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EVALUATION OF UNORTHODOX PREPARATIONS AND THEIR COMPARATIVE EFFICACY RELATIVE TO ORTHODOX INSECTICIDES AGAINST HOUSEHOLD INSECTS IN LAGOS

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A B S T R A C T

Various insecticides including industrially compounded orthodox and mixed-up or single concentrate unorthodox (Otapiapia) formulations are used for controlling household insects in Lagos. Empirical information on the use of these formulations by Lagos residents and their efficacy is scanty. This study was consequently conducted to determine the use of unorthodox (Otapiapia) and orthodox formulations in Alimosho Local Government Area (LGA), Lagos and evaluate their efficacy against *Anopheles gambiae, Musca domestica* and *Periplaneta americana* using standard laboratory bioassays. For Otapiapia use, 150 structured questionnaires were administered to Alimosho LGA residents and the Otapiapia available in markets within the LGA were purchased to identify those used as insecticides. Unsexed *Anopheles gambiae* (0 – 2 d), *M. domestica* (0 – 3 d) and *P. americana* (adult) were exposed to various concentrations of selected Otapiapia (GO-90) or each of 13 orthodox formulations in standard air-tight glass cages. The LC_{50} values of each test formulation were computed. The results show that 72 % of respondents use Otapiapia instead of orthodox formulations because it is cheaper and effective, and most respondents use Sniper (35.30 %) and GO-90 (15.30 %). Based on computed 15 min-LC_{50} values, GO-90 was the most effective of all test formulations against *An. gambiae* (10.72 μlL^{-1}) and *M. domestica* (15.51 μlL^{-1}) while Baygon demonstrated higher efficacy against *P. americana* (13.42 μlL^{-1}) relative to other formulations. The GC-MS analyses show that the major constituents in GO-90 by volume are Naphthalene (19.03 %), Cyclododecane (11.48 %) and Tetradecane (10.34 %). Test unorthodox formulations showed comparable efficacy relative to orthodox insecticides.

Keywords: Household insects, unorthodox preparations, orthodox insecticides, bioassay.

INTRODUCTION

The control of nuisance insects using chemicals has become the norm in rural and urban settlements alike. These chemicals may be termed orthodox (OIs) or unorthodox insecticides (UIs) depending on their mode of preparation, packaging and extent of usage. The conventional insecticides compounded using a combination of two or more synthetic compounds especially under well supervised and standardized industrial settings are termed orthodox insecticides. These insecticides are commonly neatly packaged in pressurized aerosol cans and atomizer-fitted covers or in economy large-sized cans and dispensed into spray guns for application. In conformity with the requirements of the National Agency for Food and Drugs Administration and Control (NAFDAC) (NAFDAC, 2005) these orthodox insecticides have well defined modes of application and operation, and they have clearly spelt out content. In contrast, the unorthodox insecticides come in mostly unbranded packages and may take the brand name of a well-used insecticide. They are often not in pressurized cans and are available in plastic containers with or without proper content labels. They

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may also be insecticide concentrates dispensed into small plastic containers, a development that has arisen due to the growing popularity of entrepreneurial activities and government current emphasis on the establishment and development of Small and Medium Enterprises (SMEs). These insecticides are locally referred to as Otapiapia, denoting their quick-action nature. Examples include Sniper, ABi, Go-90, Nopest, Indocide, Lara force, Rambo Rambo, Pestoff, Legacy, Mulvap, New dawn, DDforce, Pestox, Misty-Jom and so on.

In using this Otapiapia, the insects targeted act as carriers of several pathogenic organisms which activity results in human and animal diseases. Mosquito (*Anopheles gambiae*), Housefly (*Musca domestica*) and Cockroach (*Periplaneta Americana*) are among the most encountered and with devastating diseases they cause. Coupled with their nuisance value, each of these insects rank high serving as vectors of diseases. *Anopheles* is the vector for the malaria parasite, *Plasmodium* spp causing malaria responsible for over 5 million infant death and high toll of man-hour losses. *Musca domestica* and *Periplaneta americana* are respectively responsible for spreading many pathogenic micro-organisms such as *Shigella*, *Vibrio cholera*, *Cryptosporidium*, *Entamoeba* etc causing enteric diseases. These alimentary diseases also cause high mortality in epidemic situations (Oyewole *et al*., 2010; Nouctcha and Anumudu, 2011; Omudu and Aluor, 2011). The control of the vectors of these diseases is therefore justifiable. The quest for control of the insect vectors has led many rural and urban folks to use cheap and readily available compounds such as the Otapiapia. The wide and indiscriminate use of Otapiapia in Nigeria is well known as is in Alimosho Local Government (ALG) Area of Lagos State, Nigeria. However, the perception of users of Otapiapia on its uses and its efficacy have neither been determined nor documented. Furthermore, the justification for the use of the Otapiapias instead of the OIs in terms of insecticidal efficacy is not known. The foregoing underscores the need for the present study. The study was conducted to determine the perception of otapiapia users on its efficacy, and generate a checklist of the ones in ALGA, Lagos and characterize the chemical constituents of the prominent Otapiapias.

