



Parquetina nigrescens Species: A Concise Review of Phytochemistry and Pharmacology

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ABSTRACT

Parquetina nigrescens species is a member of the Periploceaceae family, found majorly across countries in Africa. It has myriads of folkloric uses till date in this region. It is sometimes used in combination with other plants traditionally to treat several ailments such as inflammation, insanity, diarrhoea, skin infections, gonorrhoea, menstruation aberrations, helminthic infections, sexual disorders and some other complicated disorders. Based on our search, there is no review article to date on the authenticated biological activities of *P. nigrescens*, despite numerous researches. This review aims at presenting a novel summary of established pharmacological properties and mechanisms of action of *Parquetina nigrescens*.

Several bioactive components such as flavonoids, saponins, alkaloids, tannins, free and bound anthraquinones, phlobatins, terpenoid, cardenolides, triterpenes etc. have been derived from chemical analysis of *Parquetina nigrescens*, these play important roles in the detected pharmacological activities of the plant such as anti-diabetic, anti-cancer, anti-inflammatory, anti-oxidant, anti-diarrhoea, anti-sickling, anti-neurotoxic, anti-apoptotic anti-microbial, anti-nociceptive, antiulcer, aphrodisiac and anti-neurodegenerative properties as reported by several researchers. Thus, the plant has a promising outlook for drug discovery and development.

Keywords: *Parquetina nigrescens*, Bioactive Component, Pharmacologic Activity, Phytochemical.

Introduction

Plants have been a mainstay in the treatment of diseases and healing practices since time immemorial.¹ Medicinal plants have gained a wide affirmation as a great therapeutic option in medicine as a result of its high efficacy in the treatment of ailment, little/no side effects, cost-effectiveness and availability compared to conventional drugs. This further corroborates the integration of plant-based drugs for the formulation of contemporary drugs in developing and developed countries.² Thus, plants have continued to provide lead compounds which serve as precursors for pharmaceutical synthesis with improved pharmacological properties.³ The enormous and multifaceted pharmacological effects of medicinal plants are as a result of their phytochemistry. Medicinal plants contain inherent chemical substances called phytochemicals responsible for the diversified pharmacologic activities of plants.^{4,5} These phytochemical constituents have been valuable for the treatment of several infectious diseases, metabolic syndrome, neurological disorder and nutritional disorders amongst others.

In folk medicine, *Parquetina nigrescens* have also been acclaimed as efficacious when utilized for management of different ailments. However, some of these assertions have been scientifically authenticated and the phytochemical constituents of *Parquetina nigrescens* that are accountable for its potency have also been elucidated.

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Thus, this review collates several pharmacological activities of *Parquetina nigrescens* and proposed mechanism of action as established by different researchers. This will serve as a repository of information that can be explored for the benefit of mankind.

Methodology

The report covers the phytoconstituents and established pharmacological activities of *Parquetina nigrescens* obtained through an extensive search of scientific databases such as Science Direct, Google, PubMed and Medline. Seventy-five (75) Journals were retrieved using the key words; *Parquetina nigrescens*, bioactive component, pharmacologic activity, mechanism of action, phytochemicals and the information retrieved was utilized for the review paper.

Results

Distribution and morphology

Parquetina nigrescens (Afzel.) Bullock (family: Periploceaceae), is also known as African Parquetina (English). This plant is found in secondary forests, growing on ant-hills across several African regions such as Senegal, Nigeria, Zimbabwe, Angola etc. In Nigeria, it is called Ewe ogbo, Kwakwanin, and Mbgidim gbe in Yoruba, Hausa and Igbo languages respectively. The “Ewe Ogbo” in Yoruba means “the leave that hears” and it is used in incantations, thereby reflecting the belief in its efficacy for cure of several ailments. *Parquetina nigrescens* is the only specie of the monotypic genus.⁶ It is a perennial plant and possesses a climbing stem, woody base ranging between 10-15 cm and 6-8 cm in length and width respectively.^{7,8} Its flowers have a whitish outer part and an inner reddish colouration. The fruits are made up of an outer woody and an inner softer part.⁵ Several parts of *Parquetina nigrescens* such as the leaves, roots and the latex have been used extensively in traditional medicine practice across Western Africa.

