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RESEARCH ARTICLE

Formulation and preparation of aerosol using garlic oil and its insecticidal effects on crawling and flying insects

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ABSTRACT

Mosquitoes, houseflies and cockroaches pose significant public health threat owning to their ability to mechanically transmit human intestinal parasites. A more effective way of controlling the diseases carrying vector is spraying the breeding sites, homes, with insecticides which contain as active ingredients organochlorides and carbamates. Ruijten. The effects of the aerosol on flying and Crawling insects most especially mosquitoes, Houseflies and Cockroaches was investigated. About 25.8 mls of oil was extracted from the 20.5kg of garlic. The specific gravity and saponification value of the extracted oil was 0.892g/cm 3 and 191mg/KOH respectively. The acid value, which is an index of free fatty acid content, was 8.54mg/NaOH. The averages knock down time for pure garlic oil on Mosquitoes, Cockroaches and Houseflies was 10s, 45s and 15s respectfully while the average knock down time for formulated garlic aerosol was 13s, 58s, and 26s respectively. The average knock down time Baygon [R] Rambo [R] Mobil [R] is (17s 18s 16s), (59s 57s 59s), and (37s 30s 39s) respectively. The study reveals that garlic oil has insecticidal properties on the flying and crawling insects used in the experiment. The formulated aerosol also demonstrated insecticidal properties as revealed in the knock of time and knock down time on the insects. Garlic oil may be considered as an alternative to organophosphates and carbamates currently being used yet with a hidden potential of causing an increased toxicity and morbidity to our major organs and neurological system.

Keywords: *Aerosol, insecticidal effect, organochlorides, garlic oil, carbamates*

1. INTRODUCTION

Allium the Latin word given connotes a flowering Plant with hundreds of distinct species belonging to the family alliaceae and closely related to the onion [1]. *Allium sativum* L. consists of Sulphur containing compound such as allicin, allin, ajoene, diallysulfide, dithin, and s-allylcysteine [2]. Garlic contains an

essential oil, and can be extracted by different methods the best of which is steam distillation, Garlic oil has numerous uses in the world today, its documented uses includes reduction of blood pressure, prevent heart disease including atherosclerosis, and mosquitoes repellant properties [3].

Garlic contains 0.1-0.36% of volatile oil and these volatile oil are considered to be responsible for most of the Pharmacological properties of garlic. It contains at least 33 sulphur compounds like Allicin, Ajoene,Diallyltrisulfide, sallylcysteine and others [4]. However one of the most biologically active compounds, allicin does not exist in garlic until it is crushed or cut, injury to the bulb activates the enzyme allinase, which metabolises allin to allicin [5].

The extraction of Garlic oil can be carried out using different extraction techniques but steam distillation appears to be the best method considering the volatility of the oil in garlic [5]. Steam distillation is a special type of distillation a separation process for temperature sensitive materials like natural aromatic compound or volatile oil. Water or steam is introduced into the distillation apparatus, the water vapour carries small amounts of the vaporized compounds to the condensation flask, where the condensed liquid phase separates, allowing for easy collection. This process effectively allows for distillation at lower temperatures [1]. There has been various documented medicinal uses of garlic these are acne treatment [6], Fights common cold, [7], lowering of blood pressure, Garlic is believed to activate the production of endothelium-derived relaxation factor, this lead to smooth muscle relaxation and vasodilatation.

Garlic has a long ethinomedicinal use as an insect repellent. It was used to combat aphids, white flies, spiders and other pests. Diallyl Sulphides ad trisulfide, have also been reported to be insecticidal. Previous studies by Belsinger in 2014 revealed the larvicidal properties of garlic against the mosquito's larva [8].

Mosquitoes are small, midge-like flies that constitute the family Culicidae. Females of most species are ectoparasites, the tube like mouthparts called proboscis pierce the hosts skin to consume blood. Mosquitoes are the major carrier of the *Plasmodium* which is the causative organism of Malaria. The world health Organization had prescribed the use of Artemisinin-based combination (ACT) for the treatment of Malaria. However, there have been reported cases of resistance to the ACT currently being used in the treatment of Malaria. As of March 2017, artemisinin resistance has been confirmed in 5 countries of the Greater Mekong Sub region (GMS): Cambodia, the Lao People's Democratic Republic, Myanmar, Thailand and Africa most especially in West Africa where Malaria is endemic. However, along the Cambodia-Thailand border, Plasmodium falciparum has become resistant to almost all available antimalarial medicines. There is a real risk that multidrug resistance will soon emerge in other parts of the sub region as well [4].

