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Mini Review

A Review on Medicinal Uses and Pharmacological Activities of African Star Apple *(Chrysophyllum albidum)*

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Abstract

African star apple also known as *Chrysophyllum albidum* is a medicinal plant used in various vegetation zone in Uganda, Nigeria, Niger, Cameroon and Coted'voire due to its pharmacological activities (antioxidant, anti-diabetes, anti-plasmodial, anti-microbial and among other). The studies has been shown that this plant is enriched with various phytoconstituents such as alkaloids, tannins, Saponins, flavonoids, terpenoids, steroids, cardiac glycosides, phlobatanin, phenols etc. Therefore, this review summarized the medicinal uses, phytoconstituents and pharmacological activities of *C. albidum.*

Keywords: *Chrysophyllum albidum*; Phytoconstituents; Alkaloids; Pharmacological; Antioxidant

Introduction

African star apple belong to family *sapotacea*, a plant species usually found in various various vegetation zone in Uganda, Nigeria, Niger republic, Cameroon and Coted'coire [11,18].

C. albidum is seasonal fruit usually available during dry season (December to March) with a small to medium tree species, up to a height of 25 - 37 meters having a mature girth varying from 1.5 to 2.0 meter [30,32].

It is found that *C. albidum* contain high amount of abscorbic acid when compared with orange, cashew, and guava [5,9,25,26], other Vitamin, iron, food flavor, fat, carbohydrates and mineral elements such sodium, magnesium, potassium etc. [7,17,29,48].

The seeds are good source of oil which is used for different purposes [9,11,22,32].

The roots, barks, fruit pulp and seeds of albidum have different medicinal uses. For instance, Anan., *et al.* [32], olorunnisola and Sayyar., *et al.* [45] reported that the roots, bark and the leaf of *C. albidum* are used as natural remedy to sprain, bruise and wound in southern Nigeria and also inhibit microbial growth of known wound contaminants. The high saponin content of *C. albidum* leaves and roots justifies the use of the extracts to control human cardiovascular disease and reduce blood cholesterol as documented by Aletor [10].

In addition the bark of *C. albidum* has been used in treatment of yellow fever, fibroids and malaria while the leaf is used as emollient and for the treatment of skin eruption, stomach ache and diarrhea [6,7]. Okwu and Iroabuchi; Okwu and Morah [37] suggested that *C. albidum* is used as therapeutic, antiseptic, antifungal, bacteriostatic activity due to the phenolic content in this plant.

Furthermore, Burit and Bucar, Orijajogun., *et al.* [25] suggested the antioxidants properties of *C. albidum* has improved health by protecting the body against harmful radical which has been implicated in the origin of many ailments/diseases such as cancer, cardiovascular diseases, diabetes mellitus, neural disorder and arthritis.

The objective of this review paper is to outline and discuss the studies that had been done on the bioactive compounds, phytoconstituents and pharmacological activities of *C. albidum*.

Figure 1

Different local names of Chrysophyllum albidum

Country	Local names
Nigeria	Agbalumo in Yoruba, udara in Igbo, Ibiobio and Efik, Agwaluma in Hausa, ehya in Igala, Utieagadava in Urhobo and Otien in Ijaw and Edo/Benin.
Southern Benin Republic	Azongogwe or azonbobwe in "Fon, Goun" and azonvivo, azonvovwe or azonbebi "Aïzo"
Republic of Uganda	nkalate,mululu
Ghana	Alasa in Ga, Adasima in Fantes or Akans.