The plant has a wide range of adaptation to climates and soil than most plants. It is quite sensitive to temperature higher than 37°C and its yield increases during the rainy season of the year. *Parquetina nigrescens* is adapted to different soil types, but it grows optimally when on moist fertile soil.

Folkloric/Enthnobotanical claims

Over the years, different parts of *Parquetina nigrescens* plant have been utilised in folk medicine for the treatment of various ailments. The leaves of *Parquetina nigrescens* have been traditionally acclaimed to be effective in the treatment of helminthiasis, it has also been widely acclaimed to be an essential ingredient in the treatment of insanity and dropsy in India.⁹ In Nigeria, the decoctions from the leaves and root have been used for the treatment of gonorrhoea, menstrual irregularities, diabetes, skin diseases, headache, insomnia, hypertension, ricket, diarrhoea. The decoction from the stem bark has also been used to produce tonic for the improvement of heart functions.^{10,11} The root of *Parquetina nigrescens* have been used in the management of rheumatism in Oyo State, Nigeria.¹² *Parquetina nigrescens* is also a constituent of Jubi formular, a commercial herbal tonic, used in the treatment of anaemia in Nigeria.¹³ Furthermore, in East Africa, *Parquetina nigrescens* leaves decoction serves as an aphrodisiac.¹⁴ In Congo Basin, the leaves have been used as arrow poison.¹⁵ Cameroonians use *Parquetina nigrescens* latex as body paint.^{7,11}

Physicochemical parameters of *Parquetina nigrescens*

Several researches have been carried out on the proximate analysis of *Parquetina nigrescens*. The most recent result of the analysis of the leaves showed that the percentage composition moisture content, ash content, crude protein, crude fibre, carbohydrate content are 12.4%, 15.4, 20.6, 11.9 and 24.1% w/w respectively.¹⁶ The major dietary nutrient composition are 2.68, 6.05, 3.45, 7.19 and 5.15 mg/kg dry weight for sodium, magnesium, calcium, potassium and phosphorous respectively. Furthermore, *Parquetina nigrescens* leaves also contain some minor dietary mineral such as manganese (4.56), cobalt (0.05), copper (0.37), zinc (4.35), iron (5.20), nickel (0.07) mg/kg dry weight.¹⁶ However, some traces of heavy metals such as cadmium (0.11) and lead (0.15) were also found in *Parquetina nigrescens* leaves. Cadmium and lead are toxic metals which could be taken up by plants from the soil. The volatile oils from *Parquetina nigrescens* stem contained 6 non-terpenes and 8 terpenes respectively. The terpene constituents were reportedly four hydrocarbon terpenes and four oxygenated triterpenoids. Moreover, the major compounds present in the volatile oil are two oxygenated triterpenes, α -myrincin acetate (19.15%) and lanosterol acetate (18.43%).

Amino acid and mineral composition

Twenty standard amino acids were detected in the aqueous leaf extract of *Parquetina nigrescens* with concentration ranging from 0.3 to 2.12 mg/g.⁸ The determination of the amino acid constituent showed that, cysteine was the most abundant (2.12 mg/g) while methionine (0.30 mg/g) was the least abundant phytochemical.⁸ The anti-sickling activities of plant-derived compounds have been associated with the presence of amino acids.¹⁷ The therapeutic effect of the leaves, stem and root of *Parquetina nigrescens* has been reported earlier in the management of sickle cell anaemia.^{18,19} Glutamic acid, cysteine and glycine are well-known precursors of glutathione which protects cells and organ of the body from toxic free radicals and diseases. Thus, *Parquetina nigrescens* leaves provide glycine, cysteine and glutamic acid required for the production of glutathione, and also antioxidant nutrients capable of preventing the lysis and destruction of the red blood cell membrane. Phenylalanine, tryptophan, tyrosine, glutamine and arginine have been implicated in the enhancement of pro-sexual functioning of animals following the administration of *Parquetina nigrescens* leaves extract to paroxetine hydrochloride induced sexually dysfunctioned rats.⁸

