



ANTIMALARIAL POTENTIAL OF ETHYL ACETATE LEAF EXTRACT AND COLUMN FRACTIONS OF *Jatropha tanjorensis* (Euphorbiaceae) IN MICE INFECTED WITH *Plasmodium berghei*

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ABSTRACT

Malaria remains a significant global health challenge, with the rise of drug-resistant strains emphasizing the urgent need for novel therapeutic agents. This study examines the antimalarial potential of *Jatropha tanjorensis* leaf extracts, particularly the crude ethyl acetate extract and its column fractions, against *Plasmodium berghei*-infected mice. The primary aim was to evaluate the therapeutic effects of these extracts, focusing on parasitemia reduction, hematological indices, weight gain, and survival times of the infected mice. The leaves of *Jatropha tanjorensis* were collected and prepared according to standard procedures, with extraction carried out using the maceration technique. The resulting ethyl acetate extract was then fractionated through column chromatography. The curative effects of the crude extract and fractions were assessed using Rane's test by monitoring parasitemia and evaluating the effects on hematological indices. The survival times and weight changes of the mice were also recorded to assess the overall therapeutic potential of the extracts. The results showed that column fraction (3) demonstrated the highest inhibitory potential, exhibiting a dose- and time-dependent reduction in parasitemia level, from 20.5% on Day 5 to 5.8% on Day 8 of treatment. Both the crude ethyl acetate extract and column fraction (3) indicated weight gain and anti-anaemic effects in a dose-dependent manner, enhancing the overall health of the infected mice. Moreover, these treatments led to increased survival rates compared to the control group. This study supports the promising antimalarial activity of *Jatropha tanjorensis* leaf extracts, suggesting their potential for the development of novel therapeutic strategies. Further research is needed to isolate the active compounds and investigate their mechanisms of action to more effectively combat malaria, especially in the context of drug-resistant strains.

**Keywords:** Malaria, *Plasmodium berghei*, Parasitaemia, and Rane's Test

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INTRODUCTION

Malaria remains one of the most significant public health challenges worldwide, with *Plasmodium falciparum* being the primary causative agent of severe malaria in humans. Despite ongoing efforts to control the disease, malaria continues to place a substantial burden on many regions, particularly sub-Saharan Africa, where it is responsible for millions of infections and deaths each year [1]. Although antimalarial treatments, such as artemisinin-based combination therapies (ACTs), have been used successfully, the growing emergence of drug-resistant strains has made the search for alternative therapeutic options increasingly urgent [2].

In this regard, *Plasmodium berghei*, a rodent malaria parasite, has emerged as a crucial model for studying malaria biology and evaluating potential antimalarial treatments. *P. berghei*, a member of the genus *Plasmodium*, class Aconoidasida, and phylum Apicomplexa, is the causative agent of murine

malaria and is widely used in experimental studies as a substitute for human malaria, especially *P. falciparum*. This is because *P. berghei* shares similarities with *P. falciparum* in terms of pathophysiology, molecular biology, and transmission mechanisms [3, 4]. These similarities make *P. berghei*-infected rodents' valuable models for studying the disease and testing new antimalarial drugs [5]. Various strains of *P. berghei* used in research, include the *Plasmodium berghei* ANKA strain, which causes cerebral murine malaria, and the *Plasmodium berghei* NK65 strain, which does not induce cerebral malaria [6]. These strains are widely employed in preclinical studies to assess the efficacy of new antimalarial agents. Additionally, other rodent malaria species, such as *P. vinckei*, *P. yoelii*, and *P. chabaudi*, are used in research and provide alternative models for studying malaria and evaluating potential treatments [7].

As the fight against malaria continues, exploring plant-based compounds as potential

therapeutic agents remains a promising area of research. Many plants with traditional medicinal uses have demonstrated antimalarial properties, offering new hope for the development of effective treatments. One such plant is *Jatropha tanjorensis*, whose leaves are known to contain a variety of bioactive compounds with potential pharmacological effects [8]. This study aims to evaluate the antimalarial activity of the ethyl acetate leaves extract of *Jatropha tanjorensis* in mice infected with *P. berghei*. The findings of this research could provide valuable insights into the potential of plant-derived compounds as alternatives to conventional antimalarial therapies.

## MATERIALS AND METHODS

### Ethical approval

Ethical approval was sought from the Ahmadu Bello University Zaria (A.B.U) Committee on Animal use and care (Approval no; ABUCAUC/2023/034). Following the Organization for Economic Cooperation and Development (OECD 425) [9] guidelines for rats and mice, Good Laboratory Practice (GLP), and Animal Research Reporting of In vivo Experiments (ARRIVE) guidelines, experimental research design and a basic random sampling technique were employed to select and group experimental animals.

### Preparation and extraction of plant material

Fresh leaves of *Jatropha tanjorensis*, grown in private gardens in Zaria Local Government Area of Kaduna State, were taken from their natural environment. A voucher number (V/N-ABU01911) was assigned to a sample of leaves from the harvest, which was then taken to the Department of Botany's Herbarium unit at A.B.U. Zaria, Kaduna State, Nigeria, for verification. The leaves were gathered and prepared following the method of Aiwonegbe *et al.* [10]. After being cleaned under running water, the leaves were allowed to air dry for three weeks at room temperature in a shaded area before being ground into a powder. The plant powder was extracted following the methods described by Matabane *et al.* [11]. The extraction process utilized the maceration technique, by soaking the plant powder in ethyl acetate within a clean, sterile, airtight container for three days (72 hours) at room temperature (20-23°C). The mixture was vigorously shaken at regular intervals. After 72 hours, the mixture was filtered through muslin cloth and re-filtered using Whatman No. 1 filter paper. The filtrate was concentrated using a water bath at 45°C.

### Fractionation of ethylacetate extract of *Jatropha tanjorensis* leaf

**Thin-layer chromatography:** Thin-layer chromatography was performed on the ethyl acetate

extract of *J. tanjorensis* leaf following the method described by Segan *et al.* [12]. A sheet of aluminum foil (1.5 cm by 10 cm), coated with silica gel was used as the stationary phase. The sample was spotted on four TLC plates, each containing different analytes. The plates were viewed with UV light, sprayed with *P*-anisaldehyde sulfuric acid, and placed in a hot air oven (Fischer Scientific) at 105°C.

