

Research Article

Hepatotoxicity Following Concurrent Administration of Aqueous Extract of Azadirachta Indica Leaf (Neem Leaf) and Chloroquine Sulphate in Rabbits

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Abstract: Background: Recently herbal medications have been introduced into modern health scheme for the treatment of diseases. Aqueous extract of *A. indica* is commonly used in treatment of malaria in combination with chloroquine, especially now that a combined therapy is said to be more effective. Objectives: This study is designed to investigate the effects of aqueous extract of *A. indica* leaf and concomitant administration of chloroquine sulphate+aqueous extract of *A. indica* leaf on the weight and liver cells of rabbit. Methods: Eight adult male rabbits with average weight range between 1.29 kg-1.52 kg obtained from department of Zoology University of Ekpoma, Edo state, Nigeria, were used for this study. They were weighed at intervals of five days before and after the experiment. They were randomly divided into four groups (A-D) of two rabbits each. The chloroquine and aqueous extract of *A. indica* leaf was administered to the animals orally via a cannula inserted through the oral cavity. They were treated as follows, group A received (15 mg/kg dry extract solution of aqueous extract of *A. indica*), Group B received (15 mg/kg of chloroquine sulphate), group C received (100 mg/mL dry extract solution of aqueous extract of *A. indica*+15 mg/kg of chloroquine sulphate and the control animals (group D) were given normal saline. Both treatment and control animals were sacrificed at the end of the experiment. The liver was carefully dissected out and immediately fixed in Bouin's fluid for histological studies. Results: Groups A-D animals showed normal liver histoarchitecture and increase in weight: 2.1% (group A), 1.4% (group B), 0.7%, (group C) and 1.4% (group D) respectively. When the average weight increase by the treated animals was compared to the average weight increase by the control animals, it was statistically not significant ($p>0.6$). Conclusions: Our findings revealed that aqueous extract of *A. indica* leaf has no effect on the histology of the liver and weight of adult male rabbits, even when it is administered concomitantly with chloroquine sulphate at a reported and recommended safe dose.

Keywords: Aqueous extract, *Azadirachta indica* leaf, chloroquine sulphate, histoarchitecture, liver, rabbits, weight

INTRODUCTION

The use of herbal medications in the treatment of malarial is popular in many parts of Africa and Asia where malarial infestation is endemic, *Azadirachta indica* A. Juss (Meliaceae), in many countries referred to as the neem tree (Dogonyaro) has been extensively reported as being effective in the treatment of malarial caused by various strains of plasmodium parasite even those resistant to traditional antimalarial drugs Nwafor *et al.*, 2003; Iwu *et al.*, 1986; Okpanyi *et al.*, 1981; Obaseki and Fadunson, 1982; Khalid *et al.*, 1986a, b; Nokov *et al.*, 1982), reported that serious phytochemical constituents have been isolated from the neem plant and demonstrated to possess antimalarial properties. The use of chloroquine as a single first line drug treatment is now increasingly limited following the evolution of chloroquine-resistant Plasmodium Falciparum. Nevertheless, the low cost and easy

availability makes chloroquine the choice for most patients in Africa (Nwafor *et al.*, 2003).

The neem tree, a member of the Meliaceae family, appears to have originated in India and Southeast Asia and been spread throughout drier lowland tropical and subtropical regions of Africa, the Middle East, the Americas, Australia and South Pacific islands. The leaves, used as medicine, are generally available year-round as the tree is ever green except during severe droughts or if exposed to frost. In these ancient texts neem is mentioned in almost 100 entries for treating a wide range of diseases and symptoms (Schmutterer *et al.*, 1995). Neem came close to providing a cradle-to-grave health care programme and was a part of almost every aspect of life in many parts of Indian subcontinent up to and including the modern era (Malanie, 2003). The major active constituents in neem are terpenoids such as azadirachtin, which are considered to be antimicrobial and insect repellent

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amongst many other actions and fatty acids and possibly other compounds in neem oil (Remboid, 1989; Schmutterer *et al.*, 1995).

