Journal of Medicine and Health Sciences Research 2023, 6: 3-6
https://doi.org/10.21839/jmhsr.2023.v6.8381

Review Article

A review on larvicidal and repellent effects of *Brassica nigra* towards malaria mosquito

Damtew Bekele*

Department of Biology, College of Natural and Computational Sciences, Ambo University, Ambo, Ethiopia

(Received: March 31, 2023; Revised: June 20, 2023; Accepted: June 22, 2023; Published: July 07, 2023
*Corresponding author: Damtew Bekele (E-mail: *damtish2002@gmail.com*)

ABSTRACT

The efficacy of synthetic insecticides to control malaria vectors is compromised by increased mosquito resistance to insecticides. Furthermore, the use of inorganic insecticides raises serious environmental toxicity concerns. It is hoped that this review would incorporate plant-based control tools in modern malaria vector control at the community level. Therefore the use of synthetic insecticides is the challenge faced for malaria vector control because of the resistance of mosquitoes and their toxicity to the environment. Medicinal plants used like *Brassica nigra* in traditional medicine are promising and largely unexplored sources for the development of potential new compounds particularly in plant-rich countries like Ethopia.

Key words: *Brassica nigra*, Insecticide, Vector control

INTRODUCTION

In addition to being readily available in different parts of the country, locally grown plants are economically more viable and the methods employed are usually simpler. Though several compounds of plant origin have been reported as insecticides and larvicides, there is still a wide scope for the discovery of more effective plant products particularly in the indigenous flora of lesser studied countries like Ethiopia (Yadav *et al.,* 1987).

HISTORY OF BRASSICA

"Myrosyne" was first characterized from *Brassica nigra* seeds in 1839 by Bussy as a substance analogous to albumin and emulsion, i.e., a protein, necessary for the release of essential oil from mustard seed (Byssy, 1839, 1840). In the phloem sap of young leaves of *B. nigra*, glucosinolates have been detected in concentrations as high as 10 mM (Merritt, 1996).

TRADITIONAL USE OF PLANTS FOR VECTOR CONTROL

Although the application of plant derivatives for larvicides and adulticides to malaria vector control is uncommon in Ethiopia, some reports showed many plant species are traditionally used as repellents and insecticides (Abebe *et al.,* 2003; Berhanu *et al.,* 2006). Plant species including *Olea europaea* ssp. *cuspidata*, *Ostostegia integrifolia*, *Azadirachta indica*, *Silene macrosalen* and *Echinops* sp. are shown to be the most commonly used traditional mosquito repellent plants in Addis Zemen Town, South Gonder, Ethiopia (Karunamoorthi *et al.,* 2009).

Information on *B. nigra* indigenous Ethiopian plants against mosquito vectors is dominated by oral tradition and is not scientifically well documented. This traditional information is further complicated by the loss of biodiversity and tradition. In this context, our traditional knowledge on plant-based insect repellents would be immensely valuable and helpful. The literature, however, offers no data about the scientific repellent activities of these selected plants against larvicides and repellents.

BRASSICA NIGRA GEOGRAPHICAL LOCATION

Brassica nigra (L.) Koch (Brassicaceae), black mustard (Eng) grows between 1600-2450 m.a.s.l. Leaves are used as vegetables and seeds are used to make a condiment (Senafech, in Amh) and a spicy sauce used particularly during fasting seasons (Edwards *et al.,* 2000). The plant is also widely called Senafech locally (Figure 1). *B. nigra* seeds, which were crushed, are used as insecticides (Bekele *et al.,* 2012). In addition, it was shown in the Bekele *et al.* (2012) study that the people in Akaki District (east-central Ethiopia) consistently and frequently use *B. nigra* as traditional mosquitocides and in the control of cattle ticks and other arthropod pests.

It is reported that plant species that include *B. nigra* are traditionally used for insect repellents and insecticides in Akaki District and also have mosquitocidal effects against *A. arabienis* (Bekele & Petros, 2017). The selection of *B. nigra* was based on its use in traditional medical practices and as an insecticide confirmed by the ethnobotanical research made in Ethiopia. It is reported that the 80% methanol crude leaf

Figure 1: *B. nigra* L. Koch (Brassicaceae) were collected from Yerer Lencho locality of Akaki District

extract of *B. nigra* exhibited potent mosquitocidal activities against *Anopheles arabiensis* (Bekele & Petros, 2017).

