

A COMPREHENSIVE REVIEW ON ETHNO-MEDICINE, PHYTOCHEMISTRY AND ETHNOPHARMACOLOGY OF *CHRYSOPHYLLUM ALBIDUM*

Abstract

Chrysophyllum albidum (Sapotaceae), commonly called white star apple is a very useful medicinal plant common in the tropical and sub-tropical regions of the world. This review is an update assemblage on the traditional, phytochemical and ethno-pharmacological studies carried out on it. Its reported pharmacological activities in this review include; antioxidant, anti-microbial, anti-plasmodial anti-inflammatory, analgesic and anti-diabetic properties, which justifies its traditional uses. The information in this work is intended to serve as a reference guild to researchers in the fields of ethnopharmacology, drug discovery and development of natural products from medicinal plants.

Keywords: *Chrysophyllum albidum*, Ethnopharmacology, Ethno-medicine, Phytochemistry, medicinal plants.

1.0 Background

Medicinal plants play a significant role in the health of humanity [1]. Most conventional medicines, food supplements, folk medicines and pharmaceutical intermediate are derived from medicinal plants [2]. The affordability, accessibility, wider acceptability factor among the population as well as the high safety profile of medicinal plants has negated the numerous problems associated with synthetic therapeutics [3].

As an avenue to unveil the hidden potential of medicinal plants and also advance research in ethnopharmacology, information update on medicinal plants had aided the frontier of research. Review updates on *Buchhoizia coriacea* [4], *Terminalia catappa* [5], *Mangifera indica* [6], *Ageratum conyzoides* [7], among others had been published in different scientific journals.

In other to promote the avalanche of medicinal plant review, there is need to carry out more search by gathering information on the medicinal values of natural remedies from plants. This had necessitated this present review on the ethnomedicine, phytochemistry and ethno-pharmacology of *Chrysophyllum albidum*.

1.1 *CHRYSOPHYLLUM ALBIDUM*

Plant picture



***Chrysophyllum Albidum* fruit**



***Chrysophyllum Albidum* tree**



***Chrysophyllum Albidum* seed**



***Chrysophyllum Albidum* fruit**

28

29

30 **1.1.1 Description:**

31 *Chrysophyllum albidum* (*C. albidum*), commonly called white star apple, belonging to the family of
 32 *Sapotaceae* (which has up to 800 species) is a lowland rain forest tree species that grows up to 25 to 37 m
 33 in height at maturity with a girth varying from 1.5 to 2 m [8]. The Scottish botanist George Don described
 34 it as a forest fruit tree [9]. It is common throughout the tropical Central, East and West Africa regions and
 35 other parts of the world [10]. When it is ripe, the fruit is ovoid to sub-globose, pointed at the apex, and up
 36 to 6 cm long and 5 cm in diameter. The skin or peel, is orange to golden yellow when ripe and the pulp
 37 within the peel may be orange, pinkish, or light yellow. Within the pulp are three to five seeds which are
 38 not usually eaten. The seed-coats are hard, bony, shiny, and dark brown, and when broken reveals white-
 39 coloured cotyledons. The fruit is seasonal (usually from the months of December to March). The plant is a
 40 crop of commercial value in Nigeria [11]. The seeds are also used for local games or discarded. The fleshy
 41 fruit pulp is suitable for jams and is eaten especially as snack by many locals [10].

42 **1.1.2 Local names:**

43 African star apple (*C. albidium*) is an edible tropical fruit known by various tribal names. It is called
44 Utieagadava in Urhobo, *agbalumo* in Yoruba, *udara* in Ibo, Efik and Ibibio, *ehya* in Igala, agwaluma in
45 Hausa tribes of Nigeria [10, 12]. In southern Benin, it is called azongogwe or azonbobwe in local language
46 "Fon, Goun" and azonvivo, azonvovwe or azonbebi in local language "Aïzo" [13].