Historical or traditional use (may or may not be supported by scientific studies); it has a long history of use in the traditional medical systems of India (Schmutterer *et al.*, 1995). Neem leaf and bark extracts are most consistently recommended in ancient medical texts and by herbal practitioners for treatment of diseases such as gastrointestinal upsets, diarrheal, intestinal infections, Skin ulcers infections and malaria (Schmutterer *et al.*, 1995). Neem twigs are the most regularly used toothbrush for a large portion of the population of India and Nigeria and other countries where the tree is common (National Research Council, Board on Science and Technology for International Development, 1992). The claimed contraceptive effects of neem have been confirmed in some animal studies showing that seed extracts of neem are spermicidal (Garg *et al.*, 1993).

The effectiveness of many of the uses of aqueous extract of neem leaf have been confirmed in modern research studies, showing, for example, that leaf extracts can combat scabies infections (Bandyopadhyay *et al.*, 2004; Pai *et al.*, 2004; Charles and Charles, 1992). The potential adverse effects and its safety on some human vital organs have been reported; Ucheya and Ochei (2011a) in her extensive research work on the use of aqueous extract of neem leaf as antimalarial agent reported that “the administration of *A. indica* at a high dose beyond 350 mg/kg/day of aqueous extract of *A. indica* leaf should be avoided especially in pregnant state in order to prevent low birth weight. Ucheya and Ochei (2011b) reported that aqueous extract of *Azadirachta indica* leaf at a dose greater than 350 mg/kg/day is capable of inducing teratogenic effects on the liver histology, liver weight and body weight of neonatal rats therefore the use of aqueous extract of *A. indica* leaf during pregnancy in the treatment of malaria and other diseases at a dose >350 mg/kg/day should be avoided. In their investigation titled “is a safe dose of aqueous extract of *A. indica* toxic on the histology of the rabbit liver?” they reported that a safe dose (≤ 350 mg/kg body weight of rabbit) of aqueous extract of *A. indica* should be administered when used as a curative agent for any disease”. In their findings on “is a combine therapy of aqueous extract of *A. indica* leaf (neem leaf) and chloroquine sulphate toxic to the histology of the rabbit cerebellum? they reported that though a concomitant administration of chloroquine and aqueous extract of *A. indica* is capable of altering the pharmacokinetic properties of serum level and chloroquine in blood plasma, it has no effect on the histology of the cerebellum when administered at a recommended safe dose and despite the fact that it has been previously reported by several authors (Nwafor *et al.*, 2003; Malanie, 2003, Nokov *et al.*, 1982; Pant

et al., 1986) to consist of biologically active substances, these substances apparently have no effect on the histology of the rabbit brain when administered at a reported/recommended safe dose. They also investigated on the histological changes in rabbit kidney following a concomitant administration of aqueous extract of neem leaf and chloroquine sulphate, they reported that if *A. indica* is given at a safe concentration/dose, it is safe on the histology of the kidney and can be administered concomitantly with chloroquine sulphate if further research is carried out to prevent its ability to induce the reduction of the pharmacokinetic properties of chloroquine in the plasma when administered concomitantly (Ucheya and Ochei, 2011c).

Acetone-water neem leaf extract has been reported to have antimalarial (Udeinya *et al.*, 2006) and antiretroviral potentials (Udeinya *et al.*, 2006). Traditionally, neem has been administered as roughly 10 to 20 mL (2 to 4 teaspoons) of leaf juice or 2 to 4 g (1/7 to 1/10 of an ounce) of powdered leaf two or three times per day (Khare, 2004). Leaf extract gel or toothpaste, 1 g (1/5 of a teaspoon) in the morning and at bed time brushed all over the mouth, has been shown helpful for people with stomach ulcers (Bandyopadhyay *et al.*, 2004). Creams containing 5% or more of neem oil or neem leaf extracts are typically applied at least twice per day for skin or vaginal infections. Neem oil (in a concentration of 1 to 4%) mixed in coconut, mustard, or other oil base is used for repelling insects (Mishra *et al.*, 1995).

Neem leaf extracts and teas appear to be very safe at recommended intake levels with no significant reports of problems, neem should be avoided in pregnancy until its safety is demonstrated (Ucheya and Ochei, 2011d). Water extracts of neem leaf have been shown to decrease blood levels of chloroquine in rats (Nwafor *et al.*, 2003).