MATERIAL AND METHODS

Location for administration of questionnaires and conduct of bioassays: Markets in ALG Area of Lagos State served as the location where questionnaires were administered. The LGA is the largest Local Government Area in Lagos State. Alimosho Local Government area is a sub-urban formally part of Ikeja division of Lagos State. It has an estimated population of 1,319,517 inhabitants who are mainly traders, artisans and civil servants. Bioassays were conducted in the Central Research Laboratory, Faculty of Science, Lagos State University, Ojo, Lagos under ambient laboratory temperature and relative humidity.

Test insect species: *Anopheles gambiae*, *Musca domestica* and *Periplaneta americana* were used respectively for bioassays to determine the efficacy of each test insecticide or preparation in the laboratory. Insects were maintained as previously described by Denloye *et al.* (2004, 2009). The *An.gambiae* and *M. domestica* used in the studies were reared in the laboratory of Lagos State University. The test *P. americana* were collected from homesteads and acclimated in the laboratory for ≥ 14 days before exposure to test formulations. Only adult *P. americana* were used for the exposures.

Perception and market sampling for insecticides: The perception of ALG residents on the use of insecticides was evaluated using structured questionnaires randomly administered on 150 respondents living in Ikotun, Igando, Isheri-Olofin, Egbeda and Iyana Ipaja respectively to extract information on their knowledge, attitude towards the use and actual usage of formulations, with particular reference to Otapiapia. Various insecticide samples were procured from vendors in four major markets in ALGA namely – Egbeda, Ikotun, Igando, Iyana-Ipaja for a compilation of names of the unorthodox insecticides on sale and to test them against insect species.

Test insecticides: A total of 14 insecticide samples were tested namely, Raid Flying Insect Killer, Raid multipurpose insect killer, Baygon, GO-90 ("Otapiapia"), Gongoni Tripple Action, Good Knight Flying Insect Killer, Good Knight MultiInsect Killer, Killit Flying and Crawling Insecticide, Mobil Insecticide, Mortein Power Guard Roach Killer, Mortein Power Guard, Rambo Green and Rambo insecticide.

Efficacy of Insecticide samples against *An. gambiae*, *M. domestica* and *P. americana*: Adults of *An gambiae* or *M. domestica* aged 0 – 2 day old were used for formulation exposures as described in previous studies using aluminium sided glass cages that served as fumigation chambers. Each cage measured 0.5 X 0.5 X 0.5 m. Adult *P. americana* of unknown age already acclimated in the laboratory were similarly exposed to insecticides under ambient laboratory conditions. For each formulation/test insect assay various volumes of insecticide vapour were released in the fumigation chamber. The effect of insecticides were determined based on insect mortality after 15 minutes of exposure for *An gambiae* or *M. domestica*, while mortality of *P. americana* was determined after 1 hr of exposure. All tests and controls were replicated four times.

Constituents of selected unorthodox insecticides: Two of the unorthodox insecticides namely – Sniper and Go 90 were selected and analyzed for their respective chemical composition in the laboratory. Samples obtained from each of the two unorthodox insecticides analyzed for their respective constituents by Gas chromatography coupled with mass spectrophotometery (GC-MS) following standard procedure. The GC-MS analysis was carried out on the oils from the two unorthodox insecticide samples with an aglient 5775C chromatography equipped with an aglient mass-spectrometric detector, with a direct capillary interface and fused silica capillary column Hp-5ms (30 x 0.32mm i.d x -0.25pm film thickness). Helium was used as carrier gas at approximately 1.0ml/min, pulsed split less mode. The solvent delay was 4mins and the injector size was 1.0µl. The signal graph, chromatogram generated show peaks represents specific chemical compounds.

Data Analyses: Insect mortality data were subjected to probit analyses using computer programme of the United States Environmental Protection Agency (Version 5.1). Mortality figures obtained were corrected using Abbott (1925) formula before subjecting them to the computer programme.

RESULTS

Perception and availability of insecticides: Respondents to questionnaires indicated that there are 13 different brands of Otapiapia with names and 12 of orthodox used in ALGA Table 1. There are also those that are used but without any label on them. On the basis of use, Sniper was the Otapiapia mostly used in the Local Government Area followed by GO-90 (Table 1). Figure 1 shows the result obtained from questionnaire analyses and the reasons why residents use Otapiapia. A total of 70.00% of the respondents use the Otapiapia because of their efficacy within short time (Figure 1).