Artemisinin resistance has occurred as a consequence of several factors: poor treatment practices, inadequate patient adherence to

prescribed antimalarial regimens, and the widespread availability of oral artemisinin-based monotherapies and substandard forms of the drug. The geographic scope of the problem could widen quickly and have dire public health consequences: the spread or independent emergence of artemisinin resistance in other parts of the world could pose a major health security risk as no alternative antimalarial medicine is available at present with the same level of efficacy and tolerability as ACTs.

One of the approved alternatives arrived at the tropical disease session, fellow international Pharmacist Conference in Brazil 2016 was to lay more emphasis on Preventive medicine and control of vectors causing tropical diseases. Hence in case of Malaria, female anopheles mosquitoes are the vector. Vector control is significant in the light of increasing drug resistant malaria, as well as for cost effective reasons. Insecticide treated bed nets trials are being conducted in some parts of Nigeria and the results so far have been promising for the reduction in severity and prevalence of malaria in Children and young adults. The cost effectiveness of using insecticides and insecticides treated beds in reducing admission due to malaria also reduces the personal costs that family and friends bear during a hospital admission. A more effective way of controlling the mosquito the carrier of Malaria parasite Plasmodium is Spraying the breeding sites, homes, with insecticides such as Organochlorides, OrganoPhosphates, Dichlorodiphenyltrichloroethane(DDT), and Carbamates which are the major constituents of (^{R}Raid, ^{R}Baygon, ^{R}Mobil), Pyrethroids , Neonicorticoids, Ryanoids [10]. Insecticides such as Dichlorodiphenyltrichloroethane (DDT), ^{R}Raid insecticides, ^{R}Baygon, ^{R}Mobil insecticides, which are all pharmaceutically available as an aerosol and widely used to control mosquitoes. All these insecticides contain as their active ingredients Organophosphates and Carbamate.

Organophosphates interfere with the enzymes acetylcholinesterase and other cholinesterases, disrupting nerve impulses and killing or disabling the insect. Organophosphate insecticides and chemical warfare nerve agents (such as sarin, tabun, soman,) work in the same way. Organophosphates and carbamates have an acute and cumulative toxic effect to wildlife and human so multiple exposures to the chemicals amplify the toxicity [11]. In the US, Scientists are already searching for an alternatives to organophosphate and carbamates use due to associated toxicity involved with the use on the neurological system [12].

Acute exposure to organophosphate is a significant cause of morbidity and mortality in developing countries most especially in Africa. Although there is no exact estimates available in Nigeria. Hospital based studies suggest that it is the commonest poisoning in India with nearly ha lf of the admissions to the 'emergency' with poisoning being due to these compounds [13].

As a result of insecticides use every year, 200,000 deaths occur worldwide and most of these deaths occur in developing countries [14]. The anticholinesterase organophosphate

compounds (OPC) are the organic derivatives of phosphorous containing acids. In Nigeria they are freely available in shops and are widely used as insecticides in agriculture and in homes, they are sold with different trade names like [R]Raid, [R]Mobil, [R]Baygon, kill it etc. Hence, photochemical derived from plant sources can act as larvicides, insect growth regulators, repellents, and can also play an important role in the transmission of the disease through the control of the vector [15]. World health Organization had specified the use of ACT in the treatment of malaria, and with the reported cases of resistance to ACT, more emphasis are laid on the control of the vector. Hence the search for alternative insecticides from a natural source devoid of any major hazards to health in both acute and cumulative exposure to control the vector is very imperative. This research is based on investigating the insecticidal properties of Oil extracted from garlic oil and formulated into aerosol on flying and Crawling insects most especially mosquitoes, Houseflies and Cockroaches and as an alternative to organophosphates and carbamates.

2. METHODS AND MATERIALS

2.1. Sample collection and characterization

The sample of this study, Garlic was bought, identified and authenticated by forest research institute of Nigeria (FRIN). The garlic bulbs were sorted and selected for the following characteristics like uniform shape and size, full matured with no greenness without sprouts and firm texture. The selected bulbs were cleaned to remove dust/earth, chaff, dry stalk and any other foreign materials. The clean bulbs were manually separated into cloves and winnowed to remove dust and dirt. The cloves were graded for their size and only medium sized cloves will be used. The outer skins of the cloves were removed by hand while taking care of the surface of clove to remain undamaged. Whole cloves were used for the extraction process.

