field pest.

Furthermore, the study documented farmers and the associated key field insect pests and their pest control methods in specific term, the study aimed to:

1. Identify major vegetable crops grown, their socio economic importance and harvest;
2. Examine major vegetable insect pests problems and their control methods in the field and
3. Highlight the plant based pest management options and their efficacy as control methods among vegetable farmers.

METHODOLOGY

The study was conducted in the farming communities of Akure North and Akure South Local Government Areas of Ondo State, Nigeria as shown in Figure 1. Ondo State is one of the six states in the South-West zone of Nigeria. The State is located in the forest zone with bi-modal rainfall pattern. The temperature ranges from 21 to 29°C with a high relative humidity. The annual rainfall varies between 1150 and 2000mm in the Northern and Southern parts, respectively. The state is endowed with luxuriant vegetation and pockets of swamp (Fadama) land located in different local government authorities in the State. These features provide a favorable environment for production of both cash and food crop. More importantly, pocket of fadama plots in the state supports the growth of different types of vegetables, especially during the dry season.

Data collection method

The study used both primary and secondary data sources. The primary data were collected through the use of pre-tested questionnaire/interview schedule, key informant interview (KII), focus group discussions (FGDs) and observation techniques (OT). The questionnaire served as a guide to the interview schedule, KII and FGDs. The survey instrument was designed to capture: (a) information on respondents' socio-economic data (b) types of vegetables grown, acreage, yield and losses due to pest (c) major pest species and farmers control method in the field with emphasis on plant-based formulations and (d) farmers' perceived efficacy of the indigenous control methods and (e) specimen of individual plant species known to have pesticidal properties on field crops pest were collected, identified and authenticated by experts from the Department of Crop Soil and Pest Management, the Federal University of Technology, Akure, Nigeria.

Also plants that farmers perceived to be nest for birds/insect

Figure 1. Ondo State Map.

predators that feed on vegetable pest were identified, the types of birds/insect predators they attracts were also collected. The questionnaire was pre-tested so as to ensure that respondents' have clear understanding and able to provide appropriate answers to issues contained in line with the objectives of the study.

Sampling techniques

Two Local Government Authorities (LGAs), Akure South and Akure North were purposively selected. In addition, fadama sites (wet land) located in Ayedun, Ago Alaye and Olode communities in Akure South LGA and Bolude camps, Bankemo, Ayadi and Loda communities in Akure North LG were also purposively selected. The selection was based on their proximity to the state capital, and the location of fadama sites which make vegetable production prominent and profitable than other local authorities in the state. In order to obtain a representative sample, 200 vegetable farmers were selected and interviewed based on the population of vegetable growers from the various fadama sites. This was distributed as follow: 25 from Ayedun, 30 from Ago Alaye, 38 from Olode, 40 from Bolude camp, 20 from Bankemo, 27 from Ayadi and 20 from Loda.

Data analysis

Data collected were analysed using descriptive statistics.

RESULTS

This section presents the findings of the study and discussed the implications of the research outputs. A total of two hundred respondents were interviewed, out of the respondents, 70% were females. The age of the respondents ranges between 25 and 60 years (Mean = 37.2 years). Their primary occupation was farming and it was subsistence in nature. The respondents' farming experience ranged from 5 to 40 years (mean 8 years). Majority of the respondents (75%) had primary education and only 10% had no formal education. A further analysis of respondents revealed that 80% of them were household heads owning farms and out of these 65% were female as shown in Table 1.

The significance of female headed households dominating vegetable production in the study area may not be unconnected with the view that vegetable production is a low income generating venture; hence most men are not favorably disposed to its cultivation as noted by Adebola (2008). This traditional belief may have contributed to small scale nature of vegetable production which has been particularly left in the hand of females using traditional production methods.

Major vegetable grown, their socio-economic importance, acreage and harvest

The result in Table 2 showed the varieties of vegetable grown in the study area and all were categorized as follows: Leafy vegetables (*Amaranthus hybridus*, *Corchorus olitorius*, *Telferia occidentale*, *Celosia argentea,*

Table 1. Demographic characteristics of vegetable farmers.