Chemical Constituents of selected unorthodox preparations: The results of GC-MS analyses of Sniper and GO-90 samples are presented in Figure 2, Figure 3 and interpreted in Table 2. The analyses showed that the principal chemicals contained in Sniper are Dichlorvos (38.74 %) and Cyclopropanecarboxylic acid (33.66%). The results also showed that the major chemicals in GO-90 are Naphtalene (19.03 %), Cyclododecane (11.48%) and Tetredecane (10.36 %). The constituents of Sniper are shown in Figure 2 while those of GO-90 are depicted in Figure 3.

Efficacy of test orthodox insecticides and unorthodox preparations against An. gambiae, M. domestica and P. Americana: The comparative computed median lethal concentrations (LC50) values based on quantal responses of each test insect species are shown in Table 3, 4 and 5. The 15 min-LC50 values showed that GO-90 (10.72 µlL-1) and a toxicity factor of 1.0 was significantly more toxic to An. gambiae than each test orthodox insecticide with no overlapping 95% confidence limits ($p < 0.05$). The next to GO-90 in toxicity ranking against An. gambiae was Rambo (Table 3). Similarly, GO-90 having the lowest 15 min - LC50 (15.51 µlL-1) was more toxic to M. domestica than any of the orthodox insecticides tested. Rambo was the most toxic to *M. domestica* among all orthodox insecticides tested (Table 4). The computed 24hr-LC50 showed that the most toxic insecticide against P. americana was Baygon (13.42 µlL-1) followed by Gonigoni Tripple Action (14.41 µlL-1). GO-90 was significantly less toxic to the cockroach than either Baygon or Gonigoni Tripple Action (Table 5).

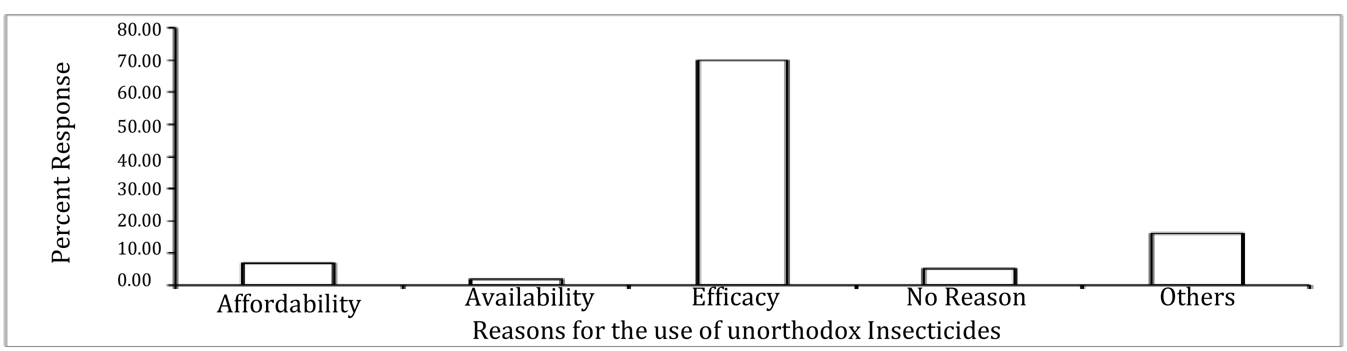

Figure 1. Reasons for choice of Unorthodox Insecticides by Respondents.