**Column chromatography:** A gel column chromatography was performed on the ethyl acetate extract of *J. tanjorensis* leaf following the outcome of thin layer chromatography that revealed the best solvent system for separation as 8:2 (n-Hexane: Ethyl acetate) equivalent to 4:1(n-Hexane: Ethyl acetate). The procedure was conducted according to the method described by Abubakar and Haque [13]. The adsorbent used was silica gel-60 (60 - 120 µm in size) and the eluting solvents used were n-hexane and Ethyl acetate. Using the wet packing technique, 150 g of silica gel was mixed with the lesser polar solvent (n-Hexane) twice its volume in a beaker and stirred with a glass rod (slurry method). Seven grams of ethyl acetate extract was mounted on top of the silica gel but prevented from having direct contact with the silica gel by the use of cotton. This settled for 3 hours before elution began. A gradient elution method was used, starting with 250 ml hexane (100%) as the initial eluting solvent. The polarity of the solvent system was increased by increasing the proportion of the more polar solvent (ethyl acetate) gradually. The column fractions obtained were labeled accordingly from CF 1-CF 30. They were monitored using a TLC plate (Silica gel-60 F254 Aluminium pre-coated plates from Merck, Germany) and similar ones from the column were pooled together, which led to CF 1-2, CF 3, CF 4-10, CF 11-15, and CF 16-30. These pooled column fractions were further subjected to *in vivo* bioassay to evaluate their antiplasmodial activity against *Plasmodium berghei*.

### *In vivo* antimalarial assay

**Experimental animals:** Swiss albino mice were used for the *in vivo* curative test. They were housed in a well-ventilated environment, with a standard laboratory animal diet and water *ad libitum*. The weight of the mice was recorded on day one of the experiment and on the last day. Daily feed, and water intake were measured and recorded according to good laboratory practice and OECD 425.

**Grouping and dosing:** Based on the LD<sub>50</sub> of *J. tanjorensis* leaf extracts, 8% of 5000 mg/kg body weight of the column fractions of ethyl acetate extract was used for the curative test. The method of Misganaw *et al.* [14] was employed and one hundred (100) mice were randomly selected and grouped as in Table 1.

**Table 1:** Grouping and dosages of experimental animals

Group (n=5)	Treatment	Dosage (mg/kg body weight/oral)
1a	Column Fraction 1-2 (CF 1-2)	100
1b	Column Fraction 1-2 (CF 1-2)	200
1c	Column Fraction 1-2 (CF 1-2)	400
2a	Column Fraction 3 (CF 3)	100
2b	Column Fraction 3 (CF 3)	200
2c	Column Fraction 3 (CF 3)	400
3a	Column Fraction 4-10 (CF 4-10)	100
3b	Column Fraction 4-10 (CF 4-10)	200
3c	Column Fraction 4-10 (CF 4-10)	400
4a	Column Fraction 11-15 (CF 11-15)	100
4b	Column Fraction 11-15 (CF 11-15)	200
4c	Column Fraction 11-15 (CF 11-15)	400
5a	Column Fraction 16-30 (CF 16-30)	100
5b	Column Fraction 16-30 (CF 16-30)	200
5c	Column Fraction 16-30 (CF 16-30)	400
6a	Sequential Ethyl acetate Extract (S-Ethyl A)	100
6b	Sequential Ethyl acetate Extract (S-Ethyl A)	200
6c	Sequential Ethyl acetate Extract (S-Ethyl A)	400
5	Positive Control - Chloroquine (CQ)	5
6	Negative Control - Distilled Water (DW)	10 ml/kg

**Curative test (Rane's test):** The method of Ndem *et al.* [15] was adopted for parasite inoculation, with three mice infected with *Plasmodium berghei* NK-65 as donor mice. Blood was collected and diluted with physiological saline to contain  $5 \times 10^7$  parasitic loads per 0.2 mL of solution. The Curative Rane test was performed on the ethyl acetate column fractions and crude extract of *J. tanjorensis* leaf using the method described by Umar *et al.* [16]. On day 0, the mice received an intraperitoneal injection of a standard inoculum (0.2ml) consisting of  $1 \times 10^7$  *Plasmodium berghei* NK-65 infected erythrocytes. On day 3, the pre-treatment parasitemia level was confirmed, and the mice were treated for 5 days with a single oral dose per day. Blood films were made daily from the tail of each mouse, stained with Giemsa, and examined microscopically. The mean survival time was calculated from the date of infection over 30 days. Haematological indices were determined using an autoanalyzer.