S/N	Socio-economic characteristics	Frequency	Mean value
	Age distribution		
	≤20 years	5	
	21 – 30	20	
A	31 – 40	35	38.7
	41 – 50	25	
	51 - 60	10	
	>60	5	
	Gender distribution	**%**	
B	Male	30	
	Female	70	
	Occupational distribution	**%**	
C	Farming	75	
	Trading	20	
	Artisan	5	
	Farming experience		
	< 10 years	15	
D	10 - 20	35	28.6
	21 - 30	25	
	31 - 40	20	
	>40	5	
	Educational distribution	**%**	
E	No formal education	10	
	Primary education	75	
	Secondary education	15	
	Gender of household head	**%**	
F	Male	35	
	Female	65	

Source: Field Survey, 2007.

Basella alba, Solanum nigrum; fruit vegetables (*Lycopersicon esculentum*, *Capsicum* spices, *Solanum melongena*, *Hibiscus esculenta*, *Cucumis melo*) and seed vegetables (*Phaseolus vulgaris*, *Arachis hypogea*, *Vigna unguiculata*, *Cucurbita pepo*). Leafy vegetables were most grown (77.8%) followed by fruit vegetables (8.7%) and seed vegetables (3.5%). Ugwu (*T. occidentale*), African spinach/amaranth (*A. hybridus*), Jute (*C. olitorius*) and okra (*H. esculenta*) were the most important vegetables grown in the study area. Ugwu ranked first among vegetable grown as food (85%), followed by African spinach, Ugwu, and Okra in that order were the most important vegetable grown for income generation (75%) (Table 2). Ugwu contributed the highest (between 55 and 49%) to households' income and amaranths contribute 15 to 25%. These vegetables were grown on an area ranging from 1000 to 1800 m^2. Crop yield from within this hectare varies from 0 to 200 kg/ha. It was anticipated that a hectare should produce between 120 to 350 kg. This discrepancy was due majorly to pest damages/losses and vagary rainfall pattern. From the FGDs, it was ascertained that the former however contributed a very significant proportion on the loss.

Vegetable pest problem and their control methods

As shown in Table 3, the major field pests identified were leaf borers (*Dysdercus superstitiosus*), webbers (*Sylepta derogata*), leaf hoppers (*Zonocerus variegatus*), sting bug (*Aspavia armigera*), weevils, leaf caterpillar (*Psara bipunctalis*), flea beetles (*Podagrica* spices). In *A. hybridus*

Table 2. Major vegetable grown, their socio-economic importance, acreage and harvest/loss.

S/A	Item	Frequency		
A	Major vegetable grown	%		
	Leafy vegetable	77.8		
	Fruit vegetable	8.7		
	Seed vegetable	3.5		
B	Socio-economic importance	Vegetable		
	Food	*Telferia occidentale* (85%)		
	Food and income	*Telferia occidentale*, African spinach, Okro (75%)		
C	Vegetable	Contribution to household income (%)		
	Telferia occidentale	49 - 55		
	Amaranths	15 - 25		
	Okra	7 - 10		
	Jute	3 - 6		
D	Vegetable	Area cultivated (ha)	Average yield/ha (kg)	Loss (kg)
	Telferia occidentale	1.3 – 1.8	200	150
	Amaranths	1.0 – 1.3	80	70
	Okra	1.0 – 1.1	60	60
	Jute	1.0 - 1.05	50	70

Source: Field Survey, 2007.

Table 3. Ranking of pest infestation on respondents farm.

Type of crop	Type of pest		Ranking
A. hybridus	Leaf borer	*Dysdercus superstitiosus*	1st
	Webbers	*Sylepta derogatus*	2nd
	Grasshopper	*Zonocerus variegatus*	3rd
	Sting bug	*Aspavia armigera*	4th
	Weevils	*Gasterodisus rhomboidalis*	5th
	Leaf caterpillar	*Psara bipunctalis*	6th
C. argentea	Webbers	*Sylepta derogatus*	1st
	Leaf borers	*Dysdercus superstitiosus*	2nd
	Leaf hoppers	*Zonocerus variegates*	3rd
	Weevils	*Lixus camerumuss*	4th
	Caterpillars	*Hymunia recurvalis*	5th
C.olitorus	Flea beetle	*Podagrica sp*	1st
	Leaf worm	*Acraea Terpsichore*	2nd
	Leaf hopper	*Zonocerus variegates*	3rd

Source: Field Survey 2007

field, leaf borers, Webbers, leafhoppers, sting bug, weevils (*Gasterodisus rhomboidalis*) and leaf caterpillars were the most problematic and ranked the highest field pest in the studied area. In *C. argentea* field leaf hoppers were found to be most notorious pest, also leaf borer and webbers were found to constitute major constraint to production. Leaf borers were key problem to 48.3% of the respondents while Webbers, leaf worms (*Acrae terpischore*), leaf hoppers and grasshoppers were problems to 25.2, 15.5 and 11% of the respondents, respectively. The pest problem emerged mostly during the rainy season.