B. nigra L. Koch (Brassicaceae) were collected from Yerer Lencho locality of Akaki District (latitude: 08047.144'N, longitude: 038053.712'E) and grows between 1600 and 2450 m.a.s.l. (Figure 1). The plant species that include *B. nigra* (seeds) in Ethiopia were used traditionally as mosquito repellent and selected for the mosquito repellent activity test.

CLASSIFICATION

Kingdom	:	Plantae - Plants
Subkingdom	:	Tracheobionta - Vascular plants
Superdivision	:	Spermatophyta - Seed plants
Division	:	Magnoliophyta - Flowering plants
Class	:	Magnoliopsida - Dicotyledons
Subclass	:	Dilleniidae
Order	:	Capparales
Family	:	Brassicaceae
Genus	:	*Brassica* L.
Species	:	*Brassica nigra* (L.) W.D.J. Koch

CHEMICAL CONSTITUENTS OF B. NIGRA

The main constituent of the oil of *B. nigra* in terms of the relative percentage of the total area in the chromatogram was 72.55% at the retention time of 28.068 min (Figure 2). In this study, the essential oil of *B. nigra* showed a total of six peaks with a major peak of 72.55% area with a retention time of 28.068 min. The strong repellent activity of this oil could be attributed to this peak due to its higher percentage as revealed by the GC peak area.

The glucosinolates are sulfur-containing natural products primarily from the Brassicaceae (mustard family). As shown in Figure 3, they consist of a thioglucose and sulfonated oxime, with a specific side chain for each of the over 100 glucosinolates that have been identified (Sørensen, 1990; Rosa *et al.,* 1997].

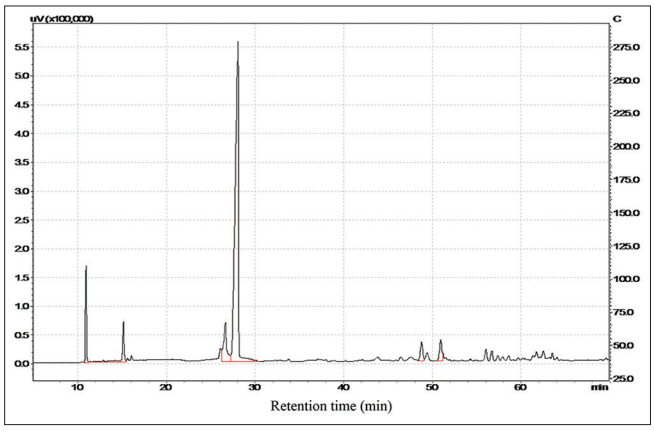

Figure 2: GC chromatogram of depicting profile of *B. nigra* essential oil (Bekele *et al.,* 2014)

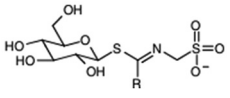

Figure 3: General structure of glucosinolates

BRASSICA NIGRA USED AS INSECTICIDE AND MODE OF ACTION

Dermal application of *B. nigra* oil produced no skin irritation in laboratory animals (rabbits) treated at 20% concentration and no signs of erythema and edema were observed (Bekele *et al.,* 2014). After exposure to *B. nigra* essential oil, populations of mosquitoes avoid possible contact with the oil indicating that it has a repellent effect on mosquitoes by stimulating them to fly away from the treated area. The change in behavior patterns leading to avoidance of the essential oil of *B. nigra* or disorienting biting mosquitoes may also take the form of decreased anthropophily. Therefore, *B. nigra* oil may assist in the interruption of the transmission of malaria by reducing contact between the vector and the oil applied to the skin.

Most insect repellents in the market contain the chemical N, N-diethylmetatoluamide (DEET). It effectively blinds the insect's senses so that the biting or feeding instinct is not triggered by humans or animals (Rose, 2001). Interestingly, *B. nigra* essential oil formulations were found to be more repellent against *Anopheles* mosquitoes than the approved synthetic repellent, DEET. These new findings may be helpful for use as a mosquito repellent product to be applied in integrated malaria control strategies to gain maximum impact on vector control. Dose-response studies of the oil of *B. nigra* indicate that it is more potent than DEET.

From *Brassica nigra* (L.) Koch, Allyl isothiocyanate drug is derived which is used as a rubefacient (Fabricant & Farnsworth, 2001). Some epidemiological data support the possibility that glucosinolate breakdown products derived from Brassica vegetables (cabbage, broccoli, and relatives) may protect against human cancers, especially in the gastrointestinal tract and lung (Johnson, 2003).

Citrus aurantifolia and *B. nigra* are pounded and mixed together as a remedy for tick infestation in the study. Similarly, the plants were often found to be administered in combination with each other, based on a local belief that synergistic actions between the plants would increase the benefit to the animal. The variations on these combinations were found to be numerous and highly varied (Bonet & Valles, 2007).