47 **1.1.3 Scientific classification:**

48 Kingdome: Plantea

49 Division: Angiosperm

50 Class: Eudicots

51 Order: Ericales

52 Family: Sapotaceae

53 Genus: *Chrysophyllum*

54 Species: *C. albidum*

55 **1.1.4 Ethno-medicinal values:**

56 In folklore medicine, *Chrysophyllum albidum* bark is employed for the treatment of yellow fever and
57 malaria [12]. The leaf is used as an emollient and for the treatment of stomachache and diarrhoea. The leaf
58 and cotyledons from its seed are used as ointments in the treatment of vaginal and dermatological
59 infections in Western Nigeria [14]. The roots, barks and leaves of *C. albidum* is widely used as an
60 application to sprains, bruises and wounds in southern Nigeria. The seeds and roots extracts of *C. albidum*
61 is used to arrest bleeding from fresh wounds, and to inhibit microbial growth of known wound
62 contaminants and also enhance wound healing process [15].

63 **1.1.5 Other uses:**

64 *Chrysophyllum albidum* leaves were occasionally used for fodder. Rotten or damaged fruits are also used to
65 feed pigs. In southern Benin, it is useful in traditional rituals and also has medico-magical properties apart
66 from its common uses. According to local socio-cultural considerations, it was also mentioned to be used to
67 chase bad spirits and the trees can only be cultivated by older people in order to avoid early death of a
68 young person who would attempt to propagate the species from seed [16].

69 **1.2 Phytochemical and Nutrient composition:**

70 Study by Okoli, (2010) [17] on the phytochemistry of *Chrysophyllum albidum* stem slash, seed cotyledon,
71 leaves and root revealed the presence of alkaloids, tannins, phenols and flavonoids; except cardiac
72 glycosides in the root; tannins in leaves; and phenol in seed. The study by Ushie, *et al.* (2014) [18] on the
73 methanol leaf extracts of *C. albidum* also revealed the presence of flavonoids, phenols, glycosides,

terpenoids, saponins, steroids and alkaloids. MacDonald *et al.*, (2014) [19] also revealed the presence of alkaloids, flavonoids, saponins and tannins in *Chrysophyllum albidum*. According to Duyilemi and Lawal, (2009) [20], leave extract of *Chrysophyllum albidum* contains anthraquinone, tannin and cardiac glycoside and with no traces of reducing sugars, saponin and alkaloids.

According to Amusa *et al.* (2003) [10], eleagnine, tetrahydro- 2 -methylharman and skatole are present in the methanol extract of *Chrysophyllum albidum* cotyledon seeds. The fruit was found to have the highest content of ascorbic acid per 100 g of edible fruit, which is about 100 times that of oranges and 10 times of that of guava and cashew Amusa *et al.* (2003) [10]. *Chrysophyllum albidum* is also an excellent source of vitamins, irons and flavours to diets [21]. The fruits also contain 90% anacadic acid, which is used industrially in protecting wood and as source of resin. Ajewole and Adeyeye (1991) [22] also confirmed that unsaturated fatty acids are the main components of the oil (74%) of *Chrysophyllum albidum*.

The physicochemical and minerals analyses of *Chrysophyllum albidum* according to Imaga and Urua (2013) [23] revealed the following; moisture (48.38 and 47.02%), crude protein (2.75 and 2.68%), carbohydrate (24.26 and 25.17%), ash (4.175 and 4.68%), crude fat (10.94 and 10.79%) and energy value (206.50 and 208.53 Kcal) for ethanol and aqueous extract. Also, 100 g mineral composition (mg) of the fruit contains sodium (123.05), iron (42.45), zinc (34.45), magnesium (34.05), calcium (24.55), manganese (4.1) and potassium (2.05). The vitamins analyzed in mg/100 g indicated vitamin K (35.36), vitamin (0.124), vitamin B1 (18.68), folate (2.02), vitamin C (3.084) and vitamin B6 (3.26). Tannins, phenols, flavonoids, cardiac glycosides, terpenoids, reducing sugar and phlobatannins were also present in both extracts. Saponins, steroids and alkaloid were present in the aqueous extract. However, anthraquinone was absent in both extracts [23].