2.2. Extraction of the oil

The garlic identified were peeled to remove the pericarp layer and immediately put inside polythene and stored in a fridge at room temperature to prevent evaporation of the volatile oil. Steam distillation of the oil was then arried out in the faculty of Pharmacy university of Ibadan Pharmaceutical Chemistry laboratory.

2.3. Physico-chemical analysis of the oil

The following test was carried out on the garlic oil, specific gravity, Saponification value, Peroxide value, Free fatty acid value, triglyceride concentration, and iodine value

2.3.1. Determination of Specific gravity

Determination of specific gravity 2mls of the oil was measured in a pre – weighed measuring cylinder. The weight of the cylinder and oil will be measured, and the weight of the oil will then be obtained by subtracting the weight of the cylinder from the weight of the oil and cylinder. The specific gravity of oil was obtained using equations 1 [16]

$$\text{Density of water} = \frac{W_1 - W_0}{V_0}$$

Where W_1=weight of empty measuring cylinder + water

W_0 = weight of measuring cylinder

V_0 = volume of water used

$$\text{Density of oil} = \frac{W_1 - W_0}{V_0}$$

Where W_1=weight of empty measuring cylinder + oil

W_0 = weight of measuring cylinder

V_0 = volume of oil used

Therefore,

$$\text{Specific gravity} = \frac{\text{Density of water used}}{\text{Density of oil use}}$$

2.3.2. Determination of Saponification Value

0.5 g of the garlic oil was added to a flask with 15 ml of ethanol; KOH was added and then attached to a condenser for 30 minutes. After cooling the sample, 1 ml of phenolphthalein was added and titrated with 0.5M Hydrochloric acid until a pink endpoint is reached [17]. Saponification value was calculated from the equation 2

$$\text{Saponification value} = \frac{(S\text{-}B) \times M \times 56.1}{\text{Sample Weight (g)}}$$

Where,

S = sample titre value

B = blank titre value

M = molarity of the HCl

56.1 = molecular weight of KOH

2.3.3. Determination of Peroxide value

1.0g of oil extracted was added to 22mls of a solution mixture of Chloroform (12 mls) and 10mls acetic acid. 0.5mls of saturated potassium iodide was added to the flask. The flask was corked and allowed to stay with occasional shaking for 1 minute. 30mls of distilled water was added to the mixture and titrated against 0.1M of $Na_2S_2O_3$ until yellow color is almost gone. 0.5mls of starch indicator was quickly added and titration continues until blue color just disappeared. A blank Titration was also carried out at the same condition

$$\text{Peroxide value} = \frac{(S - B) \times N \times 1000}{W}$$

Where Peroxide value =Meq peroxide per 100g of sample

S = volume of titrant (cm3) for sample

B = volume of titrant (cm3) for blank

N = molarity of Na2S2O3 solution (mEq/cm3)

1000 = conversion of units (g/kg)

W = Weight of oil sample

2.3.4. Determination of free fatty acid

2.0g of oil was weighed into 250cm3 Erlenmeyer flask, 100ml of ethanol was added and followed by 2ml of Phenolphthalein indicator. The mixture was shaken and titrated against 0.1M NaOH with continuously shaking until the endpoint is reached, which is indicated by a slight pink color that persists for 30 seconds.

The free fatty acid was calculated by equation 3:

$$\%FFA = \frac{V \times N \times 282 \times 100}{W}$$

Where,

%FFA = Percent free fatty acid (g/100g)

V = Volume of NaOH (cm3)

N = Molarity of NaOH

282 = Molecular weight of oleic acid

W = weight of oil sample

2.4. Aerosol Formulations

Garlic oil was formulated into aerosol following standard Pharmaceutical practice of aerosol formulation using regular non active ingredients 0.015% imiprothrin and 0.15% cyfluthrin

2.5. Insecticidal effect

The mosquitoes were exposed to prepared essential oil, garlic oil and three chemical insecticidal agents (Baygon [R], Mobil [R] and Rambo [R]). The amount of chemical used and exposure time was recorded.

3. RESULTS AND DISCUSSION

The specific gravity, saponification value, peroxide value, and free fatty acid value was observed for the extracted garlic oil are within range in British Pharmacopeia standard value. This suggests that the garlic oil extracted is of a good quality. The knock down time is the time taken after the exposure of the insects to two sprays of the sample insecticides, formulated aerosol, and garlic oil to knock down the insects and prevent further moving or flying while the knock off time is the time it takes the insect to die (figure 1a and b).