Phytochemical composition

Phytochemistry is the study of biologically active, naturally occurring chemical compounds produced by plants. These compounds contribute to the aroma, colour of plants and also play an important role in protecting plants from environmental hazards such as drought,

ultraviolet light exposure, pathogenic attack, pollution, stress etc.²⁰ Phytochemicals are naturally occurring bioactive chemical compounds found in plants. These chemical compounds protect plant against insects, pests, pathogens, herbivores, UV exposure and environmental hazards such as ultraviolet light exposure, drought, pollution and stress etc.²¹ The dietary intake of plant provides phytochemicals which play important roles in the prevention and treatment of diseases in human.²² Wide-ranging dietary phytochemicals are found in various parts of plants such as the roots, seeds, leaves, stems, fruits, flowers etc. These natural products derived from plants have been used to proffer solution to human diseases since time immemorial. It has been explored by scientists around the world for many years due to their high therapeutic potency in combating human ailments as well as its little or no adverse effects⁵. Drugs have been formulated from lead compounds derived from medicinal plants.

Parquetina nigrescens specie has produced a wide-range of diverse phytochemical constituents with medicinal values. The phytochemical screening of the *Parquetina nigrescens* leaves detected the presence of saponin, alkaloid, tannin, cardiac glycosides, flavonoid, free and bound anthraquinones, phlobatannins, terpenoid, cardenolides and triterpenes.^{8,19} The absence of cyanogenic glycosides/anthocyanides has been reported in *Parquetina nigrescens* leaves extract which suggests that the leaves might be non-toxic.¹⁹ Cyanogenic glycosides/anthocyanides are known toxic and harmful secondary metabolites found in some plants. Gas chromatography mass spectrometry (GCMS) analysis of essential oil from *Parquetina nigrescens* leaves identified five components; Myrcene (3.5%), Neral (35.0%), Geraniol, Geranial (53.7%) and (E)- α -Damascone.²³ In contrast to the report of Owolabi *et al.*, another report on GCMS analysis of *Parquetina nigrescens* (Table 1), showed the presence of entirely different nine and fourteen compounds in the leaves and stem oils respectively.²⁴ Hexahydrobenzofuran, Pentadecanal, β -vertivenene, Widrol, Cis-pinane, Phytone, Henicosane, Octacosane, Neophytadiene, Heptacosane, Lanosterol acetate, Squalene, Hexacosane, α -myrincin acetate were detected in the stem while Acorenone, Squalene, Nonadecane, Trans-pinane, Hexahydrofarnesyl acetate, Neophytadiene, Docosane, Heptacosane, Eicosane were detected from the leaves. Neophytadiene and α -myrincin acetate were the most abundant compounds in the leaves and stem oils respectively.²⁴ *Parquetina nigrescens* is also rich in cardenolides especially cardiac glycosides. These glycosides are collectively called strophanthins, most abundant in the latex and are responsible for the arrow poison activity and similar to lead or cadmium toxicity exhibited by other plants.²⁵

Pharmacological activities of *Parquetina nigrescens*

Some pharmacological activities as well details on the mode of action are discussed below and presented in Table 2. These includes antibacterial, antioxidant, antidiabetic, antifungal, antinociceptive, aphrodisiac, anti-inflammatory, antineurodegenerative, anticancer, antidiarrhoea, antisickling, antineurotoxic and antiapoptotic activities.

Anti-diarrhoeal

Some studies have reported the anti-diarrhoeal activity of *Parquetina nigrescens*. Banwo *et al.*, reported a dose-dependent reduction in the fecal *E. coli* load with simultaneous weight gain in rats 48 hours after the administration of the methanol extracts of *Parquetina nigrescens* leaves.²⁶ Also, the study on anti-diarrhoeal activity of methanol root extract of *P. nigrescens* (MPN) by Mahmud *et al.* proved that at 25 mg/kg body weight, the extract produced maximal percentage inhibition against castor oil-induced diarrhoea (COD), castor oil-induced enteropooling (COE) and gastrointestinal motility (GIT).²⁷