Table 1

Scientific classification

Kingdome: Plantea

Division: Angiosperm

Class: Eudicots

Order: Ericales

Family: *Sapotaceae*

Genus: *Chrysophyllum*

Species: *C. albidum*

Phytoconstituents of *C. albidum*

Looking at the various medicinal uses of *C. albidum*, it has been shown that seed shell pericarp contain alkaloids, tannins, Saponins, flavonoids, terpenoids, steroids, cardiac glycosides [18], fruit pulp contain phenols, alkaloids, tannins, Saponins, flavonoids, terpenoids, phlobatanin, reducing sugar and cardiac glycosides [30] while the fruit skin contain alkaloids, tannins, Saponins, flavonoids, terpenoids [25]. Egharevba., *et al.* 2015 reported the presence of phenols, cardiac glycosides, terpenoids, flavonoids, saponins, steroids and alkaloids in leaf of *C. albidum*.

The stem bark of *C. albidum* containsaponins, tannins, flavonoids and alkaloids [19].

Ajewole and Adeyeye, 1991 preliminary investigation found that *C. albidum* seed contains valuable nutrients such as crude protein, carbohydrate, crude fat, crude fibre, mineral matter in concentrations of 8.75, 83.38, 3.45, 2.42 and 2.00% respectively [12].

Idowu., *et al.* reported that eleagnine, tetrahydro- 2 - methylharman and skatole have been isolated from *C. albidum* andeleagnine was the main compound responsible for its antimicrobial activity [26].

Qualitative analysis of *C. albidum*

The mineral contents of *C. albidum* fruit showed that the fruit skin had the highest contents of the mineral elements studied except chloride and iron while the highest chloride and iron contents were found in the seed shell pericarp and fruit pulp respectively as reported by Ibrahim., *et al.* [25].

Parameters	Leaf	Seed shell pericarp	Fruit pulp	Fruit skin	Stem bark
Alkaloids	+++	+++	+++	+++	+++
Tannins	-	++	++	++	++
Saponins	+	+	+	+	+
Flavonoids	+++	+++	+++	+++	+++
Terpenoids	+++	+++	+++	+++	-
Phlobatannin	-	-	+	-	-
Cardiac glycosides	+	+	+	-	-
Phenol	++	-	++	-	-
Reducing sugar	-	-	+	-	-
Steroids	++	++	-	-	-

Table 2

Sources: [18,19,25,30].

Parameters (mg/100 g drywt)	Seed Shell Pericarp	Fruit Pulp	Fruit Skin
Na	$28.26^{c} \pm 0.02$	$31.03^{b} \pm 0.09$	$34.00^{a} \pm 0.71$
K	$532.08^{b} \pm 33.71$	$268.00^{c} \pm 0.55$	$585.75^{a} \pm 0.78$
Mg	$122.41^{c} \pm 0.20$	$135.00^{b} \pm 1.80$	$144.25^{a} \pm 1.02$
Ca	$212.50^{b} \pm 0.51$	$100.00^{c} \pm 5.51$	$258.25^{a} \pm 6.86$
C	$181.28^{a} \pm 0.56$	$24.74^{c} \pm 0.43$	$70.68^{b} \pm 0.40$
P	$12.04^{b} \pm 0.00$	$10.03^{b} \pm 0.00$	$30.22^{a} \pm 0.01$
Fe	$3.48^{b} \pm 0.17$	$7.66^{a} \pm 0.02$	$3.37^{b} \pm 0.15$
Zn	$0.12^{b} \pm 0.02$	$0.57^{a} \pm 0.04$	ND
Mn	$0.23^{c} \pm 0.03$	$0.45^{b} \pm 0.02$	$2.25^{a} \pm 0.06$
Cr	ND	0.25 ± 0.02	ND
Cu	$0.36^{a} \pm 0.02$	$0.44^{a} \pm 0.04$	$0.55^{a} \pm 0.05$

Table 3

Source: Ibrahim *et al* 2017.

Pharmacological activities of *C. albidum*

C. albidum had been reported to possess several pharmacological effects like antimicrobial, anti-malarial, antioxidant, anti-diabetic, anti-inflammatory, anticancer, anti-fungi, antibacterial, antithrombotic and among others [26,36-38,44].