Our results showed that oils of *B. nigra* have significant repellent activity against *A. arabiensis* mosquito. However, the repellent effect was decreased as time increased which was in line with an earlier report by Govere *et al.* (2000).

Leaves of *B. nigra* are used to make a condiment and a spicy sauce used particularly during fasting seasons (Edwards *et al.,* 2000). *B. nigra* was found to be the potential repellent agent against the malaria vector owing to its very pungent, irritating odor suggesting their potential uses as a broad spectrum. Furthermore, the broad spectrum of bioactivity of *B. nigra* oil is evident as reported by Indikar and Desale (2009) with conceivable antibacterial activities. Jasim (2012) showed the activity of oil extracts of *B. nigra* seeds against pathogenic oral microflora.

The repellent activity of B. nigra oil was comparable to previously screened plants using Pine (*Pinus longifolia*) oil (Ansari *et al.,* 2005), which was reported to have strong repellent action against mosquitoes as it provided 100% protection against *A. culicifacies* and 97% protection against Cx. quinquefasciatus for nine hours, respectively.

The repellents of plant origin are sustainable alternatives to synthetic chemicals and cost-effective in which they do not pose hazards of toxicity to human and domestic animals and are easily biodegradable (Das *et al.,* 2003; Ntonifor *et al.,* 2006). Furthermore, plants could be an alternative source for mosquito repellents because they constitute a potential source of bioactive chemicals and typically are free from harmful effects (Isman, 1995). The mode of repellent action of *B. nigra* oil may block impulse transmission in mosquitoes' nervous systems. The mode of action of repellents is not actually to repel biting insects but seems to be to cancel out the attractant properties of the animal body or cancel the signals of attraction of animals (Davis, 1985).

CONCLUSION

In conclusion, the present findings showed that *B. nigra* essential oil was not irritant when applied to rabbit skin and proved to be effective in repelling *A. arabiensis*. The plants could be used by rubbing on the skin directly as mosquito repellents which assists in strengthening the control strategy in the fight against the disease malaria. *B. nigra* is naturally abundant and can be grown and processed with low technology to produce affordable repellents for use against biting mosquitoes which are vectors of malaria. The present study plants are easily available, accessible, and affordable; therefore the usage of traditional repellent plants should be promoted among the local residents in order to reduce man-vector contact and transmission of malaria.

REFERENCES

Abebe, D., Debella, A., & Urga, K. (2003). Check list of medicinal plants and other useful plants of Ethiopia. Singapore: Camerapix Publishers International.

Ansari, M. A., Mittal, P. K., Razdan, R. K., & Sreehari, U. (2005). Larvicidal and mosquito repellent activities of Pine (*Pinus longifolia*, Family: Pinaceae) oil. *Journal of Vector Borne Diseases, 42*(3), 95-99.

Bekele, D., & Petros, B. (2017). Repellent Effects of *Aloe pirottae* (Aloaceae) Gel Extract and *Brassica nigra* (Brassicaceae) Essential Oil against the Malaria Vector, Anopheles *arabiensis* Patton (Diptera: Culicidae). *Biochemistry & Analytical Biochemistry, 6*(3), 1000363. https://doi.org/10.4172/2161-1009.1000336

Bekele, D., Asfaw, Z., Petros, B., & Tekie, H. (2012). Ethnobotanical study of plants used for protection against insect bite and for the treatment of livestock health problems in rural areas of Akaki District, Eastern Shewa, Ethiopia. *Topclass Journal of Herbal Medicine, 1*(2), 40-52.

Bekele, D., Petros, B., Tekie, H., & Asfaw, Z. (2014). Larvicidal and adulticidal effects of extracts from some indigenous plants against the malaria vector, *Anopheles arabiensis* (Diptera: Culicidae) in Ethiopia. *Journal of Biofertilizers & Biopesticides, 5*(2), 144. https://doi.org/10.4172/2155-6202.1000144

Berhanu, A., Asfaw, Z., & Kelbessa, E. (2006). Ethnobotany of plants used as insecticides, repellents and anti-malarial agents in Jabitehnan district, West Gojjam. *SINET: Ethiopian Journal of Science, 29*(1), 87-92. https://doi.org/10.4314/sinet.v29i1.18263

Bonet, M. A., & Valles, J. (2007). Ethnobotany of Montseny biosphere reserve (Catalonia, Iberian Peninsula): Plants used in veterinary medicine. *Journal of Ethnopharmacology, 110*(1), 130-147. https://doi.org/10.1016/j.jep.2006.09.016

Bussy, A. (1840). Sur la formation de l'huile essentielle de moutarde. *Journal of Pharmacy, 26*, 39-48.