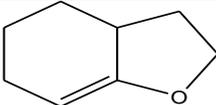
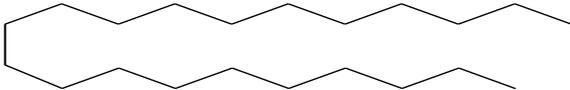
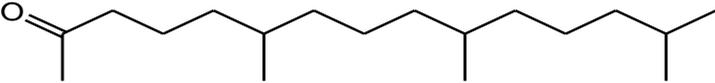
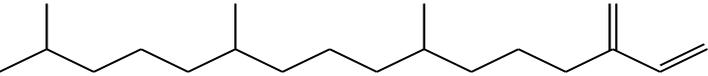
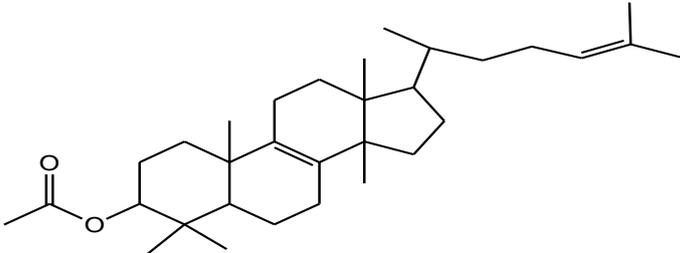
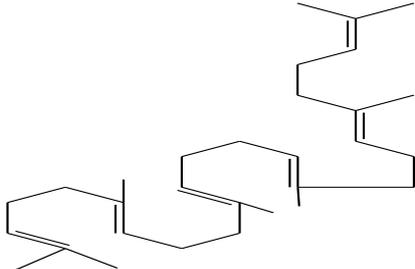
Anti-anaemic

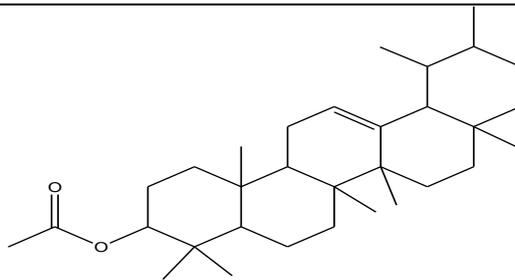
Scientific studies have lent credence on the local use of *Parquetina nigrescens* as blood tonic and therapy for anaemic patient. Ighodaro *et al.*, studied the erythropoietic potential of *Parquetina nigrescens* leaves in Cephalosporin-induced anaemia model.²⁸ The results obtained showed that the treatment of anaemic animals with *P. nigrescens* at a dosage of 250 mg/kg BW significantly ($P < 0.05$) increased the levels of red blood cells among other indices. The percentage reversal and inhibition of sickling parameters were analysed on pre-sickled HbSS blood cell suspensions by Imaga *et al.*¹⁹

The result obtained show showed a marked decrease in percentage hemolysis for the 5 mg/ml extract at 0.25% buffered saline concentration. Also, the pre-treatment of sickle cell suspensions with

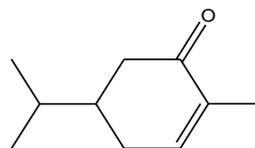
extract inhibited the formation of sickle cells under severe hypoxia, with only 5% sickle cells at 40 minutes while the untreated sickle cell suspensions had 65% sickle cells compared with the control.

Table 1: Structures of phytochemicals present in *Parquetina nigrescens* leaves and stem oil as obtained from Gas Chromatography Mass Spectroscopy analysis.

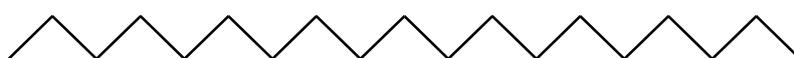
S/N	Phytochemical Components	Structures
1	Hexahydrobenzofuran	
2	Pentadecanal	
3	Heneicosane	
4	Octacosane	
5	Phytone	
6	Neophytadiene	
7	Lanosterol acetate	
8	Heptacosane	
9	Hexacosane	
10	Squalene	