Antiplasmodial/anti-malarial effect

Adewoye., *et al.* [6] reported that methanolic extract of the bark of *C. albidum* has antiplasmosdial activities and non-toxic to mice when given at 1500 mg/kg/day and it appear effective and more active at dose of 1000 mg/kg/day. It has been reported by Philipson and Wright and Christen and Kharazmi [14] that plant whose phytoconstituents/phytochemical are alkaloids, anthraquinones and saponin may have anti-malarial activities. The phytochemicals listed above was among the phytoconstituents detected by Ibrahim., *et al.* [25], Adewole., *et al.* (2010) during quantitative and qualitative analysis of aqueous extract of *C. albidum*.

Wallace., *et al.* [49] and Newbold., *et al*. [33] reported that Saponins have antiprotozoan activities as well as possible defaunation agents in the rumen. It has been found that triterpenoid, steroid and saponins are harmful/damage to several infectious protozoans, like *P. falciparum* [46].

C. albidum has also been found to alkaloids which is toxic/injurious to cells of foreihn organisms such as bacterial, viruses and protozoans to which malaria parasites is part [6].

Anti-microbial effect

Antimicrobial effect of substances are methods used in treatment of infectious ailments/disease caused by microorganisms (Olasehinde., *et al.* 2015). Aboaba., *et al*. [1] reported that secondary metabolites of plants antagonize with metabolism and growth of microorganisms.

It has been reported that plant contain alkaloids, flavonoids, tannins, saponins phytoconstituents exhibit/undergo stronger antimicrobial properties [24].

Olasehinde., *et al.* reported that highest minimum inhibitory concentration values were displayed by the ethanolic leaf extract of *C. albidum* at 25 mg/ml against *Streptococcus*, *E. coli* and *C. albicans*.

It has also been reported that antimicrobial properties of *Chrysophyllum albidum* chloroform and ethanol root extracts against *Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Bacillus subtilis*, *Aspergillusniger*, *Penicilliumnotatum*, *Mucormucedo* and *Candida albicans* [31].

Ajetunmobi and Towolawi [8] investigated antimicrobial effect of *Chrysophyillum albidum* leave extract on gastrointestinal tract pathogenic bacteria and fungi in human.

Duyilemi and Lawal [16], reported that at different concentration (125 µg/mL, 250 µg/mL and 500 µg/mL) water and methanol extract of *C. albidum* leaves work against *Staphylococcus aureus*, *Escherichia coli*, *Salmonella typhimurium* and *Shigella* spp.

Idowu., *et al*. [27] investigated the alkaloid eleagnine antimicrobial activities against *Candida albicans* (MIC 62.5 mg/ml) and *Candida pseudotropicalis* (MIC 250 mg/ml).

Adeleye., *et al.* [4], Adewusi, Okoli and Okere reported that aqueous and methanol extract at different concentration (100 mg/ml,

50 mg/ml and 25 mg/ml) showed clear zones of inhibition against *Staphylococcus aureus, Escherichia coli, Klebsiella pneumonia, Pseudomonas aeruginosa, C. tetani, Bacillus subtilis* and *Candida albicans*.