#### Statistical analysis

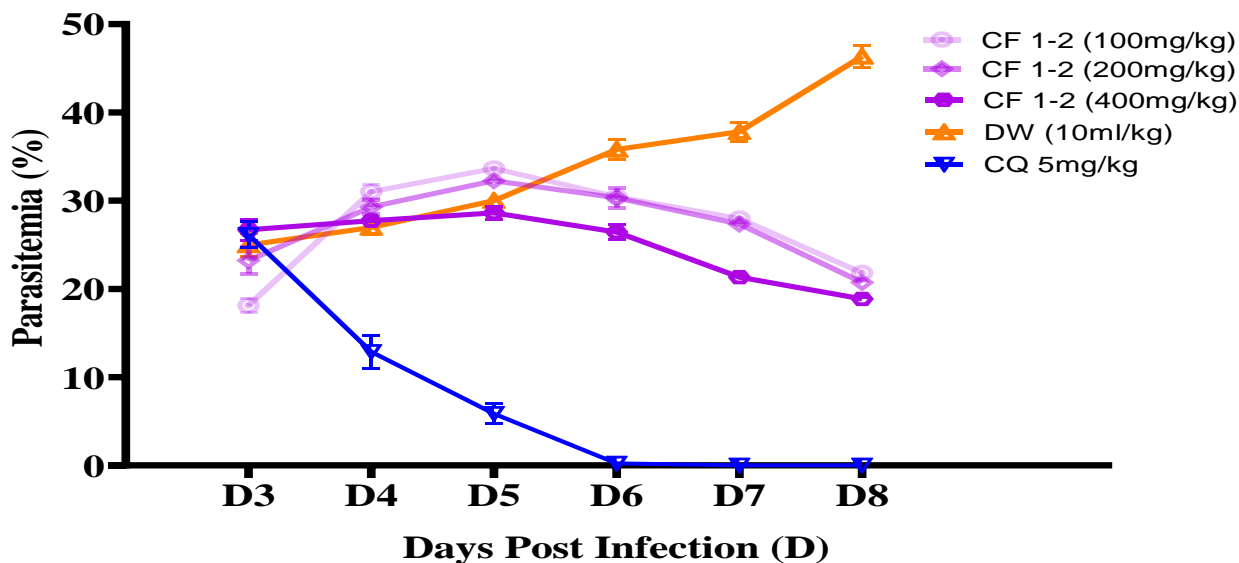
Data obtained was entered into Microsoft Excel and exported to SPSS (Statistical Package for Social

Sciences) version 25 for statistical analysis. Numerical data was presented as Mean  $\pm$  SD (Standard Mean deviation). The significance of the mean difference at  $p < 0.05$  between independent groups was determined using a one-way analysis of variance (ANOVA). The results obtained were presented in the form of tables, charts, and figures where appropriate.

## RESULTS

### Curative effect of column fractions of ethyl acetate extract of *Jatropha tanjorensis* leaf in *Plasmodium berghei* infected mice

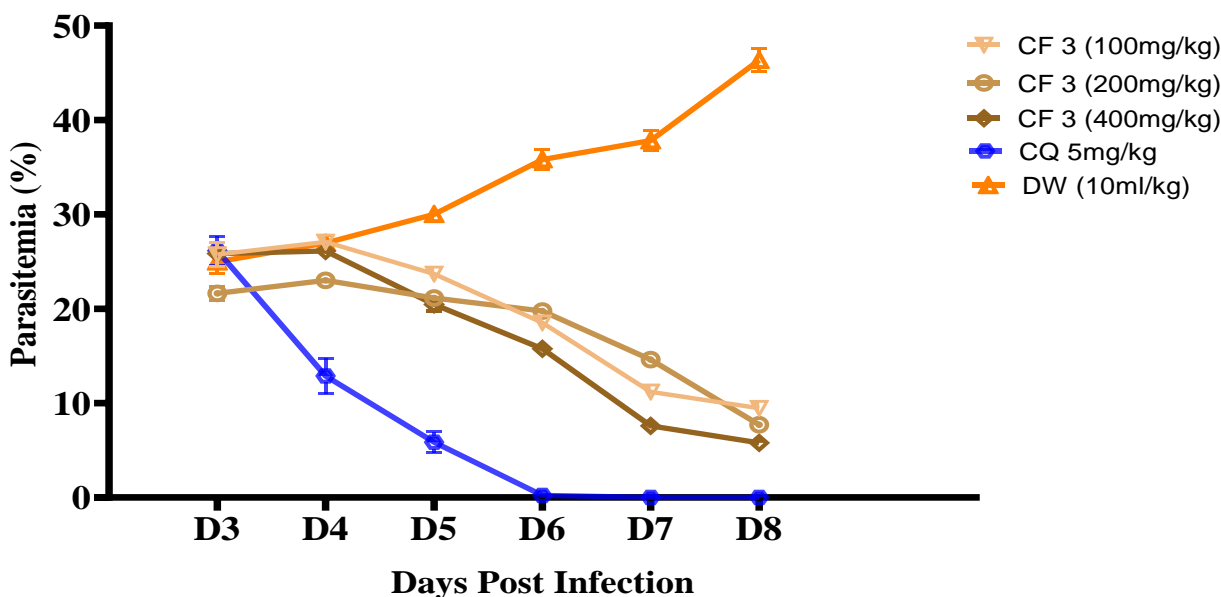
The result in Figure 1 showed that parasitemia levels in the group treated with the positive control (CQ) decreased from 12.9% on Day 4 to 0% on Day 8 while parasitemia in the negative control group treated with distilled water increased steadily up to 46.3% on Day 8. The parasitemia in the groups treated with 100, 200, and 400 mg/kg of column fraction (1-2) decreased slightly and steadily in a dose-dependent manner from 27.9% on Day 6 to 18.9% on Day 8.



**Figure 1:** Curative effect of column fraction (1-2) of ethyl acetate extract of *Jatropha tanjorensis* leaf in *Plasmodium berghei* infected mice

The result in Figure 2 showed a considerable reduction in parasitemia levels in the groups treated with increasing doses of column fraction (3) from 20.46% on Day 5 to 5.78% on Day 8. From the result, the reduction in parasitemia level was dose