Malaria is a tropical disease that poses serious problems on human well-being especially in tropical countries where the environs provides conducive ground for the parasite to thrive well. This disease is a global problem because of migration and the mutant potential of the parasite in living organisms (Ucheya and Ochei, 2011a), with legal introduction of herbal medications into national health scheme, scientist have embarked on several researches as to investigate the possibilities of using neem extracts to cure some tropical diseases such as malaria, trypanosomiasis, leishimiasis, cholera, dysentary, stroke, hypertension, cough, mouth odour, bleeding, diabetes amongst others.

Irrespective of all reports on curative potential of neem extracts, Nwafor *et al.* (2003) reported that water extracts of neem leaf have been shown to decrease blood levels of chloroquine in rats, so these should not be combined until their safety can be demonstrated in humans (Nwafor *et al.*, 2003). However, he emphasized

that at the time of his research there was no well known drug interactions with neem. Anatomically we intend to investigate the hepatic histo-architecture, since it is an organ commonly affected by malarial parasites, Secondly, neem has been documented to be a universal plant and though undocumented; it is widely used in Nigeria especially by the villagers without knowledge of neither the accurate dosage nor the adverse effects, thirdly, researchers who have worked on neem leaf extracts have suggested that the safety of the dose and extract employed should be checked and confirmed (Nwafor *et al.*, 2003).

The reports of adverse effects of unconventional medications have stimulated researchers to investigate on plants parts commonly use as herbal medications. However, this has formed the basis for this research work since the liver is the major organ for detoxification of drugs and toxins.

MATERIALS AND METHODS

Materials: Soxhlet extractor (50 mL capacity), Mattler weighing balance, dissecting instruments-set, tissue processing materials (Xylene, Formaline, Alcohol, Rotary microtome, Knife, Slides, Cover slips, Paraffin and embedding mould. Microscope with digital camera, film mountant. Test chemical- aqueous extract of neem. Chloroquine sulphate (May and Baker, Products, UK), Nivaquine Fort®, a brand of chloroquine sulphate (May and Baker Pharmaceutical PLC, Nigeria), fresh leaves of *A. indica* (collected from neem trees at the campus of the University of Nigeria, Enugu campus. Digital pH meter (P107, Consort, Belgium), ultraviolet-visible spectrophotometer (SP 8-100, Pye Unicam, UK), centrifuge (Beckman GS-15, UK), were used.

Animals: A total of eight healthy adult male rabbits weighing between 1.29 to 1.52 kg (bought from Zoology department university of Ekpoma, Edo-state Nigeria, were used for this study. They were randomly divided into (4) groups of two Rabbits each. Group (A) was administered aqueous extract of *A. indica* only, group (B) was administered Chloroquine Sulphate only, group (C) was given a combination of chloroquine and aqueous extract of *A. indica* leaf, while group (D) was the control and was given feed and saline water ad libitum. They were allowed two weeks for acclimatization. Ethical standards of the University were adhered to in the course of the study (Nwafor *et al.*, 2003).

Extract preparation: The method used by Nwafor *et al.* (2003) was employed. The leaves were cut fresh and allowed to air dry under room temperature. The extract was prepared as follows: fresh leaves of *A. indica* (580 g) were thoroughly mashed in distilled water (2 L). The decoction was filtered using a clean sieve cloth. Its concentration was determined by

evaporating the extract to dryness. Freshly prepared extracts were used. Concentration of the aqueous extract was found to be 15.25 mg/mL dry extract and pH was 5.2, indicating a weakly acidic extract. The extractive yield (expressed as dry mass of the extract relative to the mass weight of the leaves) was determined to be 4.2%. The extract was concentrated so as to prepare 100 mg/mL dry extract solution.