Hyperglycemia/hypolipidemia effect

Diabetes is metabolic disorder associated with elevation in blood glucose as a result of defect in insulin or insulin resistance. Ehigiator and Adikwu [21] investigated ethanolic extract of *Chrysophyllum albidum* stem bark prevents alloxan-induced diabetes. Ehigiator and Adikwu [21] reported that no mortality was observed during the evaluation of the LD50 of (ethanolic extract of *C. albidum)* EECA however, at the highest dose (5000 mg/kg) there were behavioral changes such as sluggish movements, lack of appetite and thirst. Furthermore, 100 mg/kg, 200 mg/kg, and 400 mg/kg of EECA did not produce significant ($p > 0.05$) effects on glucose levels in normal rats when compared to non-diabetic control. On the other hand, glucose levels were significantly ($p < 0.001$) increased in diabetic rats when compared to non diabetic control. However, glucose levels were significantly decreased in a dose and time-dependent fashion in diabetic rats administered with 100 mg/kg ($p < 0.05$), 200 mg/kg ($p < 0.01$) and 400 mg/kg ($p < 0.001$) of EECA when compared to diabetic control. Comparatively, decreases in glucose levels produced at 400 mg/kg of EECA were not different when compared to metformin. Serum TG, TC, LDL and HDL-C levels were normal ($p > 0.05$) in normal rats treated with 100 mg/kg, 200 mg/kg and 400 mg/kg of EECA when compared to non-diabetic control. Nevertheless, significant increases ($p < 0.001$) in serum TG, TC and LDL-C levels with significant ($p < 0.001$) decreases in serum HDL-C levels were obtained in diabetic rats when compared to non-diabetic control. Interestingly, in a dose and time-dependent fashion, the levels of TG, TC, LDL-C were significantly decreased whereas HDL-C levels were significantly increased in rats treated with 100 mg/kg ($p < 0.05$), 200 mg/kg ($p < 0.01$) and 400 mg/kg ($p < 0.001$) of EECA for 7, 14 and 28 days respectively when compared to diabetic rats.

The restored levels of TG, TC, LDL and HDL-C obtained in 400 mg/kg of EECA -treated rats did not differ from metformin-treated rats. Furthermore, normal ($p > 0.05$) levels of pancreatic GSH, CAT, SOD, GPX and MDA were observed in normal rats treated with 100 mg/kg, 200 mg/kg, and 400 mg/kg of EECA for 7, 14 and 28 days respectively when compared to non-diabetic control (Table 6). In sharp contrast, pancreatic levels of GSH, CAT, SOD and GPX were significantly ($p < 0.001$) decreased whereas MDA levels were significantly ($p < 0.001$) increased in diabetic rats when compared to non-diabetic control. However, the levels of the aforementioned parameters were significantly restored in a dose and time-dependent fashion in diabetic rats treated with 100 mg/kg ($p < 0.05$), 200 mg/kg ($p < 0.01$) and 400 mg/kg ($p < 0.001$) of EECA for 7, 14 and 28 days respectively when compared to diabetic control.

Olorunnisola., *et al.* also reported that seed cotyledon of *C. albidum* has hypoglycemic and hypolipidemic effect of *C. albidum.* Their result showed that diabetic rats treated with 100 mg/kg and 200 mg/kg of ethanolic extract of *C. albidum* seed cotyledon, the serum glucose level was reduced by 11.92 and 12.10% of the extract. They further showed that there is insignificant decreased in hepatic triglycerides, cholesterol and LDL cholesterol compared with the diabetic control rats but the treated group administered with 100 mg/kg was significantly higher than the treated group administered 200 mg/kg of EECA. Also there were significant increase in hepatic triglycerides, cholesterol and LDL cholesterol in diabetic treated group with 100 mg/kg and 200 mg/kg of the EECA when compared to diabetic non diabetic treated group with the same concentration of the extract. However there was in significantly decreased in non diabetic rats treated with 100 mg/kg and 200 mg/kg extract compared with the normal rats. The hepatic HDL cholesterol concentration was significantly increase in diabetic rats treated with 100 mg/kg and 200 mg/kg of EECA when compared with diabetic control rats but in non diabetic rats treated with 100 mg/kg and 200 mg/kg of the EECA the hepatic HDL cholesterol was reduced compared to the normal control rats.

Antioxidant effect

Antioxidants are agents that counteract free radicals such as reactive oxygen species (ROS) effect in the living system [15]. Gülçin., *et al*. [23] Oloyede and Oloyede [40], wrote that the presence of phenol in the food may be sign for the antioxidant activities of the *C. albidum*. It has also been investigated by Orijajogun., *et al.* [42] that exocarp of *C. albidum* at a concentration of 1mg/ml has the antioxidant properties.