Study by Ureigho and Ekeke, (2010) [24] on nutrient analysis of *Chrysophyllum albidum* revealed the presence of the following; carbohydrate (11%), crude fibre (4%), lipids (3%), protein (7%), Calcium (17.11ppm), Iron (<1ppm), phosphorus (9.92ppm), vitamin C (25.03ppb), A (10.74ppb), B1 and B2 (<1ppb). Chukwuemeka, (2006) [25] showed that the fresh fruit samples (both untreated and treated with 2, 4-dichlorophenoxyacetic acid), showed the presence of the following minerals elements; K, P, S, Ca, Mg, Fe, Al and Zn. The crude fiber showed no significant difference between samples.

1.3 Pharmacological activities:

1.3.1 Antioxidant activities:

Adebayo, *et al.* (2011) [8] investigated the antioxidant (DPPH free radical scavenging activity) properties of the leaves of petroleum ether, ethanol, butanol, ethylacetate, and water fractions of *Chrysophyllum albidum* by employing the *in vitro* and *in vivo* experimental models. Result from animal study showed that *C. albidum* exhibited significant ($p < 0.05$) differences on the activity of CAT, MDA and GSH. *C. albidum* has antioxidant properties by scavenging free radicals, decreasing lipid peroxidation and increasing the endogenous blood antioxidant enzymes levels. Adebayo and co-workers recommended that *Chrysophyllum albidum* could be employed as sources of natural antioxidant boosters for the treatment of free radical implicated oxidative stress disorders.

111 Imaga and Urua (2013) [23] evaluated the antioxidant properties of *Chrysophyllum albidum*
112 fruit components. Ethanol extract showed more scavenging activity of free radicals compared to the
113 aqueous extract. Reducing power increased remarkably at 75 µg/ml in the extracts. The ethanol extract
114 showed more reducing power than the aqueous at equal concentrations. Nitric oxide showed significant
115 increase in the scavenging activity of the ethanol extract at 75 µg/ml ($p < 0.05$), while there was a
116 significant ($p < 0.05$) decrease in the scavenging activity of the aqueous extract. The ethanol extract showed
117 greater scavenging activity at all concentrations than the aqueous extract.

118 *In vitro* and *in vivo* antioxidant properties of *Chrysophyllum albidum* petroleum ether, ethanol, butanol,
119 ethylacetate, and water fractions were determined in experimental models. The petroleum ether fraction
120 showed the least antiradical activity (4057.5 ± 809.6 g/kg) while ethyl ether exhibited the highest activity
121 (414.4 ± 92.0 g/kg). Myricetin rhamnoside also exhibited an excellent radical scavenging activity ($314.1 \pm$
122 60.2) which was comparable to the positive control. In animal studies, *C. albidum* exhibited significant ($p <$
123 0.05) differences on the activity of CAT, MDA and GSH. The authors recommended that *Chrysophyllum*
124 *albidum* could be employed as sources of natural antioxidant boosters and for the treatment of some free
125 radicals implicated oxidative stress disorders [26].

126 Idowu and co-workers (2006) [27] had also reported that eleagnine, an alkaloid isolated from *C. albidum*
127 seed cotyledon has antioxidant activities.

128 **1.3.2 Hypoglycemic and hypolipidemic effects:**

129 Olorunnisola, *et al.* (2013) [28] evaluated the anti-hyperglycemic and hypolipidemic effect of ethanol
130 extract of *Chrysophyllum albidum* seed cotyledon in model of alloxan-induced diabetic rats. Their results
131 showed that the daily treatment of diabetic rats with ethanol extract twice daily for 7 days (100 and 200
132 mg/kg orally) significantly decreased ($p < 0.001$) the blood glucose levels by 11.92 and 12.10%, respectively
133 in the treated induced diabetic rats compared to the diabetic control rats. The 200 mg/kg (except 100 mg
134 kg) doses of the extract showed significant ($p < 0.001$) decrease in the hepatic lipids (except HDL-
135 cholesterol) concentrations in the treated diabetic rats and treated non-diabetic rats. The various doses of
136 the extract showed no significant effect on the hepatic HDL-cholesterol in the treated non-diabetic rats.