Table 4. Plant products used to prepare the botanical pesticide formulation to control field pests.

S/N	NAME of plants (English, Local and/or Scientific name)	Mode of preparation to get the formulation and its application
1.	Diospyros affinin, *Anamirta cocculus*, *P. guineense*	The leaves of these plants are grinded, soaked in water for twenty four hours or more, after which the mixture is filtered and sprayed to act as repellant and or poison to vegetable insect-pest
2.	*Azadirachta indica*, *Cycas circinalis*, Cymbopogon and *Nicotiana tobaccum*	The leaves of *Cycas circinalis*, Cymbopogon and tobacco are parboiled and soaked for some time. After this, the mixture is filtered and kept for between 2 and 4 days, before being used. The solution produces repugnant odour that repells insect pest.
3.	*Azadirachta indica*, *Piper* guineense and *Carica papaya*	The leaves of these plant species are soaked in water and boiled for some time. Thereafter, the mixture is filtered and kept for 5 days. After the time, the filtrate is sprayed on the field.
4.	Tobacco leaves/powder with red pepper fruit and neem leaves	The leaves of neem leaves and tobacco together with red pepper fruits are sun-dried, grinded separately soaked in water in an air tight container. After 3 days the mixture is filtered and sprayed to crops.
5.	Carica papaya unripe fruit, back and leaves, Neem leaves and *Piper guineense*	Two handful of carica papaya backs are taken and soaked in a container for three days until the colour of the solution becomes greenish-yellow. Then, the leaves of neem and Piper-guineense are added to the solution and boiled for one hour. The resulting solution is later applied to crops in the field.
6.	Wood ash	The ash is put in a cloth bag, tied to the end of plant stock and by the beating the bag, the ash sprinkled on the crops.
7.	*Artocarpus heterophyllus*	Extracts from *Artocarpus heteroplyllus* is mixed with wood ash and spread on the vegetable field to trap insect pest attacking vegetable.

Source: Field Survey 2007.

This is the period when the crops are in the productive or vegetative stages, which is the stage necessary for good yield. However, during the dry season, leaf borers, webbers, leaf eating caterpillars and flea beetles, weevils, and leaf hoppers play significant roles in defoliating the leaves of vegetables.

The botanical formulations and efficacy of their control among vegetable farmers in Nigeria

In bid to mitigate the damaging effect of pests on the vegetables, farmers used variety of means, ranging from planting some indigenous plants that harbor birds/insect predators which feed on the dominant vegetable pests, using specific plant part, whole plant or animal product ash. Plants used in the field included *A. indica* (Neem plant), *Piper guineense* (black pepper), Diospyros affinin (persimmon), *Anamirta cocculus (*Fish berry*)*, *Ananas comosus* (pineapple), *Cycas circinalis* (Queen sago), *Cymbopogon* spp.(lemon grass), *Artocarpus heterophyllus* (Jackfruit). Neem leaves, red pepper (*Capsicum* spp), tobacco (*Nicotiana tobaccum*), and *Carica papaya* (pawpaw leaves) these plants were combined together in the preparation of botanical formulations to prevent and/or control pest in the field. Table 4 presents inventory of different botanical pesticide products formulated by farmers.

The most prominent among the materials used in the preparation of some of the identified botanical formulations are *A. indica*, *P. guineense*, and tobacco leaves. In addition to the aforementioned materials, wood ash is also a common botanical product used among vegetables farmers. Vegetable farmers in the study area were found to create habitat for insect/bird predators in their insect pest control strategy. Predatory wildlife such as bats, birds, gliders, predatory insect (sugar gliders) were found to consume large variety of insects as shown in (Table 5).

Apart from creating habitat for insect pest predators, under story plants increase the effectiveness of shelterbelts, improve soil fertility and reduce erosion, thus improving farm productivity. It was ascertained from our FGDs that 75.8% of the farmers were of the opinion that

Table 5. Species of birds and the insect they consume.

