Trop J Nat Prod Res, January 2026; 10(1): 6510 - 6513

ISSN 2616-0684 (Print)
ISSN 2616-0692 (Electronic)

Tropical Journal of Natural Product Research

Available online at https://www.tjnpr.org

Original Research Article

Phytochemical and *In vivo* Anti-Plasmodial Investigation of *Raphia* Palm Seed

Abimbola P. Oluyori[1]*, Charity O. Aremu [2], Charles O. Nwonuma [3], Oluwole S. Oladeji [1], Chibuike Anagbo, Adeola T. Adewusi [1]

[1]*Industrial Chemistry Programme, Physical Sciences Department, Landmark University, Omu-Aran, Kwara State.*
[2]*Department of Animal Science, Landmark University, Omu-Aran, Kwara State.*
[3]*Department of Biochemistry, Landmark University, Omu-Aran, Kwara State.*

ARTICLE INFO

Article history:
Received 24 July 2025
Revised 27 October 2025
Accepted 11 November 2025
Published online 01 February 2026

ABSTRACT

The ethanol extract of *Raphia* palm seed (RPSE) was subjected, for the first time, to phytochemical and antiplasmodial investigation to establish its curative potency in *Plasmodium berghei*-infected mice. The phytochemical analysis showed that the total alkaloid content was 20.98 mg/ 1.00 g of the endocarp while the total flavonoid and total phenolic contents were 0.7061 mg Rutin Equivalent/g and 28.82 mg Gallic acid equivalent/g of the extract respectively. The Gas Chromatography-Mass Spectrometric analysis detected hexadecanoic acid (43.09%) as the major component of the extract. A significant increase in parasitaemia was observed in the infected, untreated group, while the parasite was inhibited in both the chloroquine (CQ) and RPSE-treated groups. On day 8, treatment with 400 mg/kg of RPSE exhibited significant inhibition of parasitemia. However, the inhibitory effect of RPSE decreased after day 10. The 400 mg/kg treatment gave the greatest inhibition of *P. berghei* NK-65 (96.37% on Day 10), while the 100 mg/kg treatment resulted in the most significant effect on body weight (+1.64 g). Based on these findings, further studies would be required to establish RPSE as an invaluable addition to the list of plants that are involved in nature-based management of malaria infection.

Keywords: Phytochemical, *Raphia* palm, antimalarial, *Plasmodium berghei*, endocarp.

Introduction

The industrial relevance and importance of the palm tree (*Raphia* spp.) cannot be overemphasized. However, several palm species, such as *Raphia hookeri* and *Raphia farinifera* (amongst others), may be considered as underutilized bioresources. They are widely distributed in West Africa, where they are well known as 'Raffia Palm'.[1] Apart from Africa, Raphia palms are widely dispersed in swampy areas in tropical forests of South-East Asia and Latin America.[2] The plant grows to a height of about 10 m, with pinnate and feather-like leaves of 12 m in length. The plant is monocarpic with large, cone-like fruits covered with layers of brown overlapping scales. Furthermore, the mesocarp is yellow while the endocarp is brown and extremely hard.[3,4] In Nigeria and other West African countries, various parts of the Raphia palm have been extensively utilized as a therapy for diabetes, high blood pressure, and to regulate the heartbeat.[5,6] Economically, this plant is popularly used by local wineries in the production of fermented wine, made from the colorless sap obtained from the stem.[2] The sweet savor of the wine may be attributed to various molecules, such as xylose, lactose, glucose, sucrose, and raffinose.[7] The leaves, fruits, stems, and roots contain many micro- and macronutrients. These nutrients most likely contribute to their therapeutic potency.[8,6,9] In addition to the work that has been done on different parts of the plant, its epicarp, mesocarp, and leaf were recently shown to possess antiplasmodial potential by our group.[10]

*Corresponding author. Email: oluyori.abimbola@lmu.edu.ng
Tel: +2348038083231

Citation: Oluyori PA, Aremu OC, Nwonuma OC, Oladeji SO, Anagbo C, Adewusi TA. Phytochemical and in vivo anti-plasmodial investigation of *Raphia* palm seed. Trop J Nat Prod Res. 2026; 10(1): 6510 – 6513 https://doi.org/10.26538/tjnpr/v10i1.11