137 **1.3.3 Antimicrobial properties**

138 Okoli, (2010) [17] had demonstrated *Chrysophyllum albidum* to elicit anti-bacterial activity against
139 *staphylococcus aureus*, *B. subtilis*, *pseudomonas aeruginosa*, *E. coli* and *C. tetani*, as well as anti-fungal
140 effect against *candida albicans*.

141 MacDonald *et al.*, (2014) [19] had also investigated the antimicrobial properties of *Chrysophyllum*
142 *albidum*, *Dacryodes edulis*, *Garcinia kola* chloroform and ethanol root extracts against the test isolates
143 (*Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Bacillus subtilis*, *Aspergillus niger*,
144 *Penicillium notatum*, *Mucormucedo* and *Candida albicans*). Both extracts showed broad spectrum of
145 antimicrobial activities but chloroform extracts gave higher zones of inhibition compared to corresponding
146 concentrations of ethanol extracts. Maximal inhibitory zones were shown by *P. aeruginosa*; $30.7 \text{ mm} \pm$
147 0.01 against *G. kola* chloroform root extract. Chloroform root extracts of *G. kola* were comparatively more

148 potent against the test isolates than *C. albidum* and *D. edulis* root extracts. All the respective root extracts
149 exhibited a greater antibacterial activity in comparison with the antifungal attributes.

150 Antimicrobial effect of *Chrysophyllum Albidum* leave extract on gastrointestinal tract pathogenic bacteria
151 and fungi in human was also investigated by Ajetunmobi and Towolawi (2014) [29]. Results showed the
152 plant extract has a broad spectrum antibiotic and the organisms resistant to Ciprofloxacin were susceptible
153 to the extracts. The methanol extracts had highest antimicrobial activities than that of aqueous extracts. The
154 methanol extract had pronounced activity against *Candida albicans* whereas it did not elicit any effect on
155 *Salmonella* species.

156 Duyilemi and Lawal, (2009) [20] also investigated the antibacterial activity of water and methanol extracts
157 from *Chrysophyllum albidum* leaves against *Staphylococcus aureus*, *Escherichia coli*, *Salmonella*
158 *typhimurium* and *Shigella spp.* at different concentrations (125 µg/mL, 250 µg/mL and 500 µg/mL) using
159 the agar well diffusion technique. The methanol extracts had stronger inhibitory effects on test organisms
160 than the water extracts. The antimicrobial activity observed with the water extract ranged between 10±0.19
161 and 27±0.25 mm with no detectable activity at 125 µg/mL and 250 µg/mL on *Escherichia coli*. Stronger
162 antimicrobial activity was observed with the methanol crude extracts at all concentrations with all test
163 organisms.

164 **1.3.4 Hepatoprotective activity:**

165 Abiodun *et al.* (2011) [30] studied the hepatoprotective activity of leaf extract of *Chrysophyllum albidum*
166 against carbon tetrachloride (CCl₄) induced liver damage in Wistar rats. There was significant ($p < 0.05$)
167 increase in serum AST, ALT, ALP and total bilirubin level in rats treated with carbon tetrachloride (CCl₄),
168 while these parameters were reduced significantly ($p < 0.05$) after treatment of rats with the extract. The
169 histopathological studies of the liver tissue of rats in the group treated with CCl₄ showed marked
170 centrilobular fatty degeneration and necrosis while the groups treated with plant extract showed signs of
171 protection against carbon tetrachloride as evidenced by the absence of necrosis.

172 **1.3.5 Anti-plasmodial activity:**

173 The anti-plasmodial, hematological, serum biochemical and pathological effects of *Chrysophyllum albidum*
174 methanol bark extract were evaluated using Swiss albino male mice models. *C. albidum* methanol bark
175 extract (750 - 1500 mg/kg/day) exhibited significant ($P < 0.05$) schizontocidal activities both in a 4-day
176 (early) infection and in an established (> 7 days) infection with a considerable mean survival time
177 comparable to that of chloroquine. Appreciable anemia was developed in plant extract treated mice. Organ
178 and tissue pathology during infection was milder at low doses, compared to the untreated mice and
179 insignificant at higher doses of the extract. This study showed that the methanol extract of *C. albidum*
180 contains anti-plasmodial substance(s) which help to reduce parasitaemia and hence the rate of erythrocyte
181 destruction during infection [31].