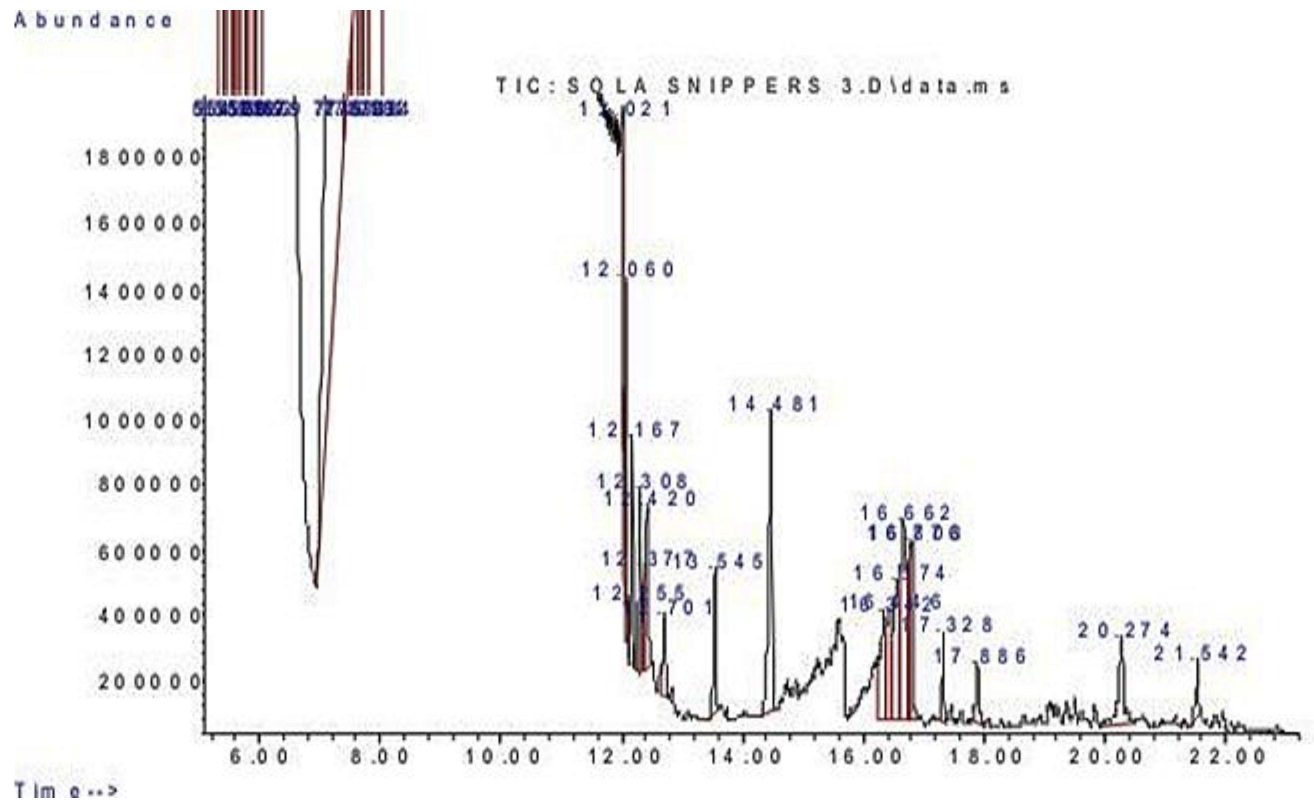

Figure 2. Gas Chromatogram showing chemical composition of Sniper.

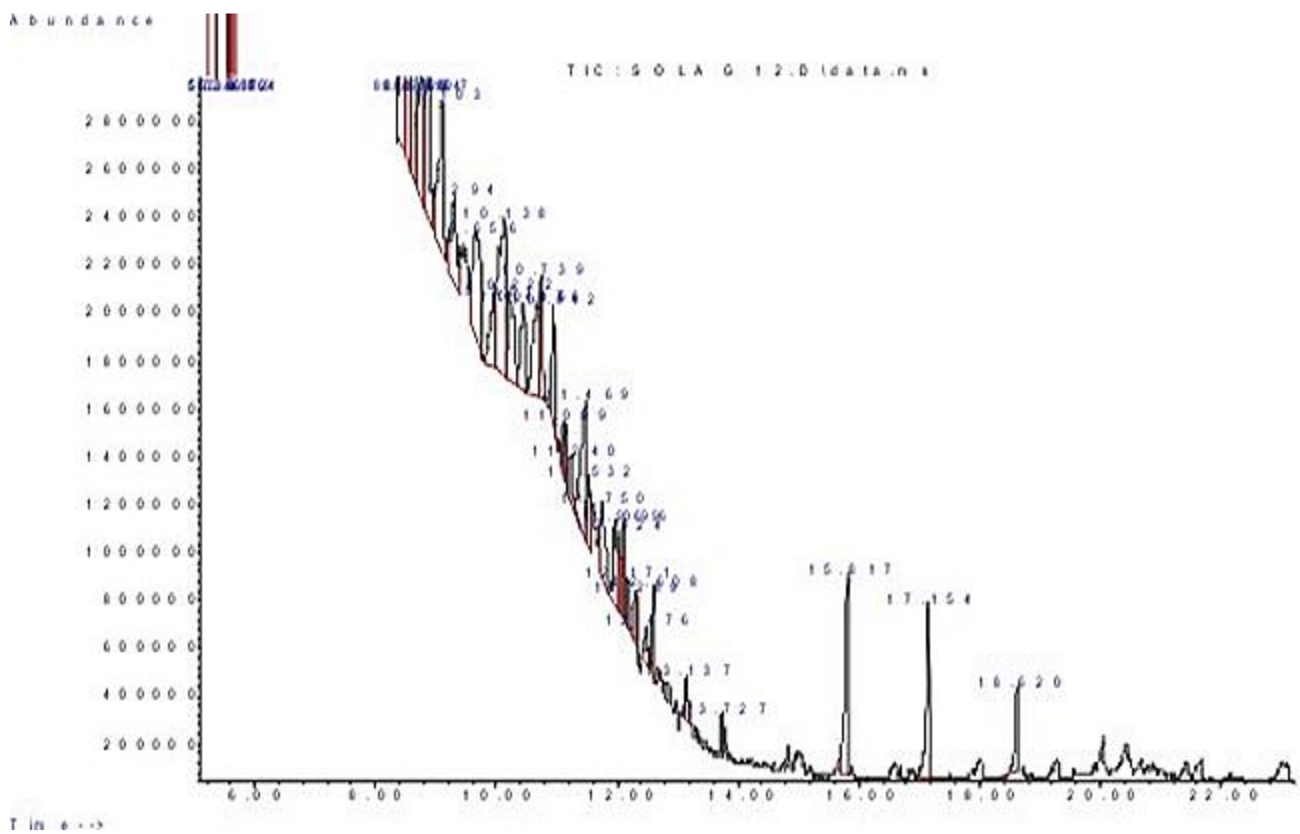

Figure 3. Gas Chromatogram Showing Chemical Composition of GO-90.