Official Journal of Natural Product Research Group, Faculty of Pharmacy, University of Benin, Benin City, Nigeria

However, the medicinal potential of the hard endocarp (the seed), which is difficult to break, was not included in our *Plasmodium* inhibitory research. Palm seeds could also contain molecules that may contribute to antiplasmodial effects. Hence, this research was tailored toward investigating the antiplasmodial potency of the *Raphia* palm endocarp. It is hoped that the results will guide and instigate further research on the therapeutic potency of the studied plant.

Materials and Methods

Collection of plant sample and identification

Fresh and healthy fruits of the Raphia Palm (*Raphia farinifera*) plant were collected from a farm beside Landmark University, Omu-Aran, Kwara state, Nigeria, in May 2019. Epicarp and mesocarp were carefully separated from the seed (endocarp). Samples of the plant were deposited and identified by a taxonomist (Mr. Bolu Ajayi) at the Herbarium of the Department of Plant Biology, University of Ilorin, where a Voucher Specimen Number: UILH/001/1834/2025 was assigned.

Preparation and extraction

Raphia palm seeds were rinsed with double-distilled water to remove extraneous substances and air-dried for about 42 days. The dried seeds were cracked into pieces, and 200 g of the broken seed was macerated in ethanol (2×750 mL). The extract solution was afterwards filtered and concentrated in vacuo to obtain the crude extract.

Qualitative Phytochemical Screening

The crude extract of *Raphia* palm seed (RPSE) was subjected to qualitative phytochemical assessment for the identification of phytoconstituents such as flavonoids, phenolics, steroids, saponins, alkaloids, and terpenoids, following the standard methods previously adopted by Zimudzi *et al*.[11]

Phytochemical Quantification

The crude extract, RPSE, was investigated for its quantitative phytochemical content using established total phenolic, total flavonoid and total alkaloid protocols. [12, 13.]

Gas Chromatography-Mass Spectroscopy

The phytochemical constituents of RSPE were detected by using GC-

ISSN 2616-0684 (Print)
ISSN 2616-0692 (Electronic)

MS equipment (Agilent 7890 A) and a procedure that was earlier reported [10]. The National Institute of Standard and Technology (NIST) library database was used to interpret the chromatogram.

Antimalarial screening of Raphia palm *seed extract*
Experimental animals
An ethical approval to conduct the research was obtained from Landmark University – LUAC/BCH/24014A. In brief, a bout twenty-four Wistar albino mice (15.89 - 21.99 g) were collected from the Biochemistry Department, University of Ilorin, Kwara State, Nigeria. The mice were kept and nurtured in clean standard cages. They were subjected to standard laboratory conditions, with necessary availability of food and clean water. The animals were used in line with the guidelines and recommendations of the ethics committee.

Animal grouping
The experimental mice were grouped into six, with three mice in each group. The grouping was based on dosage and nature of treatment (drug administered): Group A: 100 mg/kg of RPSE, Group B: 200 mg/kg of RPSE, Group C: 400 mg/kg of RPSE, Group D: Neutral control, not uninfected with *P. berghei* and untreated, Group E: Negative control, Infected, not treated, Group F: Chloroquine.

Inoculation
The chloroquine-sensitive *Plasmodium berghei* (NK65) was collected from University of Ibadan, Nigeria (Institute of Advanced Medical Research and Training, College of Medicine) and sustained in mice. During the anti-plasmodial investigations, the inoculation of the mice was done intraperitoneally according to previously established protocol.[14]

Drug administration
Using a cannula, chloroquine (CQ) and RPSE (100, 200, and 400 mg/kg body weight) were orally administered to experimental mice.