Determination of chloroquine sulphate: The method used by Nwafor *et al.* (2003). Nivaquine Fort® (a brand of chloroquine sulphate) was suspended in 3% Tween 85 to give 100 mg/mL suspension. The animals were given between 0.16 and 0.21 mL of the chloroquine sulphate suspension. The animals were given between 0.16 and 0.21 mL of the chloroquine sulphate suspension depending on their body mass. Both chloroquine sulphate and the extract were administered to the animals orally via a cannula inserted through the oral cavity. The experiment commenced by administration of 15 mg/kg of chloroquine sulphate to each rabbit orally. This dosing was based on the 15 mg/kg loading dose of chloroquine sulphate in humans (Emdex Desk Reference, 2001). The second part of the experiment commenced following the end of the 1st part by administration of 15 mg/kg of chloroquine sulphate (Nwafor *et al.*, 2003) orally to each rabbit and 100 mg/kg of aqueous extract of *A. indica* was immediately administered orally to each rabbit, this was based on the report that aqueous extract of *A. indica* is safe at a concentration ≤ 350 mg/kg/bodyweight of mice (Ucheya and Anibeze, 2009). The animals received between 1.1 and 1.4 mL of the aqueous extract relative to their body mass. The third group (c) was administered 15 mg⁻¹ chloroquine phosphate concomitantly with 100 mg/kg of aqueous extract of *A. indica* leaf. The histology of the liver structure was compared for the drug administered alone, with that administered concomitantly with the aqueous extract of *A. indica*. Finally, the animals for the drug administered alone with that administered concomitantly with the aqueous extract of *A. indica* were compared with that of the control animals. The animals were then weighed and the mean weight for each group was noted. This was done for (15) days at interval of (5) days from the time of acclimatization of animals' upto (15) days after drug administration. At the end of the fifteenth day after drug administration, the animals were sacrificed by inhalation of chloroform. The liver from each experimental and control animals were immediately extracted for histological processing and production of Photomicrograph.

The microscopic features of the liver in the Photomicrographs were assessed by comparing the cell architecture of the treated animals in groups A-C with the cell architecture of control animals in group D.

Significance of the difference between the control and test values was evaluated using Student's *t*-test.

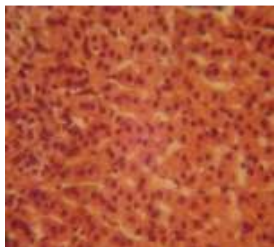


Fig. 1: Histology of the liver of the control animals. Shows normal liver architecture with normal. Mag. X400 (H&E)



Fig. 2: Histology of the liver of Rabbit treated orally with aqueous extract of *indica* only. Shows normal liver architecture, with no injury or Inflammatory reaction Mag. X400 (H&E)

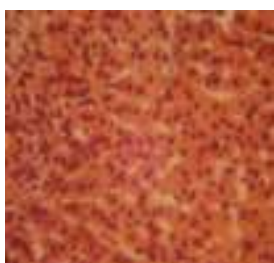


Fig. 3: Histology of the liver tissue of Rabbit (control animals) treated orally with chloroquine sulphate. Shows normal liver architecture with normal sinusoidal cells. X400 (H&E)

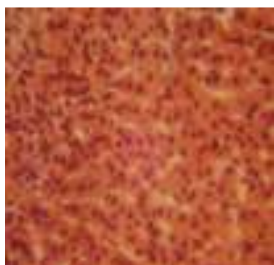


Fig. 4: Histology of the liver tissue of rabbit treated concomitantly with Chloroquine and Aqueous extract of *A. indica* orally. Shows the sinusoidal cells to be normal. Mag. X400 (H&E)

This was done using the computer programme 'Statistical Package for Social Sciences (SPSS)', version 15.0. $p < 0.05$ was taken as the significant level.

RESULTS

The effect of aqueous extract of *A. indica* leaf on the histology of the liver tissue: The control animals revealed a normal histoarchitecture as shown in the photomicrographs of the animals in group D. This is evidenced in the photomicrograph of the liver tissue, which reveals a normal microscopic structure of the liver, this is presented in the photomicrographs by the presence of normal cell features such as: regularly arranged sinusoids without any loss of liver cells (Fig. 1).

The histology of the liver of rabbit that was treated orally with aqueous extract of *A. indica* only, shows a normal architecture of the liver cell, with no injury or inflammatory reaction of the sinusoidal cells (Fig. 2). The histology of the liver tissue of rabbit that was treated orally with chloroquine presented a normal architecture of the liver cells which is evidenced by the normal appearance of the liver sinusoids (Fig. 3). Histology of the kidney tissue of rabbits treated concomitantly with chloroquine and aqueous extract of *A. indica* orally (group C) revealed a normal histoarchitecture of the liver tissue and was demonstrated by the normal appearance of the liver cells (Fig. 4).