Byssy, A. (1839). Note sur la formation de l'huile essentielle de moutarde. *Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences, 9*, 815-817.

Das, N. G., Baruah, I., Talukdar, P. K., & Das, S. C. (2003). Evaluation of botanicals as repellents against mosquitoes. *Journal of Vector Borne Diseases, 40*(1-2), 49-53.

Davis, E. E. (1985). Insect repellents: Concepts of their mode of action relative to potential sensory mechanisms in mosquitoes (Diptera: Culicidae). *Journal of Medical Entomology, 22*, 237-243.

Edwards, S., Tadesse, M., Demissew, S., & Hedberg, I. (2000). *Flora of Ethiopia & Eritrea: Magnoliaceae to Flacourtiaceae* (Vol. 2, Part 1, pp. 121-154) Uppsala, Sweeden: Addis Ababa University.

Fabricant, D. S., & Farnsworth, N. R. (2001). The value of plants used in traditional medicine for drug discovery. *Environmental Health Perspectives, 109*(S1), 69-76. https://doi.org/10.1289/ehp.01109s169

Govere, J., Durrheim, D. N., Toit, N. D., Hunt, R. H., & Coetzee, M. (2000). Local plants as repellents against *Anopheles arabiensis*, in Mpumalanga Province, South Africa. *The Central African Journal of Medicine, 46*(8), 213-216.

Indikar, F. R., & Desale, D. J. (2009). Antimicrobial activity of oils of *Brassica nigra* and its formulation as an ointment. *International Journal of Pharmaceutical Research and Development, 1*, 1-5.

Isman, M. B. (1995). Leads and prospects for the development of new

botanical insecticides. *Reviews in Pesticides Toxicology, 3*, 1-20.

Jasim, A. S. (2012). Antibacterial activity of oils extracts of *Brassica nigra* seeds on some bacteria isolated from plaque and healthy teeth in children (1-5) years. *Basrah Journal of Science, 30*(1), 105-119.

Johnson, I. T. (2003). Glusosinolates in the human diet. Bioavailability and implications for health. *Phytochemistry Reviews, 1*, 183-188. https://doi.org/10.1023/A:1022507300374

Karunamoorthi, K., Mulelam, A., & Wassie, F. (2009). Assessment of knowledge and usage of traditional insect/mosquito repellent plants in Addis Zemen Town, South Gonder, North Western Ethiopia. *Journal of Ethnopharmacology, 121*(1), 49-53. https://doi.org/10.1016/j.jep.2008.09.027

Merritt, S. Z. (1996). Within-plant variation in concentrations of amino acids, sugar, and sinigrin in phloem sap of black mustard, *Brassica nigra* (L.) Koch (Cruciferae). *Journal of Chemical Ecology, 22*(6), 1133-1145. https://doi.org/10.1007/bf02027950

Ntonifor, N. N., Ngufor, C. A., Kimbi, H. K., & Oben, B. O. (2006). Traditional use of indigenous mosquito repellents to protect humans against mosquitoes and other insect bites in a rural community of Cameroon. *East African Medical Journal, 85*(10), 553-558. https://doi.org/10.4314/eamj.v83i10.9468

Rosa, E. A. S., Heancy, R. K., Fenwick, G. R., & Portas, C. A. M. (1997). Glucosinolates in crop plants. In J. Janick (Eds.), Horticultural Reviews (Vol. 19, pp. 99-215) New York, US: John Wiley & Sons, Inc. https://doi.org/10.1002/9780470650622.ch3

Rose, R. I. (2001). Pesticides and public health: Integrated methods of mosquito management. *Emerging Infectious Diseases, 7*(1), 17-23.

Sørensen, H. (1990). Glucosinolates: structure, properties, function. In F. Shahidi (Eds.), Canola and Rapeseed: Production, Chemistry, Nutrition and Processing Technology (pp. 149-172) New York, US: Springer. https://doi.org/10.1007/978-1-4615-3912-4_9

Yadav, R. S., Saxena, S. C., & Choubey, S. M. (1987). Disruption in oviposition behaviour of malaria, filariasis and dengue vectors by plant extracts. In M. Balakrishnan & K. M. Alexander (Eds.), *Recent Trends in Ethology in India* (pp. 50-52) Bangalore, India: The Ethological Society of India.