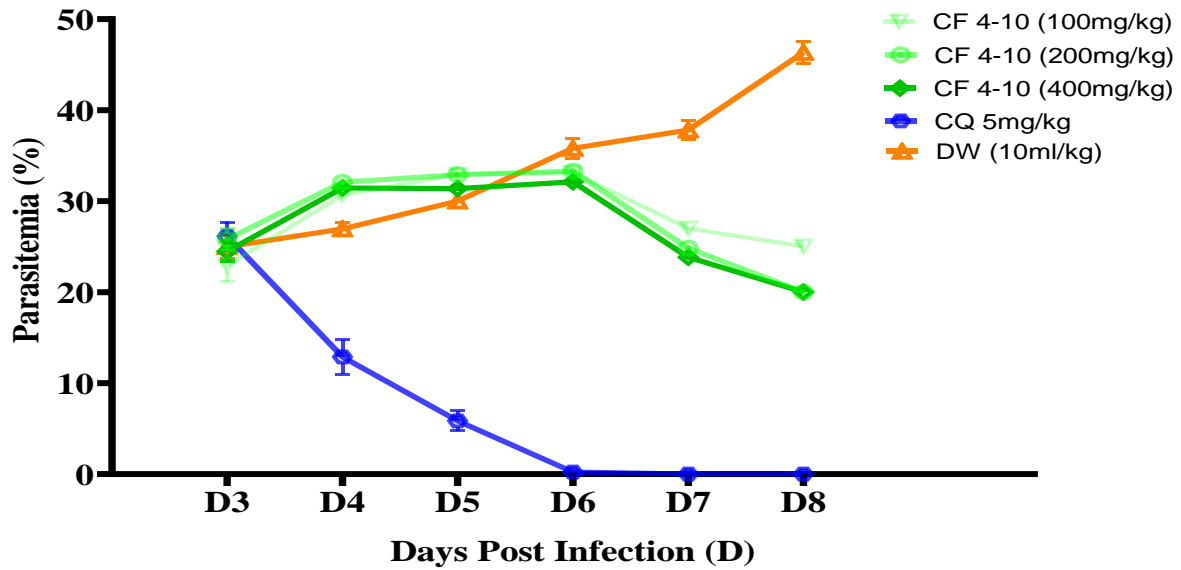
and time-dependent. However, the positive control (CQ) decreased from 12.9% on Day 4 to 0% on Day 8 while parasitemia in the negative control group treated with distilled water increased steadily up to 46.3% on Day 8.



**Figure 2:** Curative effect of column fraction (3) of ethyl acetate extract of *Jatropha tanjorensis* leaf in *Plasmodium berghei* infected mice

The result of parasitemia levels in the groups treated with graded doses of column fraction (4-10) is presented in Figure 3. From the result, parasitemia levels were steady from day 4 to Day 6, and then decreased from Day 7 to Day 8 (27.0% to 20.02%). The parasitemia levels of the graded doses of column

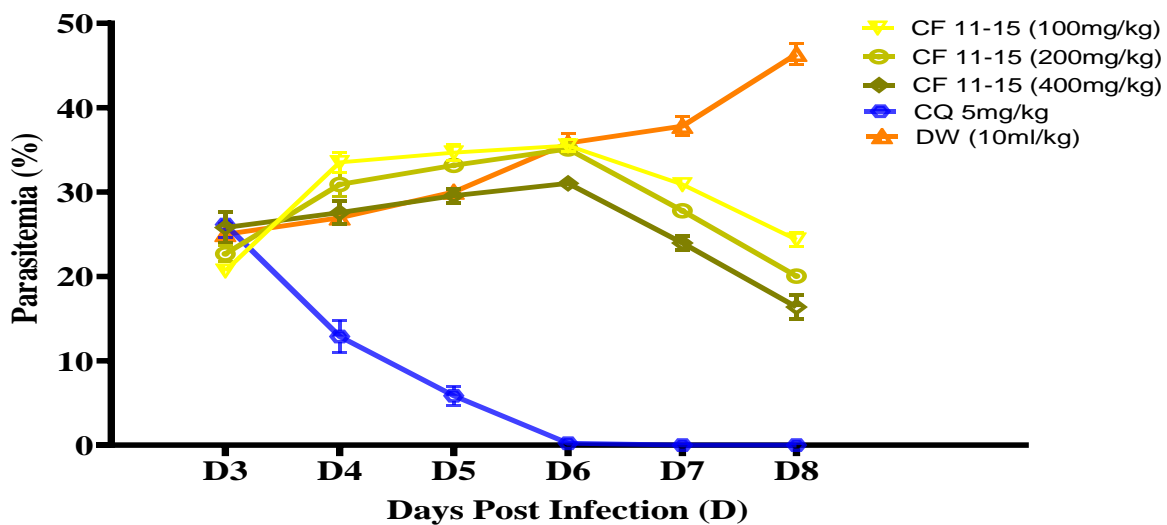
fraction (4-10) decreased in a similar pattern that was dose-dependent. The positive control (CQ) decreased from 12.9% on Day 4 to 0% on Day 8 while parasitemia in the negative control group treated with distilled water increased steadily up to 46.3% on Day 8.



**Figure 3:** Curative effect of column fraction (4-10) of ethyl acetate extract of *Jatropha tanjorensis* leaf in *Plasmodium berghei* infected mice

The result in Figure 4 showed a slight decrease in parasitemia levels in the groups treated with graded doses of column fraction (11-15) from 27.7% on Day 6 to 16.3% on Day 8 with the high dose exerting a greater effect. However, the positive control (CQ)

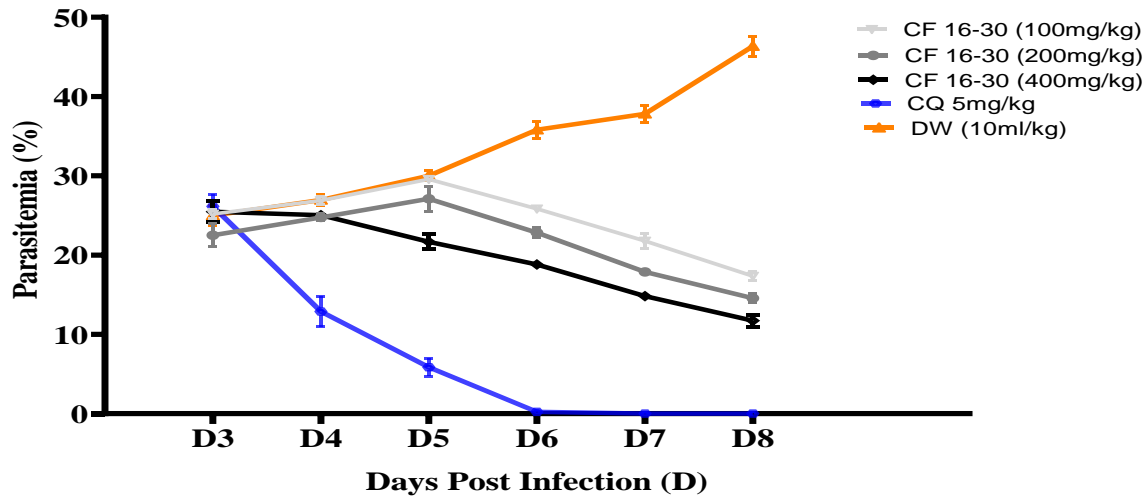
decreased from 12.9% on Day 4 to 0% on Day 8 while parasitemia in the negative control group given distilled water increased steadily up to 46.3% on Day 8.