Assessment of the therapeutic potential of the RPSE
The therapeutic effect of the extract concentrations was studied by monitoring the change in weight of mice and the level of parasitemia in infected mice. The effect of the extracts on the weight of experimental mice was recorded on day 0 (before inoculation) and compared with the weight on day 12. The curative potential of RPSE was assessed using the method described by Ryley and Peters, as adopted in our previous research.[10] The average values of the parasitaemia as well as the percentage inhibition were determined via the following formulae:

$$\textbf{Average \% parasitaemia} = \frac{\textbf{Number of parasitized erythrocytes} \times 100}{\textbf{Total number of erythrocytes}}$$

$$\textbf{\% Inhibition} = \frac{\%\,\textbf{parasitaemia control} - \textbf{parasitaemia treated group } X\ 100}{\textbf{parasitaemia in control group}}$$

GC-MS Analysis
Gas Chromatography-Mass Spectrometry (GC-MS) was employed to establish the chemical composition of RPSE, using the method that was earlier adopted by Oluyori *et al*.[10.] Compounds were identified by spectral comparison with the National Institute of Standard and Technology (NIST) Mass Spectral Library.

Results and Discussion

Medicinal plants are extensively used, specifically by traditional medical practitioners, in developing or underdeveloped nations for the treatment of diseases and infections. Generally, folkloric usage of several plants in the management of diseases is not scientifically validated. Hence, a great deal of uncertainty trails the use of many plants that have been useful in providing answers to several problematic diseases in the world today. Raphia palm is abundant and broadly used in some parts of Africa, as earlier stated. Although the mesocarp, leaf, and epicarp of this plant have been investigated by our group, our curiosity about the possible usefulness of the extremely hard endocarp motivated this additional antiplasmidial investigation.[10] Cold maceration was used for the extraction because the decomposition of thermolabile compounds must be avoided[15]. This is important because the thermolabile compounds could be a major part of the active principles in the crude extract.
Phytochemical analysis
The qualitative phytochemical screening of RPSE revealed the presence of important phytochemicals: alkaloids, saponins, flavonoids, and tannins. Terpenoids and steroids were undetected or below the traceable limit (Table 1a).

Table 1a: Phytoconstituents in Raphia palm seed extract

	Result
Alkaloid	+
Saponins	+
Flavonoids	+
Terpenoids	-
Phenolics	+
Steroid	-

Present (+); Absent (-)

As shown in table 1b, the total alkaloid content (TAC) of RPSE was found to be 20.98 mg/ 1.00 g of the endocarp. Compared to our previous report, this result shows that only the epicarp surpassed the endocarp in alkaloid content (29.4 mg/ 1.00 g of epicarp).

Table 1b: Concentration of phytoconstituents in Raphia palm seed extract

	Result
Total Alkaloid Content	20.98 mg/g
Total Flavonoid Content	0.7061 mg/g RE
Total Phenolics Content	28.82 mg/g GAE

RE=Rutin Equivalent GAE = gallic Acid Equivalent

Similarly, the leaf and epicarp had higher TFC (total flavonoid content) and TPC (total phenolic content) than the endocarp, which recorded 0.7061 mg Rutin Equivalent (RE)/ g extract and 28.82 mg/g Gallic acid equivalent (GAE), respectively. The higher phenolic content observed in the leaf compared to the seed is in line with previous reports.[16] The variation in phytochemical constitution of these extracts, coupled with their therapeutic potency, suggests that the mechanism of action could be different. Hence, there is a need for chromatographic isolation of the phytochemicals in each extract, using a bioassay-guided approach and a detailed investigation of their mode of action. Specifically, the quantitative presence of alkaloids, phenolics, and flavonoids in RPSE is instructive. Alkaloids have a prominent antecedent as antiplasmodial agents. They are predominantly found in herbaceous plants, especially tropical species, and are concentrated in the leaves, roots, or barks.[17] Similarly, phenolics and flavonoids are very well-known phytochemical classes in medicinal chemistry.[18] The synergistic combination of these molecules could therefore be responsible for the observed bioactivity in extract – RPSE, as reported in this study.

Effect of extracts on body weight change
The effect of RPSE and CQ on body weight change is presented in Table 2. There is no significant difference between the body weight change for experimental mice treated with RPSE and those treated with CQ. However, the weight of the untreated experimental group was significantly different from the RPSE and CQ groups. Furthermore, the change in body weight was found to be dose-independent, with 100 mg/kg treatment resulting in the highest increase in weight, compared to 200 and 400 mg/kg treatments.

