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Enhanced Effect of Aqueous Extract of *Telfairia occidentalis* Seed on the Microstructure of the Hippocampus of Scopolamine Hydrobromide-Induced Cognitive Dysfunction Rats

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Authors' contributions

This work was carried out in collaboration among all authors. Author EME designed the study, carried out the research protocols and wrote the first draft. Authors SOP and AOI managed the photomicrographs and interpretation of the findings and author MIA managed the literature search. All authors read and approved the final manuscript.

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ABSTRACT

Aims: This study assessed histological parameter of the hippocampus using scopolamine-induced cognitive dysfunction rats following the administration of aqueous extract of *Telfairia occidentalis* seed.

Materials and Methods: Thirty Wistar rats weighed between 180-200 g were randomly grouped into five, designated I, II, III, IV and V each containing six rats. Cognitive dysfunction was induced in groups II to V by intraperitoneal administration of 1 mg/kg body weight of scopolamine for seven days before the aqueous extract administration. Group I were fed with animal feed and water *ad libitum*. Groups III and IV received 875 and 1750 mg/kg body weight of aqueous extract of *Telfairia occidentalis* seed while group V received 1 mg/kg body weight of donepezil for fourteen days. Twenty-four hours after the last administration, the animals were anaesthetized with their brain tissues perfused, processed and stained with haematoxylin and eosin.

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Results: Results showed atrophied and karyorrhectic cells with disrupted cell membranes in group II. These pathological features were less in groups III and V but none in group IV when compared to group I. The ameliorative effect of aqueous extract of *T. occidentalis* may be attributed to the presence of exogenous antioxidants which helps to neutralize the toxic effects caused by scopolamine.
Conclusion: In conclusion, the cellular damage caused by scopolamine hydrobromide was reduced in dose dependent manner following administration of aqueous extract of *T. occidentalis* seed.

Keywords: Telfairia occidentalis; scopolamine hydrobromide; wistar rats; karyorrhectic; atrophy; cognitive dysfunction.

1. INTRODUCTION

Neurodegeneration is a progressive loss of the anatomy of neurons including death. This occurs as a result of neurodegenerative process resulting to gradual deterioration and death of neuronal cells that affect locomotion and mental functioning (dementia). Dementia caused most burdens of neurodegenerative ailments with Alzheimer's disease representing approximately 60 to 70% cases www.neurodegenerationresearch.eu, [1]. Cognitive dysfunction is a major health problem as many neuropsychiatric and neuro-degenerative disorders such as Alzheimer's are debilitating in nature Commenges et al. [2]. Dementia causes health issues in the adult Blendon et al., [3]. The global prevalence of dementia of adults >60 years account for 5 to 7% Prince et al. [4] with Alzheimer's disease (AD) more common when compared to vascular dementia Akter et al. [5].

Moreover, there are scarce and contradicting documents of dementia including its subtypes in the sub-Saharan Africa Prince et al. [4]; Paddick et al. [6]; Ferri et al. [7] which may have far-reaching implications on public health policies on dementia in the region. While some studies suggest a lower prevalence in some parts of sub-Saharan Africa Prince et al. [4]; Paraiso et al. [8]; Yusuf et al. 2011; Guerchet et al. [9]; Hendrie et al. [10], others reported prevalence rates comparable to those from Western countries Paddick et al. [6]; Guerchet et al. [9]. The incidence of dementia and Alzheimer's disease in the Yoruba Africans were two to three times less compared to African Americans [10]; however, Davies et al. [11] estimated that cases of dementia increased by 400% for 20 years (1995-2015) period. Research also revealed a marked difference in incidence of AD between women and men as estimation shows that nearly two third of the patients living with AD are women Alzheimer's Association, [12], raising the intriguing suggestions that there are biological mechanisms underlying higher incidence of AD cases in women.

Neuroprotection refers to the strategies and relative mechanisms able to defend the central nervous system against neuronal injury due to acute stroke or trauma and chronic neurodegenerative disorders for example, Alzheimer's and Parkinson's diseases Kummar, [13]. In the past 20 years, the nutritional neuroscience emerged as a recognized discipline with the potential to make significant contributions to our understanding of the relationship between nutrition and cognitive functions Gillette et al. [14]. The use of medicinal plants as an alternative prevention of AD became paramount to many scientists.

Telfairia occidentalis seed is a common plant in our locality and grows in most part of Nigeria. This seed is known to contain pharmacological activities such as antioxidants, antidiabetic, antibacterial, anti-inflammatory and antifungal effects Nkosi et al. [15]. Aqueous extract of the seed is being documented to possess neuroprotective effects as AD affects predominantly the cerebral cortex and the hippocampus with loss of mass and atrophy as the disease advances Apostilova et al. [16]. Moreover, neurodegenerative disease is attributed to oxidative stress induced by the generation of free radicals causing cellular damage by modifying macromolecules such as DNA, carbohydrates, proteins and lipids Li et al., 2015; Slupphaug et al., 2003). The endogenous (glutathione secreted by the neuronal cells) and exogenous antioxidants from *Telfairia occidentalis* help to neutralize the excess free radicals, protect cell against toxic effects and also contribute to disease prevention pharm-Huy et al. The free radical scavenging property of *T. occidentalis*, attributed to the presence of high amount of polyphenols (flavonoids and vitamin C) (Aminu et al., 2012; Oboh et al., 2010; Nwana

and Oboh, 2007) may provide a safe option, hence, the need to investigate the neuroprotective effect of aqueous extract of T. occidentalis seed in scopolamine hydrobromide-induced cognitive dysfunction rats.