Olowoyeye., *et al.* [39] reported that the wine extract *C. albidum* and that of standard red wine at 9% concentration produced a significant increase in the enzyme activities of SOD, CAT, and non-enzymic GSH activities in the brain when compared with the control group. The effect of *C. albidum* leaf extracts on biochemical and hematological parameters of albino rats was demonstrated and a myricetin rhamnoside with antioxidant activity and excellent radical scavenging activity was isolated [2,3].

Adebayo., *et al.* [2] reported on the antioxidants activities of the leave of *Chrysophyllum albidum*. They showed that all animals treated with the extract (500 mg/kg, 1000 mg/kg and 1500 mg/kg) showed a significant ($p < 0.05$) dose-dependent decrease in the activity of CAT when compared with the negative control; however, the group treated with 1500 mg/kg bw had significantly ($p < 0.05$) high CAT activity when compared with the positive control group.

Similarly, animals treated with 500 and 1000 mg/kg bw of the extract exhibited a significantly ($p < 0.05$) elevated MDA activity when compared with the negative control group. Also, the group treated with 1500 mg/kg bw had significantly ($p < 0.05$) reduced level of MDA when compared with the positive control group. All the animals in treated groups showed a significantly ($p < 0.05$) lowered level of GSH when compared with both the negative and positive control groups.

Effect on fertility

Eseohe., *et al.* evaluated the effect of aqueous root extract of *Chrysophylum albidum* on fertility in male wistar albino rats. At the 4th, 6th and 8th week of extract administration there was no significant difference ($p > 0.05$) between the total sperm count of the rats in the control group and those of the treated groups (250 mg/kg and 500 mg/kg).

At the 4th week (day 28) of extract administration, there was no significant difference ($P > 0.05$) between the number of progressively motile sperm cells of rats in subgroup B1 treated with low dose (250 mg/kg) and that of the control rats A1. However, there was a significant ($P < 0.05$) decrease in the number of progressively motile sperm cells in sub group C1 treated with high dose (500 mg/kg) than the control A1. Also, there were significant ($P < 0.05$) decreases in the percentages of non-progressively motile sperm of rats in subgroup B1 (250 mg/kg) and subgroup C1 (500 mg/kg) than those of rats in the control group A1. The administration of the extract for 4 weeks caused significant ($P < 0.05$) increases in the percentages of immotile sperm of the experimental rats in subgroups B1 and C1 (250 mg/kg and 500 mg/kg respectively) than those of the control rats A1.

At week 6 (day 42) of the experiment, administration of the extract did not result in any significant ($P>0.05$) difference in the number of progressively motile sperm cells of rats in subgroup B2 treated with low dose of the extract (250 mg/kg) as compared with the control A2. Administration of the extract resulted in a significant ($p < 0.05$) decrease in the number of progressively motile sperm cells in sub group C2 treated with high dose (500 mg/kg) as compared to the control A2. At the 6th week of extract administration, the percentage of non-progressively motile sperm cells in subgroup B2 (250 mg/kg) was not significantly different ($P > 0.05$) from that of the control A2 while that of subgroup C2 (500 mg/kg) was significantly ($P < 0.05$) higher than that of the control group A2 ($10.00 \pm 0.00\%$). There was no significant difference ($P > 0.05$) in the percentages of immotile sperm cells of rats in subgroup B2 and C2 compared with that of the control ($10.00 \pm 0.00\%$) after 6weeks of extract administration. Administration of extract of *Chrysophyllum albidium* for 8 weeks resulted in significant ($P < 0.05$) decreases in the number of progressively motile sperm cells of rats in subgroup B3 (250 mg/kg) and C3 (500 mg/kg) as compared with the control group A. Also, the administration of the extract resulted in a significant ($P < 0.05$) increase in the percentage of non-progressively motile sperm cells in subgroup B3 and no significant difference ($P > 0.05$) in subgroup C3 as compared with the control group A3. Although, as compared with control group A3, there was no significant difference ($P > 0.05$) in the percentage of immotile sperm cells of rats in subgroup B3 (250 mg/kg), there was a significant ($P < 0.05$) increase in subgroup C3 treated with high dose(500 mg/kg).