The effect of aqueous extract of *A. indica* leaf on the body weight of the adult male rabbits: Groups A, B and C animals showed varying average percentage weight increase of 2.1% (group A), 1.4% (group B), 0.7% (group C) respectively. When the average percentage body weight increase by the treated animals in groups A, B and C was compared to the average percentage body weight increase by the control animals (group D), it was statistically not significant ($p > 0.06$) as shown in Table 1.

DISCUSSION

The Analysis of results obtained from this study shows that the animals that received aqueous extract of *A. indica* orally in the treated group (A), revealed a normal histoarchitecture of the liver cells (Fig. 2) and a weight increase of 2.1% (Table 1). This result is in consistence with the report by Ucheya and Anibeze (2009) on "Histological changes in mice organs administered with various concentrations of neem extracts (*Azadirachta indica*)" in which they reported that aqueous extract of *A. indica* leaf on the histology of liver at a concentration ≤ 350 mg/kg/body weight is safe on the histology of mice organs including the liver. The animals in group (B) that were administered chloroquine sulphate also presented a normal liver cell architecture (Fig. 3) and a percentage increase in body weight of 1.4% (Table 1). This is in consonant with the report that chloroquine is safe on the organ when used at a dose recommended to be safe but when administered indiscriminately without prescription through over the counter sales of drugs, it is capable of

Table 1: Showing effects of aqueous extract of *Azadirachta indica* alone, Chloroquine alone and a combined Administration of aqueous extract of *A. indica* leaf+Chloroquine Sulphate on the weight of male rabbits

Animal group	Mean weight before drug administration (kg) (a)	Mean weight at 5th day of drug administration (kg) (b)	Mean weight at 10th day of drug administration (kg) (c)	Mean weight at 15th day of drug administration (kg) (d)	Mean weight difference (kg) (d-a)	Percentage weight gained (kg)
A	1.41±1.3	1.42±1.3	1.44±1.1	1.44±0.3	0.03±1.0	2.1%
B	1.43±1.4	1.43±1.4	1.44±3.1	1.45±2.1	0.02±0.7	1.4%
C	1.48±0.4	1.48±0.4	1.48±0.4	1.49±0.3	0.01±0.1	0.7%
D	1.43±1.4	1.44±2.2	1.44±3.1	1.45±2.4	0.02±3.4	1.40%

The weight gained was statistically not significant when compared to the control at $p > 0.06$

inducing derangement of the liver (Ngokere and Ngokere, 2005) The animals in group (C) that were administered with chloroquine sulphate+aqueous extract of *A. indica* leaf revealed normal hepato architecture (Fig. 4), there was also an increase in body weight (Table 1). However, this contradicts the report by Nwafor *et al.* (2003) that a concomitant administration of chloroquine and aqueous extract of *A. indica* leaf caused changes in of pharmacokinetic properties “a significant decrease in the serum concentration, slower absorption and elimination as well as longer half-life of chloroquine sulphate”. The group D animals (control) that were administered with saline water only also showed a normal hepato architecture which is presented by normal and regularly arranged sinusoidal cells.

The present investigation shows that even though a concomitant administration of chloroquine and aqueous extract of *A. indica* is capable of altering the pharmacokinetic properties of serum level and chloroquine in blood plasma, it has no effect on the histology of the liver when administered at a dose recommended safe. Though the effect of administration of a combine therapy of aqueous extract leaf + chloroquine sulphate on the hepato architecture is in contrast with the, effect on the pharmacokinetics properties of chloroquine in the blood plasma as reported by Nwafor *et al.* (2003), but it is in consonant with the report that combine therapy of aqueous extract of *A. indica* leaf and chloroquine sulphate is safe on the histology of the cerebellum and Kidney when administered (Ucheya and Ochei, 2011a, d).

From our present findings, it is suggested that before a concomitant therapy of aqueous extract of *A. indica* leaf and chloroquine sulphate can be employed in the treatment of malaria further research should be carried out to ascertain its possible effects on other organs and the pharmacokinetic properties of chloroquine sulphate in the serum.

Conclusively, even though *A. indica* leaf has been reported (Nwafor *et al.*, 2003; Malanie, 2003; Nokov *et al.*, 1982; Khosla *et al.*, 2000; and Pant *et al.*, 1986), to consist of biologically active substances, these substances apparently have no effect on the histology of the rabbit liver when administered at a dose recommended as safe by researches. It is recommended that further studies be carried out to corroborate these findings.

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