Parasitaemia inhibition of NK65 P. berghei-infected mice
The plasmodium inhibitory potential of RPSE and CQ is presented in Table 3. The parasitaemia level was observed after each day of treatment. In RPSE-treated (400mg/kg) and infected, untreated groups, a significant increase in parasitaemia was observed from day 8 to day 10, while the parasitaemia level in the CQ-treated group decreased

ISSN 2616-0684 (Print)
ISSN 2616-0692 (Electronic)

during the same time frame. However, the infected, untreated group did not follow this trend with a significant increase in parasitaemia until day 10 (Table 3). Overall, the curative potential of RPSE in infected mice is lower than that of CQ.

Table 2: Effect of different Raphia palm seed extract treatments on the weight of *Plasmodium berghei*-infected mice

Dose/Treatment	Initial weight	Final weight	Change in weight
100 mg/kg	18.74 ± 0.79	20.38 ± 0.40	1.64
200 mg/kg	19.65 ± 0.29	20.17 ± 0.20	0.52
400 mg/kg	19.52 ± 0.11	20.51 ± 0.18	0.99
Neutral	20.77 ± 0.93	22.06 ± 1.30	1.29
Negative	20.63 ± 0.19	18.32 ± 3.87	-2.31
CQ	20.56 ± 0.46	21.88 ± 0.66	1.32

Table 3: Curative potential of Raphia palm seed extract in *Plasmodium berghei*-infected mice

Treatment/Dosage	4°	6°	8°	10°
100 mg/kg	1.60 ± 0.93	0.57 ± 0.00	1.41 ± 0.52	2.19 ± 2.07
200 mg/kg	0.15 ± 0.27	0.66 ± 0.11	4.55 ± 3.14	2.63 ± 0.11
400 mg/kg	0.28 ± 0.40	0.55 ± 0.32	0.03 ± 0.52	0.90 ± 0.85
CQ	0.50 ± 0.33	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Infected untreated	1.20 ± 0.19	0.24 ± 0.33	0.31 ± 0.00	2.78 ± 1.79

Values are the mean of two replicates. CQ- (Chloroquine), X°- (Post-infection days).

As shown in Table 4, the RPSE-treated groups had a lower percentage parasitaemia inhibition compared to the CQ-treated groups. Similarly, while the plasmodium-inhibitory effect of CQ became pronounced on day 6, the anti-plasmodial activity of RPSE came into effect on day 8 (post-infection). On day 8, 200 and 400 mg/kg groups exhibited significant inhibition compared to day 6. However, the inhibitory effect of RPSE (400 mg/kg) decreased from day 8 to 10. The curative effectiveness of CQ, as seen in the CQ group, was sustained throughout the treatment period, while the effect of RPSE significantly decreased from day 10.

Table 4: Percentage inhibition of *Plasmodium berghei* NK-65 by Raphia palm seed extract in infected mice

Treatment/Dosage	4°	6°	8°	10°	12°
100 mg/kg	-33.00	-13.70	-35.54	91.16	-35.00
200 mg/kg	87.50	-17.50	13. 67	89.38	-48.00
400 mg/kg	76.67	-12.92	90.32	96.37	-23.33
CQ	58.33	100.00	100.00	100.00	100.00
Infected untreated	0.00	0.00	0.00	0.00	0.00

Values are the mean of two replicates. CQ- (Chloroquine), X°- (Post-infection days).

Notably, the highest RPSE-inhibition of *Plasmodium berghei* parasites was observed in 400 mg/kg treatment on day 10. Although the investigated dosage of RPSE did not produce a spectacular outcome, increasing the dosage may lead to an improved plasmodium inhibition, while the consumption of the different parts of the plant could be prophylactic. This, however, will require further investigation in line with previous research [19] and a detailed toxicological study. Also, a greater medicinal activity may be achieved if pure, chromatographically isolated compounds are obtained from the RPSE and subjected to further antiplasmodial studies.