Bird species	Insect consumed
Ibis	Grasshoppers, caterpillars, beetle larvae
Honey eaters	Scale insect, ants, flies
Fairy-wirens	Caterpillars, beetles and ants
Thrushes	Weevils and larvae
Cuckoos	Caterpillars

Source: Field Survey 2007.

indigenous control methods were as effective as synthetic pesticides. A very small proportion (4.3%) had their indigenous control method not effective. The remaining proportion did not provide the estimated rating although they were using plant botanicals formulations for the control of field insects/pests.

DISCUSSION

The results indicated that vegetable farmers in the South west Nigeria grow among other vegetables leafy vegetables in small plots primarily for sale and the crops were mostly attacked by field pest that damage the vegetative part of the crops. These pests attack the leaves and inflict much injury by making small round holes in them, thereby reducing, the leaf area which affects plant assimilation and leaf surface for photosynthesis and consequently economic loss due to reduced yield (Ogbalu and Ekweozor, 2002; Ogbalu et al., 2005; Akinlosotu, 1983; Egwuatu, 1982). This significantly reduced crop harvest vis-à-vis yield vis-à-vis income. The fact that vegetables are grown primarily for sale especially by female headed households implied that the crops have great implication on their welfare and food/nutrient security.

Results have revealed that 75.8% of the respondents were using plant-based control method on the field making it an important control method among vegetable farmers, especially in traditional agriculture where majority of the farmers do not have sufficient income to meet the large cost of synthetic pesticides.

It is evident from the result that the critical challenge of almost all the farmers was inability to estimate in what proportion the ingredients used in plant-based formulations should be combined. This failure could be attributed to the fact that (a) varied amount of plant parts were used in the preparation of their formulations, (b) No common standardized method of preparation (c) Lack of specific time of treatment/application of prepared botanical formulation (d) Different preparation time before application (e) No unified application rates of the same type of formulation to the same crop and (f) Use of same type of prepared plant-based formulation to treat different types of pests. The field observations revealed that farmers depended mostly on sight-seeing and guess work to estimate the amount of material taken and the level of concentration for a specific plant based pesticide formulation. In most cases, attainment of a definite color was regarded as having reached a required concentration. Under the current practice, these plant-based formulations will have a diverse efficacy at a given time even to the same farmer.

Thus, in absence of specific amount taken, allocated time and method of preparation coupled with no standard application method and rates, ranking of the effectiveness and efficiency of any botanical formulation may be undermined.

Conclusion

The findings from the study have revealed that vegetable farming is the main economic activity of most female headed households, who majorly operate on meso-scale and grow leafy vegetables. The major field pests of these crops were leaf borer, leaf hopper, webber, sting bug, weevils, caterpillar and flea beetles.

The IK based botanical formulation of vegetable farmers in South-west Nigeria varied with mixture of the following plant parts: *D. affinin*, *A. cocculus*, *P. guineense*, *C. papaya, Capsicum spp*., *A. heterophyllus*. These IK based pesticides were used as repellent, poison and or attractants. Farmers' formulation however is devoid of specific and appropriate preparation and layout, which subject them to varied efficacy and make their rating to be compromised. As a result, standardized techniques of preparation, bio-safety and environmental guideline for efficacy should form important consideration in formulating IK based pest control methods.

REFERENCES

Adedire CO, Lajide L (1999). Toxicity and oviposition deterrency of some plant extracts on cowpea storage bruchid, *Callosobruchus maculatus* fabricius – J. Pl. Dis. Prot. pp. 106, 647, 653.

Aduloju SO (2000). Evaluation of some aqueous plant extracts for the control of cowpea and okra field insect pests. M. Agric. Tech. Thesis, The Federal University of Technology, Akure, Ondo State, Nigeria. P. 57.

Akinlosotu TA (1983). Destructive and beneficial insects associated with vegetables in South West Nigeria. Trop. Hort. 6:217-228.

Canhilal RG, Carner GR, Griffin RP (2006). Life history of the squash vine borer, *Mellitia cucurbitae* (Harris) (Lepidoptera: Sessiidae) in South Carolina. J. Agric. Urban Entomol. 23:1-16.

DFID (Department for International Development) (2002). better livelihoods for poor people: the role of agriculture. Issues. Fuller-Davies Ltd. 1 Palace street, London, U.K., P. 23.