**Figure 4:** Curative effect of column fraction (11-15) of ethyl acetate extract of *Jatropha tanjorensis* leaf in *Plasmodium berghei* infected mice

The result in Figure 5 showed the parasitemia levels in the group treated with graded doses of column fraction (16-30). From the result, parasitemia levels reduced from 21.8% on Day 5 to 11.7% on Day 8 in a dose and time dependent manner. The positive

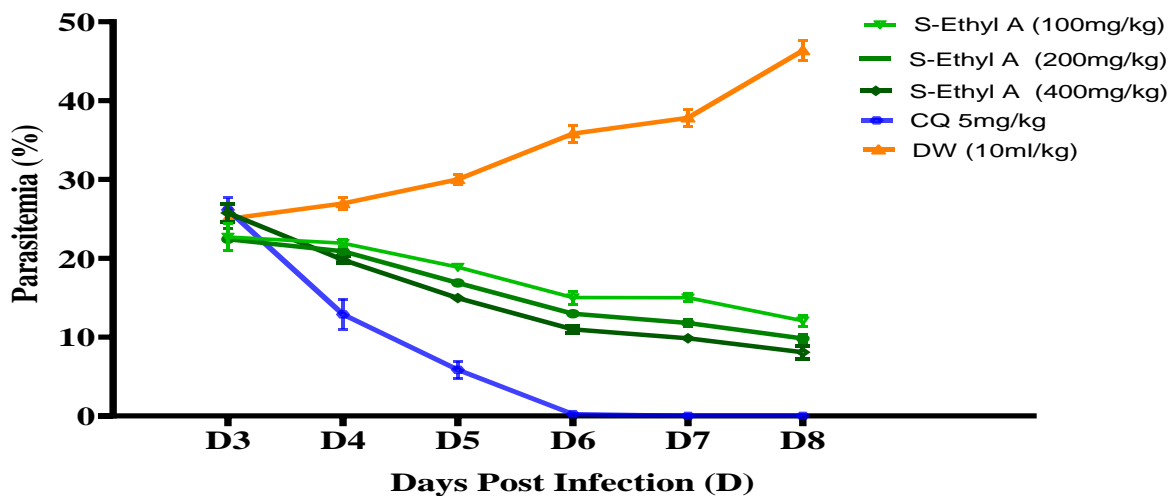
control (CQ) decreased from 12.9% on Day 4 to 0% on Day 8 while parasitemia in the negative control group given distilled water increased steadily up to 46.3% on Day 8.



**Figure 5:** Curative effect of column fraction (16-30) of ethyl acetate extract of *Jatropha tanjorensis* leaf in *Plasmodium berghei* infected mice

Figure 6 shows the result of parasitemia levels in the group treated with graded doses of ethyl acetate extract. There was a reduction in parasitemia levels from 18.9% on Day 5 to 8.0% on Day 8 in a dose and time-dependent manner. The positive control (CQ)

decreased from 12.9% on Day 4 to 0% on Day 8 while parasitemia in the negative control group given distilled water increased steadily up to 46.3% on Day 8.



**Figure 6:** Curative effect of ethyl acetate extract of *Jatropha tanjorensis* leaf in *Plasmodium berghei* infected mice

The results of the percentage change in red blood cell count, white blood cell count, platelet count, mean body weight, and mean survival time of Swiss albino mice across the period of curative test (Rane's test) are presented in Table 4. From the results, a significant difference ( $p < 0.05$ ) was observed in the % change in red blood cell count, white blood cell count, platelet count, mean body weight, and mean survival time between the experimental groups (i.e., groups treated with the extracts) and the negative control group. The negative control group exhibited

decreased % change in red blood cell count, platelet count, mean body weight, and mean survival time, with an increased % change in white blood cell count. Conversely, the groups treated with 100 and 200 mg/kg of column fractions (1-2), (4-10), (11-15), and (16-30) recorded a decrease in red blood cell count, platelet count, and % body weight, with an increased white blood cell count. However, the reverse was observed with the high dose of 400 mg/kg. The groups treated with graded doses of column fraction (3) and the ethyl acetate extract

(Ethyl A) showed an increase in red blood cell count, platelet count, body weight, and a decreased white blood cell count in a dose-dependent manner, which was higher than the result recorded by the positive control (CQ) group. The positive control group indicated a slight increase in red blood cell count, platelet count, and body weight, while the white blood cell count decreased slightly. Additionally, the

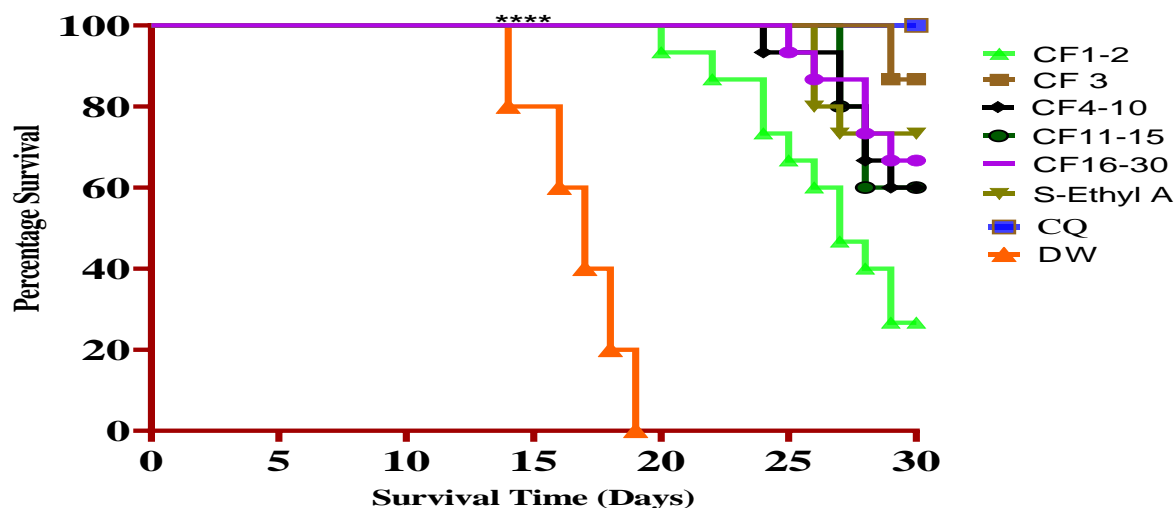
positive control group and the groups treated with 200 and 400 mg/kg doses of the different column fractions and the sequential ethyl acetate extract recorded a mean survival time of 30 days, while the groups treated with 100 mg/kg dose of the column fractions and the Ethyl A extract recorded mean survival time of between 16 and 30 days.