11 α -amyrin acetate

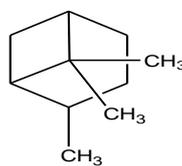
12 Acorenone



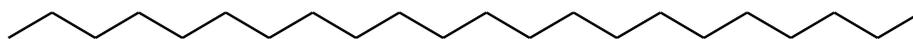
13 Nonadecane



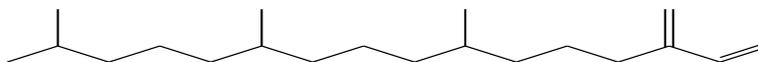
14 Trans-pinane



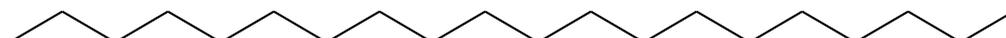
15 Docosane



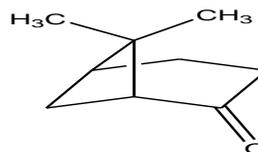
16 Neophytadiene



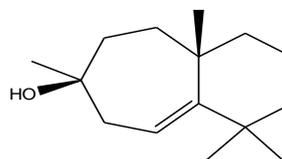
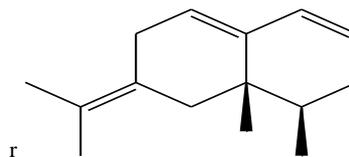
17 Eicosane



18 Cis-pinane



19 Widdrol

20 β -vertivenene

Antineurodegenerative

Ochigbo *et al.* studied the effect of the polyphenol-rich fraction of *P. nigrescens* aerial part on dichlorvos-induced neurotoxicity in rats.²⁹ The result obtained showed that the AchE expression in rats administered polyphenol-rich fraction of *P. nigrescens* was similar to the control group, the prominent effect of oxidative stress and apoptosis resulting from the neurotoxic effect was also ameliorated by the polyphenol-rich fraction of *P. nigrescens*. The study on the effect of methanolic stem extract of *Parquetina nigrescens* (Afzel) bullock on scopolamine-induced sub-chronic cognitive deficit rats showed its potential to ameliorate this cognitive disorder via its antioxidant mechanism.³⁰

Antidiabetic

Several studies on the anti-diabetic activity of *Parquetina nigrescens* plant have proven its efficacy in the management/ treatment of this chronic metabolic syndrome. The antidiabetic and antihyperlipidemic effect of the aqueous extract obtained from the whole plant of *Parquetina nigrescens* in streptozotocin–nicotinamide-induced type 2 diabetic rats as investigated by Ojuade *et al.*, showed significant reduction in fasting blood glucose, ameliorative effect on lipid profile and regeneration of the pancreatic tissue.³¹ The group administered 800 mg/kg body weight produced the most significant ameliorative effect. Similarly, the assessment of the antidiabetic property of *Parquetina nigrescens* leaves aqueous extract using chlorpropamide as a standard showed a very significant reduction in the elevated blood glucose level at 1000 mg/kg body weight and amelioration of some other diabetes-related parameters.³²

Table 2: Pharmacological activities of *Parquetina nigrescens*

S/n	Pharmacological activity	Solvent phase used	Part of plant used	Most effective dose	Animal/microbial subjects, <i>in vivo/in vitro</i>	Mode of action	Effectiveness compared to standard drug	Year of publication	Reference
1	Antineurodegenerative	Methanol	Stem	500, 1000mg/kg	Mice	Amelioration of scopolamine induced cognitive deficit through boost of brain antioxidant components	No standard drug used for comparison	2020	[27]
2	Antibacterial	n-hexane, Methanol, Water	Leaves	600mg/ml	<i>Escherichia coli</i> , <i>Klebsiella pneumoniae</i> and <i>Proteus</i> spp.	Zonal dose dependent inhibition of microbes	Less effective as standard drug streptomycin	2019	[33]
3	Antidiarrhoea		Leaves	Wistar rats	200mk/kg	Dose dependent decrease of castor oil induced watery stool	Relative to loperamide	2019	[34]
4	Antifungal	n-hexane, Methanol, Water	Leaves	600mg/ml	<i>Aspergillus flavus</i>	Zone inhibition of <i>Aspergillus flavus</i>	Less effective compared to standard drug fluconazole	2019	[33]
5	Anticancer	Ethanol	Leaves	Cell lines	8.33 µg/ml	inherent cytostaticity and/or cytotoxicity of the plant ameliorated cell proliferation.	Non used	2018	[35]