GC-MS Analysis of Raphia palm Seed extract

The GC-MS analysis of RPSE detected the presence of 16 known molecules (Table 5). Some of these compounds have been previously reported as components of antimalarial plant extracts while the antimalarial potential of others have been established via in silico or in vivo experiments [21]. Hexadecanoic acid (palmitic acid), which is usually present in palm species, is the main component (43.09%) of RPSE while other molecules such as 1-Octadecanamine (1.41 %), propanamide (1.54 %), 1-octanamine (4.29%), octadecanoic acid (5.75 %) etc, are of lower percentage abundance but with documented antimicrobial/ anti-inflammatory properties [22,23].

Table 5: GC-MS analysis of Raphia palm seed extract

Retention Time	Area (%)	Compound	Molecular formula (weight)
7.181	5. 22	*(S)*-(+)-Epichlorohydrin	C_3H_5ClO (92.524)
7.84	1.41	1-Octadecanamine	$C_{18}H_{39}N$ (269.308)
7.987	4.73	1,8-Nonadien-3-ol	$C_9H_{16}O$ (140.223)
11.598	1.46	3-methyl-Butanal	$C_5H_{10}O$ (86.132)
12.216	43.09	Hexadecanoic acid	$C_{16}H_{32}O_2$ (256.424)
12.41	5.75	Octadecanoic acid	$C_{18}H_{36}O_2$ (284.477)
13.427	2.1	2-cyano-acetamide	$C_3H_4N_2O$ (84.077)
13.527	3.56	(Tetrahydroxycyclopentadienone) tricarbonyliron(0)	$C_8H_4FeO_8$ (283.958)
13.692	2.48	5-nitro-2,4(1H,3H)-Pyrimidinedione	$C_4H_3N_3O_4$ (157.084)
15.104	1.89	N-methyl-1-Octadecanamine	$C_{19}H_{41}N$ (283.536)
15.292	1.54	Propanamide	C_3H_7NO (73.094)
16.527	2.33	5-methyl-2-Hexanamine	$C_7H_{17}N$ (115.217)
16.739	4.29	1-Octanamine	$C_8H_{19}N$ (129.243)
17.021	9	2,2,2-trichloro-acetamide	$C_2H_2Cl_3NO$ (162.402)
17.61	1.41	2-methyl-adenosine	$C_{11}H_{15}N_5O_4$ (281.268)
23.68	1.3	2-Amino-1-(*O*-hydroxyphenyl)propane	$C_9H_{13}NO$ (151.206)

The observed prominence of hexadecanoic acid in Raphia palm seed agrees with our previous observation in the leaf of the plant [10]. Apart from being a component of several medicinal plant extracts, the antimalarial potential of hexadecanoic acid, as a pure compound, has been previously reported [21]. An *in vivo* approach and molecular docking technique were used to establish the hexanoic acid molecule as a multi-stage/ multi-target antiplasmodial molecule [21]

Table 5 shows several other molecules with divers properties and medicinal history. For instance, 1-octadecanamine has been reported as a component of an antimalarial extract (*Salix ledermannii* ethanol leaves extracts) and as a lead molecule in an *in silico* antimalarial research [24, 25] while some other molecules such as 1,8-Nonadien-3-ol (4.73%) are not known antimalarial molecules. The identified molecules with antimalarial antecedent could have worked synergistically to achieve the observed antiplasmodial effect.

It is also note-worthy that hexadecanoic acid possesses a strong mosquito repellent property [26]. Hence, via vector control approach, the underutilized Raphia seed and leaf[10] which are rich in hexadecanoic acid, may be investigated for their suitability as raw materials in the preparation of novel natural mosquito repellent products.

Conclusion

The investigation of the antiplasmodial potential of *Raphia* Palm Seed extract revealed notable activity, positioning the plant as a promising medicinal bioresource. The presence of important phytochemicals such as alkaloids, saponins, and flavonoids was established and GC-MS particularly identified hexadecanoic acid as the major constituent of RPSE. Although a preliminary antiplasmodial activity of the extract was confirmed, the activity was not sustained throughout the post-infection observatory period. The extract, however, prevented weight loss in infected but treated mice. While our findings contribute to the growing list of antimalarial plants that are generally preferred in natural products research, further research is required to isolate and characterize the chemical constituents of RPSE via a bioassay guided approach.