Table 1. Brands of Unorthodox Preparations and Orthodox Insecticides In Alimosho Local Government Area.

SN	Unorthodox Preparation		Brands	Orthodox Insecticide Brands	
	Brand Name	% Usage	Producer	Brand Name	Producer
1	Pestox	3.0	Three Points Industries Ltd.	Raid Old Formulation	Sc Johnson Limited
2	Sniper	35.5	Saro Agrosciences Ltd	Raid Multipurpose Insect Killer	Sc Johnson Limited
3	Pestoff	3.0	Pestoff Industries Ltd	Baygon	Sc Johnson Limited
4	Misty-Jom	1.5	Misty-Jom Ventures	Gonigoni Tripple Action	Gonigoni Nig. Ltd.
5	Mulvap	1.5	United Phosphorus Ltd.	Good Knight Flying Insect Killer	Good Knight Industries
6	DD Force	4.5	Jubali Agrotec Ltd.	Good Knight Multipurpose Insect Killer	Good Knight Industries
7	New Dawn	4.5	Not Available	Killit Crawling and Flying Insect Killer	Good Knight Industries
8	GO-90	15.3	Oruhtrade Int'l Ltd	Mobil Insecticide	Mobil Nig
9	Nopest Benckiser Nig Ltd	6.0	Ningbo-Agrostar Industrial Co. Ltd	Mortein Power Guard Roach Killer	Reckitt Benckiser Nig Ltd
10	Govan	3.5	Oruhtrade Int'l Ltd	Mortein Power Guard	Reckitt Benckiser Nig Ltd
11	Legacy	1.5	Not Available	Rambo Green	Gonigoni Nig. Ltd.
12	Lara Force	2.2	Jubali Agrotec Ltd.	Rambo	Gonigoni Nig. Ltd.
13	Rambo Rambo	9.0	Gonigoni Nig. Ltd.		
14	No name	3.0	Unknown		

Table 2. Chemical constituents of Sniper and GO-90.

SN	SNIPER		GO-90	
	Constituents	Proportion	Constituents	Proportion
1	Dichlorvos	38.738	Silane	3.008
2	Cyclopentanecarboxylic acid	1.765	Cyclotetradecane	3.524
3	Humulane	2.991	1-Decanol	5.308
4	Pyridiine	1.872	2-Ethyl-1—dodecanol	6.615
5	3,4,5-Trimethylpyrazole	1.578	Naphthalene	19.03
6	Imidazole	3.442	7-Tetradecane	6.54
7	m-Trifluoromethylbenzonitrile	1.463	Cyclododecane	11.484
8	Pyrazole-3-carbohydrazide	2.491	Cyclotetradecane	2.690
9	Butyl dimethyl phosphate	7.725	Tetradecane	10.632
10	Cyclopropanecarboxylic acid	33.655	1-Pentadecene	4.166
11	Butylphosphonic acid	1.422	Benzyl alcohol	2.973
12	Oleic acid	2.858	1-Heptanol	5.223
13	-	-	Azulene	1.394
14	-	-	Hexadecane	1.796
15	-	-	Methoxyacetic acid	0.708
16	-	-	2-(4-Iodo-phenyl)-6-pentyl-5,6,7,8-etrahydro-quinoline	5.417
17	-	-	Benzamide	6.201
18	-	-	Unknown	3.561

Table 3. Toxicity (LC50 values) of test insecticides against Mosquitoe (*Anopheles gambiae*).