**Table 4:** Effect of column fractions and ethyl acetate leaf extract of *Jatropha tanjorensis* on percentage change in RBC count, WBC count, platelets count, mean body weight and mean survival time of mice infected with *Plasmodium berghei* after Rane's test

Groups	Dose	% Change in RBC (D0-D8)	% Change in WBC (D0-D8)	% Change in PLT (D0-D8)	% Change in BW (D0-D8)	Mean Survival Time (Days)
CQ	5 mg/kg	1.03 <sup>l</sup>	-1.27 <sup>j</sup>	5.08 <sup>h</sup>	5.98 <sup>j</sup>	30.00±0.00 <sup>d</sup>
DW	10 ml/kg	-46.42 <sup>a</sup>	62.96 <sup>q</sup>	-10.34 <sup>b</sup>	-22.18 <sup>a</sup>	16.80±1.92 <sup>d</sup>
CF 1-2	100 mg/kg	-18.60 <sup>b</sup>	31.48 <sup>pq</sup>	-3.16 <sup>e</sup>	-1.90 <sup>g</sup>	28.60±2.19 <sup>b</sup>
CF 1-2	200 mg/kg	-3.13 <sup>g</sup>	8.57 <sup>m</sup>	-5.09 <sup>d</sup>	-7.23 <sup>c</sup>	29.40±0.89 <sup>c</sup>
CF 1-2	400 mg/kg	7.70 <sup>m</sup>	-16.78 <sup>dc</sup>	11.05 <sup>ij</sup>	0.40 <sup>h</sup>	29.20±1.79 <sup>c</sup>
CF 3	100 mg/kg	2.05 <sup>k</sup>	-5.62 <sup>h</sup>	3.63 <sup>g</sup>	1.13 <sup>i</sup>	29.60±0.55 <sup>c</sup>
CF 3	200 mg/kg	2.65 <sup>kl</sup>	-8.13 <sup>g</sup>	6.40 <sup>hi</sup>	0.79 <sup>h</sup>	30.00±0.00 <sup>d</sup>
CF 3	400 mg/kg	4.92 <sup>l</sup>	-9.09 <sup>f</sup>	12.43 <sup>j</sup>	4.72 <sup>jk</sup>	30.00±0.00 <sup>d</sup>
CF 4-10	100 mg/kg	-4.21 <sup>f</sup>	12.31 <sup>m</sup>	-8.61 <sup>c</sup>	-8.09 <sup>b</sup>	26.60±2.07 <sup>b</sup>
CF 4-10	200 mg/kg	-1.01 <sup>h</sup>	1.6 <sup>k</sup>	-12.45 <sup>a</sup>	-6.20 <sup>d</sup>	27.20±2.39 <sup>b</sup>
CF 4-10	400 mg/kg	4.92 <sup>l</sup>	-11.11 <sup>c</sup>	11.67 <sup>i</sup>	4.17 <sup>j</sup>	28.60±1.95 <sup>b</sup>
CF 11-15	100 mg/kg	-5.18 <sup>e</sup>	20.55 <sup>n</sup>	-9.07 <sup>cd</sup>	-7.20 <sup>c</sup>	27.80±2.05 <sup>b</sup>
CF 11-15	200 mg/kg	-0.12 <sup>ij</sup>	7.63 <sup>l</sup>	-9.86 <sup>cd</sup>	-3.17 <sup>f</sup>	29.20±1.79 <sup>c</sup>
CF 11-15	400 mg/kg	1.56 <sup>j</sup>	-4.12 <sup>i</sup>	17.23 <sup>kl</sup>	2.00 <sup>ij</sup>	30.00±0.00 <sup>d</sup>
CF 16-30	100 mg/kg	-14.98 <sup>c</sup>	30.33 <sup>p</sup>	-0.16 <sup>f</sup>	-6.76 <sup>d</sup>	27.80±2.49 <sup>b</sup>
CF 16-30	200 mg/kg	-7.35 <sup>d</sup>	26.03 <sup>o</sup>	-4.33 <sup>e</sup>	-4.56 <sup>e</sup>	29.00±1.41 <sup>c</sup>
CF 16-30	400 mg/kg	6.67 <sup>m</sup>	-13.33 <sup>d</sup>	15.46 <sup>l</sup>	0.81 <sup>h</sup>	29.80±0.45 <sup>c</sup>
Ethyl A	100 mg/kg	11.72 <sup>o</sup>	-20.15 <sup>c</sup>	14.79 <sup>k</sup>	2.11 <sup>i</sup>	28.20±1.64 <sup>b</sup>
Ethyl A	200 mg/kg	14.81 <sup>p</sup>	-23.08 <sup>b</sup>	17.22 <sup>m</sup>	5.30 <sup>j</sup>	28.80±1.10 <sup>b</sup>
Ethyl A	400 mg/kg	33.63 <sup>q</sup>	-23.47 <sup>a</sup>	29.23 <sup>n</sup>	8.75 <sup>k</sup>	30.00±0.00 <sup>d</sup>