At 4 week administration of aqueous root extract of *Chrysophyllum albidium* no significant difference ($P > 0.05$) in the number of morphologically normal sperm cells of test rats in subgroups B1 (250 mg/kg) and C1 (500 mg/kg) compared to those of the control subgroup A1. Also, there was no significant difference ($P > 0.05$) in the number of morphologically abnormal sperm cells of test rats in subgroups B1 (250 mg/kg) and C1 (500 mg/kg) compared to those in control subgroup A1. At 6 week administration of aqueous root extract of *Chrysophyllum albidium* resulted in significant ($P < 0.05$) decreases in number of morphologically normal sperm cells of rats in subgroup B2 treated with low dose of the extract (250 mg/kg) and subgroup C2 treated with high dose of the extract (500 mg/kg) as compared to the control subgroup A2. Also, it resulted in significant ($P < 0.05$) increases in the number of morphologically abnormal sperm cells of rats in test subgroups B2 and C2 as compared to the control subgroup A2. At the 8th week of experiment, administration of the extract caused significant ($p < 0.05$) decreases in the number of morphologically normal sperm cells of rats in test subgroups B3 treated with low dose and C3 treated with high dose as compared to the control subgroup A3. Also, there were significant ($P < 0.05$) decreases in the number of morphologically abnormal sperm cells of rats in the test subgroups B3 and C3 as compared to rats in the control subgroup A3.

Obi., *et al.* [34] investigated effect of ethanol extract of leaves of *Chrysophyllum albidum* on the reproductive hormones of lead-exposed female wistar albino rats. The negative control group (200 mg/kg of lead acetate) showed a significant ($p \leq 0.05$) decrease in the concentrations of FSH, progesterone and estrogen compared to the normal control group. Though there was a marked decrease also in the LH concentration of the negative control group compared to the normal control, this decrease was not significant ($p \leq 0.05$). There were significant ($p \leq 0.05$) increase in the FSH, LH, progesterone and estrogen concentrations of *C. albidum* treated groups (From 200 mg/kg of lead acetate, 250 mg/kg of *C. albidum* and 200 mg/kg of lead acetate, 500 mg/kg *C. albidum* and 200 mg/kg of lead acetate and 750 mg/kg) compared to the negative con-

trol group except for progesterone where group treated with, 200 mg/kg of lead acetate and 1000 mg/kg *C. albidum* had the highest value.

Onyeka and co-workers [41] reported the anti-fertility of the ethanol root bark extract of *C. albidum* on sperm parameter and hormonal levels in Wistar rat. The study of Onyeka., *et al.* shown significant reduction in caudal epididymal sperm count, motility and sperm morphology at extract of 100 mg/kg and 200 mg/kg treated groups compared with the control group. The level of gonadotrophin, testosterone, follicle stimulating hormone and luteinizing hormones and sperm production were decreases in rats.

Further study by Onyeka., *et al.* suggested that the ethanol extract leaf of *C. albidum* on sperm analysis, hormonal profile, SOD and testicular histology of adult male wistar rats. 500 mg/kg and 1000 mg/kg increased body weights and testis weight, motility, morphology and number of spermatozoa in caudal epididymis without alteration in seminiferous tubule when compared with the control group. However hormonal assay showed decreased in testosterone, follicle stimulating hormone and luteinizing hormones in all the groups while there was increment in the activity of SOD which was dose dependent.

Conclusion

This review reveals that *Chrysophyllum albidum* is enveloped with several/different phytoconstituents that is responsible for its several pharmacological activities such as antihyperglycemic, antioxidant, antiplasmodial and antimicrobial effect that makes it to be potency against several ailments/diseases.

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