6	Aphrodisiac	Water	Leaves	Wistar rats	80 mg/kg	The extract ameliorated sexual dysfunction/competence by upregulating reproductive hormones and nitric oxide levels as well as inhibiting phosphodiesterase type v activity.	Extract gave better results than PowmaxM	2017	[8]
7	Antineurotoxic and Antiapoptotic	Polyphenol fraction	Leaves	Wistar rats	100,200 mg/kg	Increased expression of acetylcholinesterase and activation of antioxidant defense system. Mitigates dichlorovose induced cell death	None used	2017	[29]
8	Antinociceptive	Methanol	Fruit bark	200mg/kg	Swiss albino rats	Central and peripheral inhibition of formalin induced pain at both early and late phases	Comparable effectiveness with acetylsalicylic acid at pain inhibition	2014	[36]
9	Antioxidant	Water, Methanol	Leaves, Stem	50mg/ml	Invitro, Rats	Inhibition of Fe ²⁺ /ascorbic acid induced peroxidation of fats in hepatic cell mitochondria. It also	More effective than standard butylated hydroxyl	2011	[37]
10	Anti-inflammatory	Water	Leaves	200mg/kg	Wistar rats	Mitigates carrageenan oedema as well as granuloma activated by cotton pellet. It ameliorated arthritis induced by formaldehyde	Inhibition comparable to those of indomethacin control	2009	[38]
11	Antiulcer	n-hexane, chloroform	Leaves	Wistar rats	500, 1000 mg/kg	The extracts exhibited gastroprotective and antiulcer effect through activation of antioxidant enzymes	Performed better than standard drug Cimetidine	2009	[39]
12	Antisickling	Pet-ether, aqueous methanol	Leaves, stem	Invitro	5mg/kg	protects the integrity of the erythrocyte membrane as evidenced in the fragiliogram by the reduction in hemolysis of the Hbss cells.	Non used	2010	[19]
13	Antidiabetic	Water	Leaves	Rats	1000mg/kg	Reduction of hyperglycemia	Relative to chlorpropamide	2010	[32]

Future Perspectives

The phytochemical constituent of *Parquetina nigrescens* leaves extract has been associated with its pharmacological activities such as anti-sickling, anti-diabetic, anti-microbial, haematinic, analgesic, anti-pyretic, anti-inflammatory, anti-diarrhoea etc. The isolation and characterization of the actual bioactive principle in *Parquetina nigrescens* species is recommended to further validate these numerous pharmacological activities and this could serve as a lead step to the discovery of a new compound with better therapeutic potency for the management of some ailments. Furthermore, most research focus have been on the leaves and stem, other parts of *Parquetina nigrescens* species can be explored scientifically in order to validate its traditional use.

Conclusion

Based on the findings from this review, *Parquetina nigrescens* has myriads of medicinal uses which has been substantiated based on scientific evidence. It measures as an interesting candidate for drug discovery and development based on the inherent phytoconstituents and biological activity against metabolic disorders.

Conflict of Interest

The authors declare no conflict of interest.