182 Adewoye *et al.* (2013) [32] also investigated the probable mechanism of haematinic potential of methanol
183 extract of *Chrysophyllum albidum* (MeCaB) on the bone marrow in two separate anaemic studies. The
184 MeCaB only treated and group bled and treated with MeCaB(BMeCaB) continuously for 7 days had

185 significantly reduced M:E ratio (1.67 ± 0.00 and 1.35 ± 0.00 respectively) compared with control, bled and
186 treated with haematinic (2.13 ± 0.19 , 2.25 ± 0.21 respectively). This study thus establishes that
187 *Chrysophyllum albidum* exerts haematinic properties on bone marrow cells by stimulating the production of
188 more erythroid series which reverted anaemia induced by *plasmodium berghei* and bleeding out models.

189 1.3.6 Effects on fertility:

190 Onyeka, *et al.* (2012) [33] investigated the anti-fertility activity of the ethanol root bark extract of
191 *Chrysophyllum albidum* on sperm parameter and hormonal levels in male Wistar rats. Decrease in the
192 caudal epididymal sperm count, motility and sperm morphology was observed in extract (100 and 200
193 mg/kg) treated groups compared with the control group. The ethanol extract of the root bark of *C. albidum*
194 suppresses the hormonal (serum gonadotrophins, testosterone, luteinizing hormones and follicle stimulating
195 hormone) levels and sperm production in rats. Onyeka and co-worker suggested that the root bark extract of
196 *Chrysophyllum albidum* merit further investigation as a potential male contraceptive agent.

197 In another study, Onyeka *et al.*, (2013) [34] investigated the ethanol leaf extract of *Chrysophyllum albidum*
198 on sperm analysis, hormonal profile, SOD and testicular histology of adult male wistar rats. The ethanol
199 leaf extract (500 and 1000 mg/kg) significantly ($p < 0.05$) increased body weights and testis weight, motility,
200 morphology, and number of spermatozoa in caudal epididymidis. Histologically, testes in rats treated with
201 the plant extract showed no alterations in the seminiferous tubules when compared to the control. However
202 hormonal assay showed significantly reduced levels ($p < 0.05$) of FSH, LH and Testosterone in experimental
203 groups while there was increase in the activity of SOD, which was dose dependent. The results thus suggest
204 that *C. albidum* treatment does not cause suppression of spermatogenesis but decrease the hormonal profile.

205

206 1.3.7 Other studies

207 Methanol extract of dried barks of *Chrysophyllum albidum* and its chromatographic fractions (250 mg/kg)
208 possess potent therapeutic and healing efficacy against acetic acid induced colitis in rats, possibly due to its
209 antioxidant and anti-inflammatory properties [35].

210 Antinociceptive and anti-inflammatory activities of *eleagnine* (an alkaloid isolated from seed cotyledon of
211 *C. albidum*) had also been investigated by Idowu and co-worker (2006) [27].

212 Study by Adewoye *et al.*, (2010) [31] showed that the LD₅₀ of the methanol bark extract of *Chrysophyllum*
213 *albidum* was 1850 mg/kg body weight in Swiss albino male mice.

214 Jimoh *et al.*, (2015) [36] investigated the histological changes in the liver and kidney of *Clarias gariepinus*
215 fed *Chrysophyllum albidum* seedmeal as maize replacer. In the study, five isonitrogenous diet containing
216 maize were replaced by *Chrysophyllum albidum* at 0, 25, 50, 75 and 100%. The control diet was without
217 *Chrysophyllum albidum*, but only received isonitrogenous and isolipidic. The results showed marked
218 vacuolation of hepatocytes among the treatment after the treatment period. Jimoh and co-workers suggested
219 that it is technically feasible to replace maize with *Chrysophyllum albidum* seedmeal in the diet of *Clarias*
220 *gariepinus* without adverse effect on the kidney and liver.