Egwuatu RL (1982). Field trial and Systemic and Contact insecticides for the control of *Podagria uniforma* and *P. Sjostedti* (Coleoptera: Chrysomelidae) on okra. Tropical pest management 28(2):115 – 212.

Folorunso DO (2004). Aspects of ecology and control of podagrica species attacking okra, Abelmoschus esculentus Moench in Nigeria. Ph.D Thesis, The Federal University of Technology, Akure, Ondo State, Nigeria. P. 80.

Ijarotimi OS, Eleyinmi AF, Ifesan BOT (2003). Evaluation of the nutritional status of adolescents in institutionalised secondary schools in Akure, Nigeria. Food Agric. Environ. 1(3, 4):64-68.

Ofuya TI, Longe, OO (2009). investigation into fumigant effect of Eugenia aromatica dust against *Callosobrunchus maculatus* (Fabricius). Inter. J. Crop Sci. 1(1):44-49.

Ofuya TI, Olotuah OF, Akinyoade DO (2005). Efficacy of Eugenia aromatica (Baill.) powders prepared at different times in the control of *Callosobruchus maculatus* (Fabricius) infestation of stored cowpea seed. Proceedings of the 1st Annual Conference, School of Agriculture and Agricultural Technology; The Federal University of Technology, Akure, Nigeria. pp. 1-4.

Ofuya TI, Olowo VO (2006). Fumigant Toxicity of four volatile botanical oils to *Callosobrunchus maculatus* (Fabricius) (Coloeptera:Bruchidae). Proceeding of the 2nd annual conference of the Federal University of Technology, Akure, Ondo State, Nigeria. pp. 56-59.

Ogbalu OK, Amachree EI, Amifor PN, Ben-Kalio G (2005). The distribution of insect fauna of cultivated vegetables of the Niger Delta, Nigeria. Appl. Trop. Agric. 9:1-6.

Ogbalu OK, Ekweozor IKE (2002). The distribution of okra flea beetles on three varieties of okra in traditional farms of the Niger Delta. Trop. Sci. 42:52-56.

Ogunjobi SO, Ofuya TI (2007). Field comparison of aqueous neem seed extract and a synthetic insecticide for reducing post-flowering insect attack in cowpea *Vigna unguiculata* (L.) Walp. In a southern Guinea Savannah of Nigeria. In proceeding of the Akure-Humboldt Kellog/3rd SAAT annual conference: Medicinal Plants in Agriculture: The Nigerian Experience edited: Onibi GE, Agele SO, Adekunle, VAJ, Olufayo MO. pp. 60-63.

Okuku IE (2002). Effects of Bruchid *Callosobruchus macalatus* (F.) (Coleoptera: Bruchidae) infestation on the food value of cowpea (*Vigna unguiculata* (L.) Walp.) and bambara nut (*Vigna subterranean* (L.) Verdc.) seeds Ph.D Thesis, The Federal University of Technology, Akure, Ondo State, Nigeria. P. 158.

Okunlola AI (2007). Insect Pests Of Three Leaf Vegetables In Southwestern Nigeria and their Control in Sole and Mixed Cropping Systems Using Aqueous Plant Extracts, Ph.D Thesis, The Federal University of Technology, Akure, Ondo State, Nigeria.

Onifade AK (2000). Antifungal Effect of *Azadirachta Indica* A. Juss. Extracts on *Colletotrichum lindemuthianum*. Global J. Pure Appl. Sci. 6(3):425-428.

Perrin RM, Phillips ML (2006). Some effects of mixedcropping on the population dynamics of insects. J. Entomol. Exper. Appl. 24(3):585-593.

Schwab AI, Jager I, Stoll G, Gorgen R, Prexler – Schwab S , Altenburger R (1995). Pesticides in Tropical Agriculture: Hazards and alternatives. PAN, ACTA. Trop. Agro Ecol. No. 131.

Sithanntham SCM, Matok KA, Nyarko KVS, Reddy G Sileshi, Olubayo F (2003). Occurrence of insect pests and associated yield loss on some African Indigenous Vegetables Crops in Kenya. Afr. Crop Sci. J. 10(4):281-310.

Theunissen J (1995). Effect of Intercropping white cabbage with clovers on pest infestation and yield. Entomol. Exper. Appl. 74(1):82-86.

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