Results are expressed as Mean ± SD (n= 5), Data analysed using One-way analysis of variance (ANOVA), Duncan's post hoc test, and values with different superscripts are significantly different at ( $p < 0.05$ ). **RBC:** Red Blood Cell Count; **WBC:** White Blood Cell Count; **PLT:** Platelet Count; **CQ:** Chloroquine (positive control); **DW:** Distilled Water (negative control); **CF** = Column Fraction; **Ethyl A** = Ethyl acetate extract; **D0:** Day0; **D8:** Day8. Figure 7 shows the percentage survival time of experimental and control mice treated with different column fractions of ethyl acetate extract and the crude extract. The result indicates that there was 100%

survival of the mice treated with the positive control (CQ), while the experimental mice treated with column fraction (3) recorded 86.7%, and those treated with column fraction (1-2) showed a percentage survival of 25.0%. The groups treated with column fraction (4-10) and column fraction (11-15) indicated 60.0% survival, while the groups treated with column fraction (16-30) recorded 65% survival, and the groups treated with ethyl acetate showed 73.3% survival. In contrast, the negative control group given distilled water recorded 20% survival.



**Figure 7:** Percentage survival time of Swiss Albino mice treated with column fractions of ethyl acetate extract of *J. tanjorensis* leaf during Rane’s test. Survival data comparison (n= 6). CF = Column fraction; S-Ethyl A = Ethyl acetate extract; CQ: Chloroquine (positive control); DW: Distilled Water (negative control).

**DISCUSSION**

The findings of this study indicate that column fraction (3) of the ethyl acetate extract of *Jatropha tanjorensis* leaves exhibited significant antimalarial activity, reducing parasitemia levels to 5.78% in a dose- and time-dependent manner and achieving an 86.7% survival rate in infected mice. These results are consistent with the findings of Ebenyi et al. [17], who demonstrated that aqueous extracts of *Jatropha tanjorensis* leaves effectively reduced parasitemia and improved hematological parameters in mice infected with *Plasmodium berghei*. This underscores the antimalarial potential of *Jatropha tanjorensis*, particularly in targeting *Plasmodium falciparum*.

The curative test (Rane’s test) revealed a dose-dependent improvement in red blood cell count, platelet count, and body weight, coupled with a reduction in white blood cell count in groups treated with the positive control, column fraction (3), and ethyl acetate extract. These results align with the hematological improvements reported by Ocholor et al. [18], who observed that the aqueous extract of *Jatropha tanjorensis* leaves mitigated oxidative stress and restored normal hematological parameters in carbon tetrachloride-induced oxidative stress in Wistar rats. The observed benefits may be attributed to the plant’s bioactive compounds, which likely enhance red blood cell production and promote recovery from anemia.

Furthermore, the potential blood-replenishing effects of *Jatropha tanjorensis* align with findings by Chibuogwu et al. [19], who highlighted the safety and non-toxic nature of methanol leaf extracts in pharmacological applications, thereby supporting the plant’s use as a

blood tonic. Anaga and Opara [20] also reported the strong antioxidant properties of *Jatropha tanjorensis* leaves, which may contribute to their ability to protect red blood cells and improve overall hematological health during malaria treatment.

The bioactive compounds in *Jatropha tanjorensis* may have acted independently or synergistically to produce the observed outcomes, including antimalarial, anti-inflammatory, and antioxidant effects. These findings are consistent with Okoro and Osagie [21], who documented the anti-inflammatory effects of *Jatropha tanjorensis* leaf extracts in Wistar rats. The observed improvement in hematological parameters in this study further supports the plant’s role as a potential blood tonic nutraceutical with applications in anemia and malaria management.

Additionally, the antimicrobial properties of *Jatropha tanjorensis*, as reviewed by Oladeji et al. [22], emphasize the plant’s broad therapeutic potential. Its ability to combat infections may further enhance its role in malaria treatment by preventing secondary infections. Iweala and Obidoa [23] demonstrated the hepatoprotective effects of *Jatropha tanjorensis* leaves, suggesting their ability to support liver function during malaria treatment. This is critical, as malaria often causes liver damage and dysfunction.

Lastly, the findings of this study align with the antidiabetic potential of *Jatropha tanjorensis* leaves reported by Ayepola and Adeniyi [24], highlighting the versatility of the plant in addressing various health challenges. The combined evidence from this and previous studies strongly supports the potential of *Jatropha tanjorensis* as a valuable natural resource for developing nutraceuticals and

pharmaceuticals, particularly for managing malaria, anemia, and other related conditions.

## CONCLUSION

The column fraction (3) of the ethyl acetate extract exhibited remarkable inhibitory potential, reducing parasitemia levels from 20.5% to 5.8% between Day 5 and Day 8 of treatment. This effect was accompanied by weight gain, increased red blood cell (RBC) and platelet counts, and a reduction in white blood cell (WBC) count, with an overall survival rate of 86.7% among the experimental mice. These findings suggest that with extended treatment duration and higher doses, the column fraction (3) may demonstrate curative potential, highlighting its promise as a candidate for antimalarial therapy and hematological health enhancement.