Test formulations	15 Min LC_{50} ($\mu L L^{-1}$)	95 % Confidence Limits	Regression Equation	Degree of Freedom	Slope (± S.E)	Toxicity Factor
Raid Flying Insect Killer	23.45	19.25 - 29.52	Y = 2.27 + 1.99x	2	1.99 ± 0.31	2.19
Raid M. Insect Killer	17.86	14.32 – 21.79	Y = 2.54 + 1.97x	2	1.97± 0.30	1.67
Baygon	15.63	13.29 – 18.11	Y = 1.32 + 2.08x	2	2.08 ± 0.85	1.46
GO – 90	10.72	9.43 – 12.17	Y = 2.04 + 2.86x	2	2.86 ± 0.03	1.00
Gongoni Tripple Action	16.88	14.14 – 19.78	Y = 1.86 + 2.56x	2	2.56 ± 0.32	1.57
Good Knight F I Killer	15.83	13.32 – 18.41	Y = 1.71 + 2.75x	2	2.75± 0.32	1.48
Good Knight M I Killer	20.76	17.53 – 24.53	Y = 1.75 + 2.46x	2	2.46± 0.32	1.94
Killit Flying and Crawling In	16.25	13.82 – 18.78	Y = 1.49 + 2.90x	2	2.90± 0.33	1.52
Mobil Insecticide	21.75	18.00 – 26.43	Y = 2.15 + 2.13x	2	2.13± 0.31	2.03
Mortein P G Roach Killer	21.98	18.40 – 26.39	Y = 1.94 + 2.28x	2	2.28± 0.32	2.05
Mortein Power Guard	22.23	18.75 – 26.47	Y = 1.77 + 2.40x	2	2.40± 0.32	2.07
Rambo Green	14.40	12.09 – 17.16	Y = 2.01 + 2.58x	2	2.58± 0.88	1.34
Rambo	13.09	11.43 – 18.05	Y = 2.67 + 2.09x	2	2.09± 0.85	1.22

S. E = Standard Error; LC_{50} values with no overlap in their 95 % confidence limits are significantly different ($p < 0.05$).

Table 4. Toxicity (LC50 values) of test insecticides against Common Housefly (*Musca domestica*).

Test formulations	15 Min LC_{50} ($\mu L L^{-1}$)	95 % Confidence Limits	Regression Equation	Degree of Freedom	Slope (± S.E)	Toxicity Factor
Raid Flying Insect Killer	41.40	34.71 – 54.55	Y = 0.51 + 2.78x	2	2.78 ± 0.47	2.67
Raid M. Insect Killer	41.69	33.92 – 54.96	Y = 1.77 + 1.99x	2	1.99± 0.80	2.69
Baygon	17.39	14.49 – 20.41	Y = 2.37 + 2.12x	2	2.12 ± 0.61	1.12
GO – 90	15.51	12.62 – 20.36	Y = 3.05 + 1.64x	2	1.64 ± 0.26	1.00
Gongoni Tripple Action	16.22	13.14 – 19.45	Y = 2.36 + 2.18x	2	2.18 ± 0.31	1.05
Good Knight F I Killer	19.89	14.11 – 23.03	Y = 2.34 + 2.05x	2	2.05± 1.01	1.28
Good Knight M I Killer	17.38	14.51 – 20.45	Y = 1.93 + 2.48x	2	2.48± 0.32	1.12
Killit Flying and Crawling In	17.31	14.05 – 20.15	Y = 2.45 + 2.06x	2	2.06± 1.01	1.12
Mobil Insecticide	27.43	23.09 – 33.67	Y = 1.66 + 2.32x	2	2.32± 0.34	1.77
Mortein P G Roach Killer	25.06	21.07 – 30.50	Y = 1.81 + 2.28x	2	2.28± 0.33	1.62
Mortein Power Guard	27.77	23.75 – 33.29	Y = 1.23 + 2.61x	2	2.61± 0.36	1.79
Rambo Green	18.25	14.45 – 22.58	Y = 2.68 + 1.84x	2	1.84± 0.30	1.18
Rambo	17.53	13.93 – 21.51	Y = 2.63 + 1.91x	2	1.91± 0.30	1.13

S. E = Standard Error; LC_{50} values with no overlap in their 95 % confidence limits are significantly different ($p < 0.05$).

Table 5. Toxicity (LC50 values) of test insecticides against American Cockroach (*Periplaneta americana*).

Test formulations	15 Min LC_{50} ($\mu L L^{-1}$)	95 % Confidence Limits	Regression Equation	Degree of Freedom	Slope (± S.E)	Toxicity Factor
Raid Flying Insect Killer	68.64	62.15 – 93.02	Y = 1.53 + 1.89x	3	1.89 ± 1.27	5.11
Raid M. Insect Killer	37.94	33.65 – 67.17	Y = 1.84 + 2.00x	3	2.00± 0.54	2.83
Baygon	13.42	9.22 – 17.44	Y = 3.36 + 1.45x	3	1.45 ± 0.23	1.00
GO – 90	25.31	20.78 – 32.25	Y = 2.37 + 1.88x	3	1.88 ± 0.22	1.89
Gongoni Tripple Action	14.41	12.28 – 23.19	Y = 3.68 + 1.14x	3	1.14 ± 0.54	1.07
Good Knight F I Killer	28.40	3.47 – 185.13	Y = 1.67 + 2.29x	3	2.29± 0.51	2.12
Good Knight M I Killer	25.94	15.77 – 30.16	Y = 2.03 + 2.10x	3	2.10± 0.72	1.93
Killit Flying and Crawling In	22.05	18.83 – 25.38	Y = 1.60 + 2.53x	3	2.53± 0.27	1.64
Mobil Insecticide	67.93	44.38 – 87.16	Y = 1.95 + 1.67x	3	1.67± 1.06	5.06
Mortein P G Roach Killer	43.52	39.18 – 73.20	Y = 2.09 + 1.77x	3	1.77± 0.60	3.24
Mortein Power Guard	52.65	48.20 – 79.11	Y = 0.22 + 2.77x	3	2.77± 1.21	3.92
Rambo Green	33.99	26.84 – 45.49	Y = 2.87 + 1.39x	3	1.39± 0.24	2.53
Rambo	18.76	16.29 – 31.36	Y = 3.06 + 1.53x	3	1.53± 0.69	1.40