About 25.8 mls of oil was extracted from the 20.5kg of garlic. The specific gravity of the extracted oil is 0.892g/cm^3. The saponification value of the garlic oil was found to be 191mg/KOH/g. The acid value, which is an index of free fatty acid content, was 8.54mg/NaOH. The averages knock down time for pure garlic oil on mosquitoes, cockroaches and houseflies are 10s, 45s and 15s respectfully while the average knock down time for

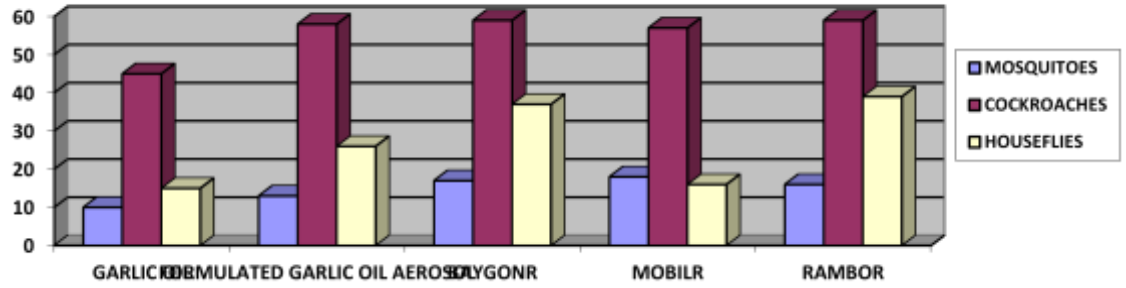

Figure 1 (a): Knock down time (average of 20 insects each in seconds)

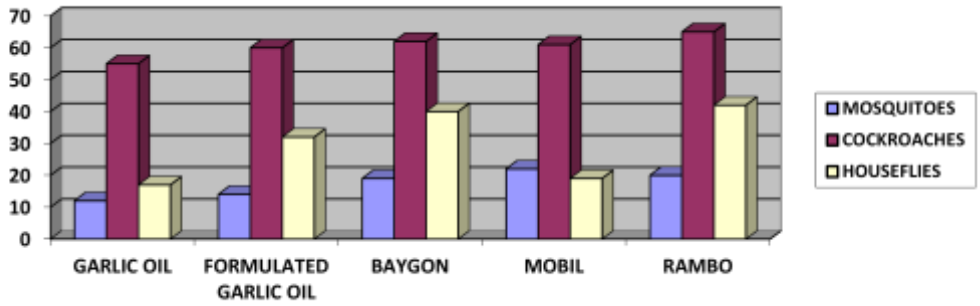

Figure 1 (b): Knock down time (average of 20 insects each in seconds)

formulated garlic aerosol are 13s, 58s, and 26s respectively. Baygon [R] Rambo [R] and Mobil [R] all insecticide had (17s 18s 16s), (59s 57s 59s), and (37s 30s 39s) respectively as average knock down time on mosquitoes, cockroaches and houseflies.

It will be noted from the result that garlic oil and formulated garlic oil aerosol had a consistently lower average knock down and knock off time on all the three insects in the study compared to the commercial insecticides Baygon, Rambo and Mobil which are known to have organophosphates and carbamates as the main active ingredients.

Many previous studies show that garlic oil is very effective in killing various insects. Recent study on insects life cycle showed that there was significant differences between the treatments and the control used for the study. The growth and development of larval and pupal duration was prolonged. The weight of pupal increased for all treatments. The major effect was observed on the percentage of hatchability of deposited eggs as I tsignificantly decreased [18]. This study shows that the decreased rate of egg hatching can lead to death of these insects.

The use of garlic oil is not only effective but also safe for humans. Extensive use of synthetic insecticides for long term has resulted in residues accumulation in food products, soil and cause adverse health effects to human. Therefore, application of natural insecticides at household and public health sectors is a best as alternative to synthetic insecticides [19].

4. CONCLUSION AND RECOMMENDATION

The study reveals that garlic oil has insecticidal properties on the flying and crawling insects used in the experiment. The formulated aerosol also demonstrated insecticidal properties as revealed in the knock of time and knock down time on the insects. Garlic oil may be considered as an alternative to organophosphates and carbamates currently being used yet with a hidden potential of causing an increased toxicity and morbidity to our major organs and neurological system.

Garlic oil has a very pungent and sharp smell. Its Pharmaceutical use will entails incorporation of a pharmaceutical inert fragrance agent. It's recommended to be used as insecticides for Agricultural purposes against pests that destroy crops and plants on the field

5. ACKNOWLEDGEMENT

NA

6. CONFLICT OF INTEREST

The authors have declared that there is no conflict of interest.

7. SOURCE/S OF FUNDING

No source of funding

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