Conflict of Interest

The authors declare no conflict of interest.

Authors' Declaration

The authors hereby declare that the work presented in this article is original and that any liability for claims relating to the content of this article will be borne by them.

References

1. Ohimain EI, Inyang IR, Osai GU. The effects of raffia palm mesocarp on haematological parameters of *Clarias gariepinus*, a common Niger Delta Wetland Fish. Annu Res. 2015; 8 (1): 1–7.
2. Umerie SC. Caramel production from saps of African oil palm (Elaeis guineensis) and wine palm (*Raphia hookeri*) trees. Bioresour. Technol. 2000; 75 (2):167–169.
3. Adeniyi AA, Akpabio UD. Nutritional potential of hard seed of *Raphia hookeri*. Obeche J. 2011; 29 (2): 366–369.
4. Mbaka GO, Ogbonnia SO, Oyeniran KJ, Awopetu PI. Effect of *Raphia hookeri* seed extract on blood glucose, glycosylated haemoglobin, and lipid profile of alloxan-induced diabetic rats. J Adv Med Med Res. 2012; 2 (4): 621–635.
5. Mpinga EK, Kandolo T, Verloo H, Bukonda NKZ, Kandala N, Chastonay P. Traditional alternative medicines and the right health: key elements for a convention on global health. Health Hum. Rights 2013; 15: 44–57.
6. Dada FA, Oyeleye SI, Ogunsuyi OB, Olasehinde TA, Adefegha SA, Oboh G, Boligon AA. Phenolic constituents and modulatory effects of Raffia palm leaf (*Raphia hookeri*) extract on carbohydrate-hydrolyzing enzymes linked to type-2 diabetes. J. Tradit. Complement. Med. 2017; 7 (4): 494–500.
7. Erukainure OL, Oyeode OA, Chukwuma CI, Matsabisa MG, Koorbanally NA, Islam MS. Raffia palm (*Raphia hookeri*) wine inhibits glucose diffusion; improves antioxidative activities and modulates dysregulated pathways and metabolites in oxidative pancreatic injury. J Food Biochem. 2019; 43 (3): e12749. doi: 10.1111/jfbc.12749
8. Obahiagbon F, Osagie A, Sugar and microminerals composition of sap produced by *Raphia hookeri* palms. Afr. J. Food Sci. 2007; 6 (6): 744–750.
9. Ibegbulem CO, Igwe CU, Okwu GN, Ujowundu CO, Onyeike EN, Ayalogu EO,. Total amino acid profiles of heat-processed fresh *Elaeis guineensis* and *Raphia hookeri* wines. Food Chem. 2013; 138 (2-3): 1616–1620.
10. Oluyori AP, Nwonuma C, Akpo T, Inyinbor AA, Dada OA, Oladeji OS, Ogunnupebi TA. In Vivo Antiplasmodial Potential of the Leaf, Mesocarp, and Epicarp of the *Raphia hookeri* Plant in Mice Infected with *Plasmodium berghei* NK65. Evid Based Complement Alternat Med. 2022; 4129045. doi: 10.1155/2022/4129045.
11. Zimudzi C, Gwenhure LF, Kunonga N, Kativu S, Jere J. Phytochemical screening, cytotoxicity and anti-inflammatory activities of the Zimbabwean endemic plant *Phyllanthus serpentinicola* Radcl.-Sm.(Phyllanthaceae). J. Appl. Pharm. Sci. 2012; 2 (10): 050-053.
12. Oluyori PA, Dada AO, Adejumoke IA. Phytochemical Analysis and Antioxidant Potential of *Raphia Hookeri* Leaf and Epicarp. Oriental J Chem 2018; 34(6):2742-2746.
13. Obadoni B. O., Ochuko P. O. Phytochemical studies and comparative efficacy of the crude extracts of some haemostatic plants in Edo and Delta states of Nigeria. Glob J Pure Appl Sci. 2002; 8(2):203-208, doi: 10.4314/gjpas.v8i2.16033.