221 **1.4 Conclusion:**

222 The present review on the phytochemistry and ethno-pharmacology (anti-oxidant, hypoglycemic,
223 hypolipidemic, anti-microbial, hepatoprotective, analgesic, anti-inflammatory and anti-plasmodial
224 activities) of *Chrysophyllum albidum* mentioned above can be attributed to its phytoconstituents, which
225 justifies its benefit in alternative medicine in the treatment of numerous diseases.

226 **1.5 Recommendations:**

227 *Chrysophyllum albidum* is a potential source for useful drug and its continued traditional medicinal uses
228 should be encouraged.

229 Although, the ethno-pharmacological properties of *Chrysophyllum albidum* highlighted above had been
230 determined, anti-ulcerative, anti-diarrhoeal, anti-spasmodic, woundhealing activities and other reported
231 ethno-medicinal uses should be validated ethno-pharmacology through standard experimental models.

232 Also, the biological mechanism of its constituents is needed to be unveiled by incoming researchers in the
233 aforementioned areas. This would offer a persuasive support on the clinical uses of *Chrysophyllum*
234 *albidum* in modern medicine.

235

236 **REFERENCES**

- 237 1. Sofowora A. Medicinal Plants and Traditional Medicine in Africa. 2nd Edn.Spectrum Books
238 Limited, Ibadan, Nigeria. 1993; pp. 1-153.
- 239 2. Ogbonnia SO, Mbaka GO, Nwozor AM, Igboke HN, Usman A, Odusanya P.A. Evaluation of
240 microbial purity and acute and sub-acute toxicities of a Nigerian commercial Polyherbal
241 formulation used in the treatment of diabetes mellitus. *British Journal of Pharmaceutical*
242 *Research*. 2013; 3 (4): 948-962.
- 243 3. Ilodigwe EE, Ndunagu LU, Ajaghaku DL, Utoh-Nedosa UA. Evaluation of wound healing activity
244 of a polyherbal remedy. *Annals of Biological Research*. 2012; 3(11):5393-5398.
- 245 4. Erhirhie Earnest Oghenesuvwe, Ben-AzuBenneth, Moke Goodies Emuesiri,Chinwuba Paul
246 Omonjiahio Innocent A. Ethno-pharmacological Review Of *Buchhoizia Coriacea* (Wonderful
247 Kola). *International Journal of advances in pharmacy, biology and chemistry*. 2015; 4(1):149-155.
- 248 5. Mallik Jony , Faruq Abdullah A , BanikRony Kumar. A comprehensive review of pharmacological
249 activity of *Terminalia catappa*(Combretaceae)- An update. *Asian Journal of Pharmaceutical*
250 *Research and Development* 2013; 1(2):65–70.
- 251 6. Nathalie Wauthoz, Aliou Balde, Elhadj SaïdouBalde, Marc Van Damme,
252 Pierre Duez. Ethnopharmacology of *Mangifera indica* L. Bark and Pharmacological Studies of its
253 Main C-Glucosylxanthone, Mangiferin. *International Journal of Biomedical and Pharmaceutical*
254 *Sciences*. 2007; 1(2), 112-119.
- 255 7. Brojendro S.S., Radhapiyari, WD, Marina A., Indira, WD, Swapana, N, Chingakham BS.
256 Ethnobotany, phytochemistry and pharmacology of *Ageratum conyzoides*Linn (Asteraceae).
257 *Journal of Medicinal Plants Research*. 2013; 7(8), pp. 371 -385.
- 258 8. Adebayo AH, Abolaji AO, Kela R, Ayepola OO, Olorunfemi TB, Taiwo OS. Antioxidant activities
259 of the leaves of *Chrysophyllum albidum*. *Pak J Pharm Sci*. 2011; 24(4):545-51.