S. E = Standard Error; LC_{50} values with no overlap in their 95 % confidence limits are significantly different ($p < 0.05$).

DISCUSSION

This report documents the attitude of Alimosho Local Government Area residents to the use of insecticides to control insect-vectored parasitic diseases. In particular, the questionnaires provide insight to the knowledge, attitude and practices of using unorthodox insecticides known locally as Otapiapia by residents of ALGA, Lagos State. It establishes the fact that some of the residents of ALGA rely on unorthodox insecticides for various reasons especially economic since they perceive it as cheap. It is well known that residents of this Local Government Area are mostly artisans, middle-low cadre civil servants, market men and women, petty traders and skilled professionals who survive on meager income and yet have to protect themselves and the families from insect bites. The approved minimum wage by the Federal Government is ₦18, 000.00 (Nwude, 2013). This implies that there is a little fund, part of which will go for procurement of such groceries as insecticides. Consequently, these residents rely on the purchase and use of Otapiapia which cost far less than the orthodox insecticides.

The study also revealed that the residents use unorthodox insecticides because it is readily available. Availability is an important factor to consider in the use of insecticides. As low income earners ALGA residents would prefer to procure insecticides that are available as soon as they get the required funds and when the need for its use arises. The artisans are often daily paid workers who earn little and would therefore spend a fraction of it on their immediate needs like insecticides. Consequently not-far-fetched insecticides are the ones they go for. It is notable that most of the respondents to questionnaires administered on them use unorthodox insecticides because its perceived effectiveness and that majority use Sniper. GC-MS analyses of the two selected insecticides (Table 2), Sniper and GO-90 shows their respective chemical constituents. The analyses also reveal why Sniper gives the best result of insecticidal efficacy since its major constituent is Dichlorvos, an organophosphate insecticide which efficacy is well documented. Similarly, the major constituents of GO-90 are Naphtalene (19.03 %), Cyclododecane (11.48 %) and Tetredecane (10.34 %). Dichlorvos is an organophosphate residual insecticide which has been employed over several decades in Nigeria for the control of malaria vector (Foll *et al*., 1965; Foll and Pant, 1966). Although it has proven to be an effective fumigant control against mosquitoes, chronic exposure by humans and domestic animals result in neurotoxicity, carcinogenicity, DNA damage and even death (ASTDR, 1997; Alavanja *et al*., 2004; Jamal *et al*., 2002; Kathyrene *et al*., 2006; Okeniyi and Lawal, 2007; Remmington *et al*., 2008). Also, it is fairly well established that Naphtalene is a naturally occurring bicyclic aromatic compound which is a component of crude oil and widely used in insecticide formulations. The other major constituents of GO-90 such as Tridecane and Dodecane are also hydrocarbons but are found as components of insecticides although they are part of kerosene (paraffin) which is a solvent for the active ingredient in the Otapiapia. These hydrocarbons have hazardous effects documented by Chilcott (2006) including dermatitis, cataract, vomiting etc. The major constituents of GO-90 namely Naphthalene, Cyclododecane and Tridecane as well as the minor constituent, Azulene are natural constituents of some plant essential oils such as *Morus rotunbiloba, Psidium cattleianum* var. *lucidum* and *Zanthoxylum gilletii* (Japhet *et al*., 2014; Chalanavar *et al*., 2012; Patharakom *et al*., 2010). The natural occurrence of these chemical constituents of GO-90 suggests its biological safety to animals and the environment, but there is need to verify this by empirical means.

This report shows a high efficacy of GO-90 against the test insects especially *An. gambiae* and *M. domestica*. It therefore gives credence to the perception of ALGA residents who justified their use of Otapiapia relative to orthodox insecticides because of the perceived efficacy of the former more than the latter. This indicates that the continued use of GO-90 by the population sampled in this study is not a mere adherence to tradition but a response to the real activity of the Otapiapia. Also the study gives an empirical documentation of the efficacy of Otapiapia as exemplified by GO-90. By the foregoing, it would be advisable for governments to encourage SMEs producing Otapiapia and create enabling environment for them to thrive. Insecticide users should also be advised to procure locally produced preparations that are safe, environmentally benign and registered with NAFDAC.