## REFERENCES

1. NNAMONU, E.I., NDUKWE-ANI, P.A., IMAKWU, C.A., OKENYI, C.I., UGWU, F.J., ANIEKWE, M.I. & EZENWOSU, S.U. (2020). Malaria: Trend of Burden and Impact of Control Strategies. *International Journal of Tropical Disease & Health*, 18-30.
2. WORLD HEALTH ORGANIZATION (2022). World Malaria Report 2022. Switzerland: World Health Organization.
3. CRUZ-BUSTOS, T., FEIX, A.S., RUTTKOWSKI, B. & JOACHIM, A. (2021). Sexual development in non-human parasitic apicomplexa: just biology or targets for control. *Animals*, 11(10): 2891.
4. GHAZANFARI, N., MUELLER, S.N. & HEATH, W.R. (2018). Cerebral malaria in mouse and man. *Frontiers in Immunology*, 9: 2016.
5. FLORES-GARCIA, Y., HERRERA, S.M., JHUN, H., PÉREZ-RAMOS, D.W., KING, C.R., LOCKE, E. & ZAVALA, F. (2019). Optimization of an in vivo model to study immunity to Plasmodium falciparum pre-erythrocytic stages. *Malaria Journal*, 18(1): 1-9.
6. ALI, A.H., SUDI, S., SHI-JING, N., HASSAN, W.R.M., BASIR, R., AGUSTAR, H.K. & LATIP, J. (2021). Dual anti-malarial and gsk3 $\beta$ -mediated cytokine-modulating activities of quercetin are requisite of its potential as a plant-derived therapeutic in malaria. *Pharmaceuticals*, 14(3): 248.
7. RAMAPRASAD, A., KLAUS, S., DOUVROPOULOU, O., CULLETON, R., & PAIN, A. (2021). Plasmodium vinckei genomes provide insights into the pan-genome and evolution of rodent malaria parasites. *BMC Biology*, 19(1): 1-22.
8. OLADEJI, O.S., PETER, O., DEBORAH, T.B. & TOKUNBO, Y.A. (2020). Natural Products as Sources of Antimalarial Drugs: Ethnobotanical and Ethnopharmacological Studies. *Scientifica*, 2(22): 25-29.
9. OECD 425 (2008). Acute oral toxicity: Up and down procedure. Guideline for the Testing of Chemicals, pp. 1-2.
10. AIWONEGBE, A.E., OMORUYI, U., OGBEIDE, O.K., IMOUKHUEDE, B.O. & GABRIELSSON, B.O. (2022). Anxiolytic Effects, Antioxidant and Anti-inflammatory Activities of the Methanol Extract of *Jatropha tanjorensis* Leaf. *Tanzania Journal of Science*, 48(3): 596-606.
11. MATABANE, D.L., GODETO, T.W., MAMPA, R.M. & AMBSHE, A.A. (2021). Sequential Extraction and Risk Assessment of Potentially Toxic Elements in River Sediments. *Minerals*, 11(8): 874.
12. ŠEGAN, S., ŽIVKOVIĆ-RADOVANOVIĆ, V., TOSTI, T., RISTIVOJEVIĆ, P., & MILOJKOVIĆ-OPSENICA, D. (2021). Thin-layer chromatography in bioassays of antimicrobial compounds from plants. *Journal of Liquid Chromatography & Related Technologies*, 44(9-10): 507-518.
13. ABUBAKAR, A.R. & HAQUE, M. (2020). Preparation of medicinal plants: Basic extraction and fractionation procedures for experimental purposes. *Journal of Pharmacy and Bioallied Sciences*, 12(1): 1-10.
14. MISGANAW, D., AMARE, G.G. & MENGISTU, G. (2020). Chemo suppressive and curative potential of Hypoestes forskalei against Plasmodium berghei: evidence for in vivo antimalarial activity. *Journal of Experimental Pharmacology*, 313-323.
15. NDEM, J.I., BASSEY, E.I., EFFIONG, B.O., BASSEY, U.E. & INI, S.D. (2019). Haematopoietic potential of *Jatropha tanjorensis* leaf extract in Plasmodium berghei-berghei infected mice treated with Hippocmiceea africana root bark extract. *Journal of Diseases and Medicinal Plants*, 5(4): 69-73.
16. UMAR, M.B., ABDULSALAMI, H., ISIAQ, R.B., ODU, N.M. & MUHAMMAD, F.M. (2022). Evaluation of the in vivo anti-plasmodial activity of ethyl-acetate extract of *Cassia occidentalis* leaf in Plasmodium berghei-infected mice. *AROC in Natural Product Research*, 2(1): 13-20.
17. EBENYI, L.N., YONGABI, K.A., ALI, F.U., OMINYI, M.C., ANYANWU, C.B., BENJAMIN, E. & OGBANSHI, M.E. (2021). Effect of Aqueous Leaf Extract of *Jatropha tanjorensis* on parasitaemia and

- haematological parameters in mice infected with *Plasmodium berghei*. *Nigerian Journal of Biotechnology*, **38**(1): 146-153.
18. OCHULOR, O.C., NJOKU, O.U., UROKO, R.I. & EGBA, S.I. (2018). Nutritional composition of *Jatropha tanjorensis* leaves and effects of its aqueous extract on carbon tetrachloride induced oxidative stress in male Wistar albino mice. *Biomed Research Journal*, **29**(19): 3569–3576
19. CHIBUOGWU, C.C., NJOKU, U.O., NWODO, F.C.O., OZOUGWU, V.O.E. & NWEZE, N.V. (2021). Toxicity assessment of the methanol extract of *Jatropha tanjorensis* (Euphorbiaceae) leaves. *Future Journal of Pharmaceutical Sciences*, **7**: 143-148.
20. ANAGA, A.O. & OPARA, J.I. (2020). Antioxidant properties of *Jatropha tanjorensis* leaves. *Journal of Medicinal Plants Research*, **14**(6): 123-130.
21. OKORO, O. & OSAGIE, S. (2019). Anti-inflammatory effects of *Jatropha tanjorensis* leaf extract in Wistar rats. *Nigerian Journal of Experimental and Clinical Biosciences*, **7**(2): 98-105.
22. OLADEJI, S.O., ODELEYE, M.O. & ADEWOLE, A.A. (2022b). Review on the antimicrobial properties of *Jatropha tanjorensis*. *African Journal of Plant Science*, **16**(1): 23-33.
23. IWEALA, E.E.J. & OBIDOA, O. (2021). Hepatoprotective effects of *Jatropha tanjorensis* leaf extract on carbon tetrachloride-induced liver damage in rats. *Journal of Ethnopharmacology*, **278**: 114327.
24. AYEPOLA, O.R. & ADENIYI, B.A. (2019). Antidiabetic potential of *Jatropha tanjorensis* leaves. *BMC Complementary and Alternative Medicine*, **19**: 45.