14. Dibessa TT, Engidawork E, Nedi T, Teklehaymanot T. Antimalarial activity of the aqueous extract of the latex of *Aloe pirottae* Berger. (Aloaceae) against *Plasmodium berghei* in mice. J Ethnopharmacol. 2020; *255*: 112763. https://doi.org/10.1016/j.jep.2020.112763
15. Ayisi F, Mensah CN, Borquaye LS. Antiplasmodial potential and safety evaluation of the ethanolic stem bark extract of *Distemonanthus benthamianus* Baill. (Leguminosae). Sci. Afr. 2021*;* 12: e00809.
16. Nascimento K, Reis I, Augusta I. Total phenolic and antioxidant capacity of flower, leaf, and seed of *Moringa oleifera*. Int. J. Food Nutr. Res, 2017; 1:1-6.
17. Kurek J. Introductory Chapter: Alkaloids - Their Importance in Nature and for Human Life. Alkaloids - Their Importance in Nature and Human Life. 2019; Intech Open doi:10.5772/intechopen.85400
18. Sharma RK, Sharma N, Kumar U, Samant SS. Antioxidant properties, phenolics and flavonoids content of some economically important plants from North-west Indian Himalaya. Nat Prod Res. 2022; 36(6):1565-1569. doi: 10.1080/14786419.2021.1881959.
19. Ali BH, Mohammed I, Muhammed MA, Mohammed SY, Garba D, Busola OA, Khadijah II., Manager MM. Evaluation of In vivo Antiplasmodial Activity of the Methanol Root Bark Extract and Fractions of *Bombax costatum* (Bombacacea) in *Plasmodium berghe*i-Infected Mice. Trop. J. Nat. Prod. Res. 2022*; 6*(6): 926-930. doi.org/10.26538/tjnpr/v6i6.18.
20. Abdussalam US, Aliyu M, Maje IM. In vivo Antiplasmodial Activity of Ethanol Leaf Extract of *Marrubium vlgare* L. (Lamiaceae) in *Plasmodium berghei*-Berghei Infected Mice: Trop. J. Nat. Prod. Res 2018; *2*(3): 132-135. doi.org/10.26538/tjnpr/v2i3.6
21. Afolayan FID, Odeyemi RA, Salaam RA. In silico and in vivo evaluations of multistage antiplasmodial potency and toxicity profiling of n-Hexadecanoic acid derived from *Vernonia amygdalina*. Front Pharmacol. 2024; 15:1445905. doi: 10.3389/fphar.2024.1445905.
22. Manivannan P, Muralitharan G, Balaji NP. Prediction aided in vitro analysis of octadecanoic acid from *Cyanobacterium lyngbya* sp. as a proapoptotic factor in eliciting anti-inflammatory properties. Bioinformation 2017; 30;13(09):301–6. doi.org/10.6026/97320630013301.
23. Nyaitondi OD, Wanjau R, Nyambaka H, Hassanali A. Anti-bacterial properties and GC-MS analysis of extracts and essential oils of selected plant product. Biofarmasi J Nat Prod Biochem. 2018; 16: 36-50.
24. Afolayan F, Ayinde E. In silico Antimalarial Docking and Admet Studies of Phytocompounds derived from *Tithonia diversifolia*. J Sci Res. 2019; 18:35-47.
25. Nanven AF, Nannim N, Monday EA, Mark SWilson NB, Anthony D. Gas Chromatography-Mass Spectrometry Analysis and Antimalarial Activity of *Salix ledermannii* Ethanol Leaves Extracts. Trop J Nat Prod Res. 2024; 8(11): 9121–9130 https://doi.org/10.26538/tjnpr/v8i11.22.
26. Hassan J, Jebanesan A. Bio-efficacy of hexadecanoic acid on larvicidal, pupicidal and repellent activities against malarial vector, *Anopheles stephensi* (Liston).(Diptera: Culicidae). Int J Pharma Bio Sci. 2022; 13(1): 37-43. Doi: 10.22376/ijpbs.2022.13.1.B37-43