- 260 9. Ehiagbonare JE, Onyibe HI, Okoegwale EE. Studies on the isolation of normal and abnormal
261 seedlings of *Chrysophyllum albidum*: A step towards sustainable management of the taxon in the
262 21 st century. Sci. Res Essay. 2008; 3(12), pp. 567-570.
- 263 10. Amusa NA, Ashaye OA Oladapo MO. Biodeterioration of African star apple (*Chrysophyllum*
264 *albidum*) in storage and the effect on its food value. *Afr.J.Biotechnol.* 2013; 2:56-59.
- 265 11. Oboh IO, Aluyor EO, Audu TOK. Use of *Chrysophyllum albidum* for the removal of metal ions
266 from aqueous solution. Scientific Research and Essay. 2009; 4(6), pp.632-635.
- 267 12. Florence AB, and Adiaha AH. Storage effects and the postharvest quality of African star apple
268 fruits (*Chrysophyllum africanum*) under ambient conditions. African Journal of Food Science and
269 Technology. 2015; 6(1) pp. 35-43.
- 270 13. Laurent G Houessou, Toussaint O Lougbegnon, François GH Gbesso, Lisette ES Anagonou, Brice
271 Sinsin. Ethno-botanical study of the African star apple (*Chrysophyllum albidum* G. Don) in the
272 Southern Benin (West Africa). Journal of Ethnobiology and Ethnomedicine. 2012; 8:40. 1-10.
- 273 14. Adewusi HA. The African star apple *chrysophyllum albidum* indigenous knowledge from Ibadan,
274 South western Nigeria. In proceedings of a National workshop on the potentials of the star apple in
275 Nigeria (eds). 1997; pp: 25-33.
- 276 15. Okoli BJ, Okere OS. Antimicrobial Activity of the Phytochemical Constituents of *Chrysophyllum*
277 *albidum* G.Don_Holl. (African Star apple). Plant Journal of Research in National Development.
278 2010; 8(1).
- 279 16. Laurent G Houessou, Toussaint O Lougbegnon, François GH Gbesso, Lisette ES Anagonou, Brice
280 Sinsin. Ethno-botanical study of the African star apple (*Chrysophyllum albidum* G. Don) in the
281 Southern Benin (West Africa). Journal of Ethnobiology and Ethnomedicine. 2012; 8:40. 1-10.
- 282 17. Okoli BJ. Antimicrobial Activity of the Phytochemical Constituents of *Chrysophyllum*
283 *albidum*G.Don_Holl. (African Star apple) Plant. *Journal of research in national development.*
284 2010; 8: 1.
- 285 18. Ushie OA, Adamu HM, Abayeh OJ, Chindo IY, Lawal U. Phytochemical screening of
286 *Chrysophyllum albidum* Leaf Extracts. *Journal of Applied Chemistry.* 2014; 2 (2):40-46.
- 287 19. MacDonald Idu, Nosa O Obayagbona, Emmanuel O Oshomoh, Joseph O Erhabor. Phytochemical
288 and Antimicrobial Properties of *Chrysophyllum albidum*, *Dacryodesedulis*, *Garcinia kola*
289 chloroform and ethanolic root extracts. J IntercultEthnopharmacol. 2014; 3(1): 15-20.
- 290 20. Duyilemi OP, Lawal IO. Antibacterial activity and phytochemical screening of *Chrysophyllum*
291 *albidum* leaves Asian Journal of Food and Agro-Industry. Special Issue, 2009; S75-S79.
- 292 21. Adisa SA. Vitamin C, protein and mineral content of African apple (*Chrysophyllum albidum*) in
293 proceedings of the 18th Annual Conference of NIST. (eds). 2000;pp: 141-146.