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REFERENCES

Alavanja, M.C., J.A. Hoppin and F. Kamel. 2004. Health effects of chronic pesticide exposure: cancer and neurotoxicity. *Annual Review of Public Health*, 25: 155-197.

ATSDR (Agency for Toxic Substances and Disease Registry). 1997. *Toxicological Profile for Dichlorvos.* U.S. Department of Health and Human Services Public. Health Service 1600 Clifton Road NE, E-29 Atlanta, Georgia 30333, 119pp.

Chalanavar, R.K., V.K. Narayanswamy, H. Baijinath and B. Odhav. 2012. Chemical composition of essential oil of *Psidium cattleianum* var. *lucidum* (Myrtaceae). *African Journal of Biotechnology*, 11 (33): 8341 – 8347.

Chilcott, R.P. 2006. Compendium of Chemical Hazards: Kerosene (Fuel Oil). Health Protection Agency, UK. 31pp.

Denloye, A. A. B., K.O. Teslim, O. Ogundele, Y.A. Abe and W. A. Makanjuola. 2004. Comparative insecticidal effects of Raid and Mortein formulations on mosquitoes (*Anopheles gambiae*) and cockroaches (*Periplaneta americana*). *Journal of Research and Review in Science* 3: 82 – 89.

Denloye, A.A., K.A. Oluwakemi, Rasak, A. Olowu, Eshilokun, Adeolu and W.A. Makanjuola. 2009. Insecticidal activity of petroleum ether extract and essential oil of *Chenopodium ambrosioides* L. (Chenopodiaceae) against *Anopheles gambiae* (Diptera; Culicidae). *Acta Entomologica Sinica* 52 (8): 923 – 928.

Foll, C.V. and C.P. Pant. 1966. The conditions of malaria transmission in Katsina Province, Northern Nigeria, and a discussion of the effects of dichlorvos application. *Bull World Health Organ*. 34(3): 395-404.

Foll, C.V., C.P. Pant and P.E. Lietaert. 1965. A large-scale field trial with dichlorvos as a residual fumigant insecticide in Northern Nigeria. *Bulletin of World Health Organization* 32(4): 531-550.

Jamal, G.A., S. Hansen and P.O. Julu. 2002. Low level exposures to organophosphorous esters may cause neurotoxicity. *Toxicology,* 181-182: 23-33.

Japhet, O.O., M.C. Josphat and V.M. John. 2014. Chemical composition and larvicidal activity of *Zanthoxylum gilletii* essential oil against *Anopheles gambiae*.

African Journal of Biotechnology, 3 (2): 2175 – 2180.

Kathryn, M., Atherton, M.W. Faith, J. Samantha and M. Elaine. 2006. DNA damage by dichlorvos and repair profiles in human lymphocytes *in vitro*. *Toxicology*, 226 (1): 53.

National Agency for Food and Drugs Administration and Control (NAFDAC). 2005. Drugs and related products (Registration etc) Act 1996. Pesticide Reigstration Regulations 2005. NAFDAC, 15pp.

Noutcha, M.A.E. and C.I. Anumudu. 2011. *Anopheles gambiae* Complex: Molecular forms and occurrence of the KDR Gene in rural southwestern Nigeria. *Nigerian Journal of Entomology*, 28: 7–16.

Nwude, E.C. 2013. The Politics of Minimum Wage in Nigeria: The Unresolved Issues. *Asian Journal of Empirical Research*, 3(4): 477–492.

Okeniyi, J.A. and O.A. Lawal. 2007. Accidental Poisoning with Otapiapia: a Local Organophasphate-Containing Rodenticide: A Case Report. *The Nigerian Medical Practitioner* 52(4): 100-101.

Omudu, E.A. and E.T. Aluor. 2011. Cockroach (Dictyoptera; Blattidae) infestation and their perceived importance in some hospitals and restaurants in Makurdi, Nigeria. *Nigerian Journal of Entomology* 28: 17 – 25.

Oyewole, O.I, D.O. Moronkola, I.O. Ogunwande, H. Okoh, C.A. Ibidapo, A.A.B. Debloye, A.A. Ogunnowo and M. Adedayo. 2010. Larvicidal activity of the essential oil from *Phillantus amarus* Sch. et Thonn (Euphorbiacea) against three species of mosquitoes. *Der Pharmacia Lettre*, 2 (6): 136 – 141.

Parthakorm, T., T. Arpornsuwan, N. Wetprasit, A. Promoboon and S. Ratanapo. 2010. Antibacteria activity and cytotoxicity of the leaf essential oil of Morus rotunbiloba Koidz. *Journal of Medicinal Plant Research*, 4 (9): 837–843.

Remington, S.E, P.A. Jowsey, F.M. Williams and P.G. Blain. 2008. Investigations into the genotoxic potential of dichlorvos. *Toxicology*. 253 (1-3): 13-14.