Authors' Declaration

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

References

- Sofowora A, Ogunbodede E, Onayade A. The Role and Place of Medicinal Plants in the Strategies for Disease Prevention. *Afr J Trad Compl Altern Med*. 2013; 10(5):210-229.
- World Health Organisation. WHO Traditional Medicine Strategy 2014-2023. 2013; 13-25 p.
- International Union for Conservation of Nature (IUCN). Selected medicinal plants of Chittagong Hill Tracts. Dhaka Bangladesh. 2011; 4-12p.
- Gracelin DS, Britto AJ, Kumar PB. Qualitative and quantitative analysis of phytochemicals in five *Pteris* species *Int J Pharm Sci*. 2012; 5:105-107.
- Omoboyowa DA, Ogunneye AI, Igara CE, Otuchristian G. Phytochemical screening and haematological studies of *Parquetina nigrescens*, ethanol and chloroform leaves extracts in normal albino rats. *Acad J*. 2016; 10(10):164-169.
- Sopeyin AO and Ajayi GO. Pharmacognostic study of *Parquetina nigrescens* (Afzel.) Bullock (Periplocaceae). *Int J Pharmacogn Phytochem Res*. 2016; 8(2):321-326.
- Kokwara JO. Medicinal plants of East Africa. 3rd ed. Kenya/Nairobi: University of Nairobi Press. 2009; 1-463p.
- Kayode OT and Yakubu MT. *Parquetina nigrescens* leaves: Chemical profile and influence on the physical and biochemical indices of sexual activity of male Wistar rats. *J Integr Med*. 2017; 15(1):64-76.
- Iwu M.M. Handbook of African Medicinal plants. CRC Press Broca Raton FL. 1993; 351p.
- Sofowora A. Medicinal plants and traditional Medicine in Africa 2nd edition. Spectrum Books Publisher. Ibadan Nigeria. 1993; 134-136p.
- Odetola AA, Oluwole FS, Adeniyi BA, Olatiregun AM, Ikupolowo OR, Labode O, Busari KO, Shorinola JA. Antimicrobial and gastroprotective properties of *Parquetina nigrescens* (Afzel.) Bullock. *J Biol Sci*. 2006; 6:701-705.
- Adeyemi SO. Ethnobotanical study of the antirheumatic plants in parts of Oyo Ogun and Lagos States. Project Report in the Department of Microbiology and Botany University of Ibadan. 1994; 46p.
- Owoyele BV, Oyelowo OT, Biliaminu SA, Alaran ON, Alimi SA, Saliu RS. Hematological and biochemical studies on *Parquetina nigrescens* root extract in albino rats. *J Appl Pharm Sci*. 2011; 01(10):176-179.
- Airaodion AI, Olatoyinbo PO, Ogbuagu U, Ogbuagu EO, Akinmolayan JD, Adekale OA, Airaodion EO. Comparative assessment of phytochemical content and antioxidant potential of *Azadirachta indica* and *Parquetina nigrescens* leaves. *Asian Plant Res J*. 2019; 2(3):1-14.
- Terashima H and Ichikawa M. A comparative ethnobotany of the Mbuti and Efe hunter-gatherers in the Ituri forest Democratic Republic of Congo. *Afr Study Monogr*. 2003; 24(1/2):1-168.
- Odukoya JO, Odukoya JA, Oshodi AA. Evaluation of the nutritional qualities of the leaves of *Parquetina nigrescens* *Launaea taraxacifolia* and *Solanum nigrum*. *Eur J Pure Appl Chem*. 2018; 5(1):18-31.
- Acquaye CTA, Young JD, Ellory JC, Gorecki M, Wilchek M. Mode of transport and possible mechanism of action of L-phenylalanine benzyl ester as an anti-sickling agent. *Biochim Biophys Acta*. 1982; 693(2):407-416.
- Kade IJ, Kotila OO, Ayeleso AO, Olaleye AA, Olawoye TL. Antisickling properties of *Parquetina nigrescens*. *Biomed Res*. 2003; 14:185-188.
- Imaga NA, Gbenle GO, Okochi VI, Adenekan S, Duro-Emmanuel T, Oyeniyi B, Ekeh FC. Phytochemical and antioxidant nutrient constituents of *Carica papaya* and *Parquetina nigrescens* extracts. *Sci Res Essays*. 2010; 5(16):2201-2205.
- Isah T. Stress and defense responses in plant secondary metabolites production. *Biol Res*. 2019; 52(1):39.
- Mathai K. Nutrition in the Adult Years. In Krause's Food Nutrition and Diet Therapy 10th ed. ed. L.K. Mahan and S. Escott-Stump. 2000; 271:274-275.
- Prakash D, Gupta C, Sharma G. Importance of phytochemicals in nutraceuticals. *J Chin Med Res Dev*. 2012; 1(3):70-78.
- Owolabi MS, Oladipupo A, Lawala RM, William NS. The Volatile Constituents of *Parquetina nigrescens* from South-western Nigeria. *Nat Prod Commun*. 2014; 9(6):857-858.
- Oghenejoboh UM and Josiah NN. Chemical Composition Cytotoxicity and Antioxidant Activities of Essential Oils of *Parquetina nigrescens* (afz.) Bullock from Ibadan Nigeria. *The Pharm Chem J*. 2018; 5(5):99-104.
- Brzezicha-Cirocka J, Grembecka M, Szefer P. Monitoring of essential and heavy metals in green tea from different geographical origins. *Environ Monitor Assess*. 2016; 188(3):1-11.
- Banwo K, Alao MB, Sanni AI. Antioxidant and antidiarrhoeal activities of methanolic extracts of stem bark of *Parkia biglobosa* and leaves of *Parquetina nigrescens*. *J Herbs Spices Med Plants*. 2020; 26(1):14-29.
- Mahmud B, Ijudigal L, Yunusa I, Shehu A, Magaji MG. Activity of methanol root extract of *Parquetina nigrescens* (Afzel.) Bullock on castor oil-induced diarrhoea in mice. *J Pharm Bioresour*. 2020; 17(2):180-188.
- Ighodaro OM, Asejeje FO, Adeosun AM, Ujomu TS, Adesina FC, Bolaji KT. Erythropoietic potential of *Parquetina nigrescens* in cephalosporin-induced anaemia model. *Metabol Open*. 2020; 8:100064.
- Ochigbo GO, Saba AB, Oyagbemi AA, Omobowale TO, Asenuga ER. Polyphenol-rich fraction of *Parquetina nigrescens* mitigates dichlorvos-induced neurotoxicity and apoptosis. *J Ayurv Integr Med*. 2017; 8(1):27-36.
- Mahmud B, Shehu A, Magaji MG. Ameliorative effect of methanol stem extract of *Parquetina nigrescens* (Afzel) bullock on scopolamine-induced sub-chronic cognitive