22. Ajewole K, Adeyeye A. Seed oil of white star apple (*Chrysophyllum albidum*) physiochemical characteristics and fatty acid composition, *Journal of Science, food and Agriculture*. 1991; 54:313-315.
23. Imaga NOA, Urua EE. Chemical and Antioxidant Evaluation of Star Apple Fruit (*Chrysophyllum albidum*) Crude Extracts. *Planta Med*. Congress Abstract. 2013; Pg 79 – 83.
24. Ureigho UN, Ekeke BA. Nutrient Values of *Chrysophyllum Albidum* Linn African Star Apple as a Domestic Income Plantation Species. *An International Multi-Disciplinary Journal Ethiopia*. 2010; 4 (2):50-56.
25. Chukwuemeka AN. Nutritional value and mineral contents of *Chrysophyllum albidum* Fruit. *Journal of the Science of Food and Agriculture*. 2006; [33 \(3\)](#); 283–286.
26. Abiodun HA, Amos OA, Roseline K, Olayemi OA, Titilayo BO, Olugbenga ST. Antioxidant activities of the leaves of *Chrysophyllum albidum*. *Pak. J. Pharm. Sci.*, 2011; 24; (4); 545-551
27. Idowu TO, Iwalewa EO, Aderogba MA, Akinpelu BA, Ogundaini AO. Antinociceptive, Anti-inflammatory and Antioxidant activities of *Eleagnine*: an alkaloid isolated from seed cotyledon of *C. albidum*. *J. Biol. Sci*. 2006; 6 (6); 1029 – 1034.
28. Olorunnisola OS, Amao S, Ehigie LO, Ajayi AF. Anti-Hyperglycemic and Hypolipidemic Effect of Ethanolic Extract of *Chrysophyllum albidum* Seed Cotyledon in Alloxan Induced-Diabetic Rats. *Research journal of applied science*. 2013; 3 (2); 123-127.
29. Ajetunmobi AO, Towolawi GA. Phytochemical Analysis and Antimicrobial Effect of *Chrysophyllum Albidum* Leave Extract On Gastrointestinal Tract Pathogenic Bacteria and Fungi in Human. *IOSR Journal of Applied Chemistry*. 2014; 7 (1) II; 01-051.
30. Abiodun HA, Amos OA, Roseline K, Samuel OO, Olumide OO, Oluwaseun AO. Hepatoprotective activity of *Chrysophyllum albidum* against carbon tetrachloride induced hepatic damage in rats. 2011; 5 (3); 1597-1602.
31. Adewoye EO, Salami AT, Taiwo VO. Anti-plasmodial and toxicological effects of methanolic bark extract of *Chrysophyllum albidum* in albino mice. *Journal of Physiology and Pathophysiology*. 2010; 1 (1); 1 – 9.
32. Adewoye EO, Salami AT, Jagun AT. Attenuation of Plasmodium berghei-induced Bone Marrow Suppression by Bark Extract and fractions of *Chrysophyllum albidum* on bone marrow response to haemolytic conditions in male albino mice. *Afr. J. Biomed. Res*. 2013; 16; 47 – 53.
33. Onyeka CA, Aligwekwe AU, Olawuyi TS, Nwakanma AA, Kalu EC, Oyeyemi AW. Antifertility Effects of Ethanol Root Bark Extract of *Chrysophyllum albidum* in Male Albino Rats. *International Journal of Applied Research in Natural Products*. 2012; 5 (1), pp. 12-17.
34. Onyeka C Anna, Fabunmi O Oladapo, Aligwekwe A Ugochukwu, Ofoego U Chikere, LekoBankole Anthony O. Ethanolic Leaf Extract of *Chrysophyllum albidum* on sperm analysis,

- 329 hormonal profile, SOD and testicular histology of adult male wistar rats. Agric. Biol. J. N. Am.
330 2013; 4(3): 160-165.
- 331 35. Salami AT, Oyelami AI, Omayone TP, Adewoye EO, Olaleye SB. Effect of methanolic bark
332 extracts of *Chrysophyllum albidum* on acetic acid-induced colitis in rats. Congress Abstracts.
333 Poster presentations: Basic Science. 2014.
- 334 36. Jimoh WA, Sodamola MO, Adebayo MD, Banjo OT, Ayeloja AA, and Adeleke AB. Histological
335 changes in the liver and kidney of *Clarias gariepinus* fed *Chrysophyllum albidum* seedmeal as
336 maize Replacer. *International journal of zoological research*. 2015; 11 (1): 29-36.
- 337