- deficit in mice. *J Basic Clin Physiol Pharmacol.* 2020; 31(3):
31. Ojuade FI, Olorundare OE, Akanbi OB, Afolabi SO, Njan AA. Antidiabetic and antihyperlipidemic effects of aqueous extract of *Parquetina nigrescens* in streptozotocin–nicotinamide induced type 2 diabetic rats. *Heliyon.* 2021; 7(6):e07363.
 32. Saba AB, Oyagbemi AA, Azeez OI. Antidiabetic and haematinic effects of *Parquetina nigrescens* on alloxan induced type-1 diabetes and normocytic normochromic anaemia in Wistar rats. *Afr Health Sci.* 2010; 10(3):276-283
 33. Adoga SO, Ekle DE, Kyenge BA, Aondo TO, Ikese CO. Phytochemical screening thin-layer chromatography and antimicrobial activity study of *Parquetina nigrescens* leaf extracts. *Ovidius Univ Ann Chem.* 2019; 30:88-94.
 34. Kola-Mustapha AT, Ghazali YO, Ayotunde HT, Atunwa SA, Usman SO. Evaluation of the antidiarrheal activity of the leaf extract of *Parquetina nigrescens* and formulation into oral suspensions. *J Exp Pharmacol.* 2019; 11:65-72.
 35. Onyegeme-Okerenta BM, Agyare C, Bradshaw TD, Spriggs KA. Cytotoxic potential of ethanol extract of *Parquetina nigrescens* on MCF-7 C4-2WT HT 29 and HTC 116 cell lines. *Afr J Pharm Pharmacol.* 2018; 12(23):310-318.
 36. Okunrobo LO, Uwaya JO, Ehimhen PE. Antinociceptive effect of methanol extract of *Parquetina nigrescens* (afzel) bullock (Periplocaceae) fruit bark. *J Sci Prac Pharm.* 2014; 1(1):16-19.
 37. Ayoola O, Akinloye O, Oguntibeju OO, Oke JM, Odetola AA. Antioxidant Activities of *Parquetina nigrescens*. *Afr J Biotechnol.* 2011; 10(24):4920-4925.
 38. Owoyele BV, Abdulrazaq BN, Idris AO, Lukuman AO, Ayodele OS. Studies on the analgesic anti-inflammatory and antipyretic effects of *Parquetina nigrescens* leaf extract. *J Ethnopharmacol.* 2009; 122:86–90.
 39. Kayode AA, Kayode OT, Odetola AA. Antiulcerogenic activity of two extracts of *Parquetina nigrescens* and their effects on mucosal antioxidants defense system on ethanol-induced ulcer in rats. *Res J Med Plant.* 2009; 3:102-108.