2. MATERIALS AND METHODS

Thirty adult Wistar rats weighing between 180-200g were randomly grouped into five each containing six rats designated I, II, III, IV and V. Prior to extract administration, cognitive dysfunction was induced to groups II to V by administering 1mg/kg body weight of scopolamine for a period of seven days. Twenty-four hours after induction, groups III and IV received 875 and 1750 mg/kg body weight of *T. occidentalis* seed while group V received 1 mg/kg body weight of donepezil drug. Twenty-four hours after the last administration, the experimental animals were anaesthetized with their brain tissues perfused before being processed and stained with haematoxylin and eosin for histological observations with a light microscope.

3. RESULTS AND DISCUSSION

Scopolamine hydrobromide-induced cognitive model in rodents is an established method to facilitate research and the development of compounds for Alzheimer's disease and other diseases with negative impact on memory and cognitive functions Nitta, [17]. The cognitive impairment associated with scopolamine hydrobromide (SHB) is similar to that in AD. After intraperitoneal injection of SHB, the cholinergic neurotransmitter is blocked, leading to cholinergic dysfunction and impaired cognition in rats Oh et al. [18]. A study was reported that memory impairment induced by SHB in rats is associated with altered brain oxidative stress status Fan et al., [19]. In this study, the rats with SHB-induced memory deficits were used as an animal model for elucidating the potentials of *Telfairia occidentalis.*

In this study, loss of cellular integrity, degeneration of cells and cellular vacuolations in the hippocampus with atrophied and karyorrhectic cells were observed in rats in group B treated with SHB alone. These histological changes imply cellular damage, which may account for poor performance observed in the neurobehavioral test. This changes is similar to a study carried out by Deb et al. [20] where scopolamine induced marked impairment of memory in behavioural test which correlate with the histomorphological changes in the hippocampus of rats. The exact mechanism responsible for this degeneration is however not clear but may be due to the generation of reactive oxygen species since oxidative stress has been shown to cause neuronal damage Zou et al. [21]. Previous reports have it that SHB triggers the induction of reactive oxygen species which causes free radical injury Lin and Beal, [22]: Fan et al. [19].

The cytoarchitecture of group III and V showed mild effects (Plates 3 and 5) compared to group B treated with SHB (Plate 2) but group IV showed normal cytoarchitecture of the hippocampus compared to the control group A (Plate 4). In the current study, all the treated groups were able to ameliorate the insult inflicted by the SHB to the pyramidal cells of the hippocampus (Plates 3 to 5). A study has it that neuronal cell death, gliosis, swollen or destroyed axons and myelin sheath are characteristics of chemically induced neurodegeneration Cavanagh, [23]. This is true because the neurodegenerative disease caused by SHB in group II showed atrophic pyramidal cells and numerous vacuolations filled with lipids (Plate 2).The normal integrity of the soma as well as it processes is very important for normal nervous system function. When the soma is injured,

Table 1. Showing the administration process and the results

S/N	Group	No	SHB	Donepezil	*T. occidentalis*	Results
1	I	6	-	-	-	Normal pyramidal cells.
2	II	6	1 mg/kg	-	-	Cells were Karyorrhectic, atrophied, and shrunkened and dysrupted cell membranes.
3	III	6	1 mg/kg	-	875 mg/kg	Atrophied pyramidal cells.
4	IV	6	1 mg/kg	-	1750 mg/kg	Normal pyramidal cells.
5	V	6	1 mg/kg	1 mg/kg	-	Cells were Karyorrhectic, atrophied, and shrunkened and dysrupted cell membranes.

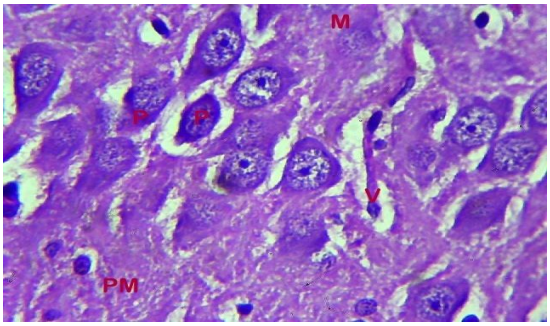

Plate 1. Photomicrograph of a section of hippocampus of the negative control group I stained with H and E showing normal pyramidal cell layer, molecular and polymorphic cell layers

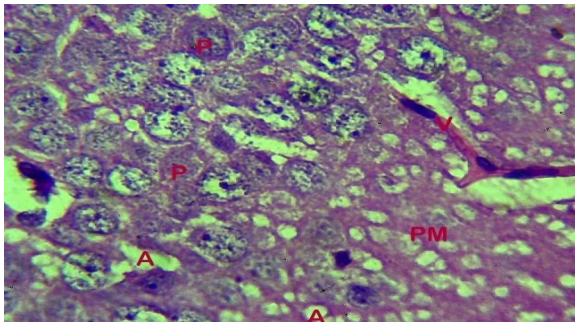

Plate 2. Photomicrograph of a section of hippocampus of the positive control group II treated with 1mg/kg body weight of SHB showing karyorrhetic,shrunkened, hyperchromatic pyramidal cells with some disrupted cell membranes

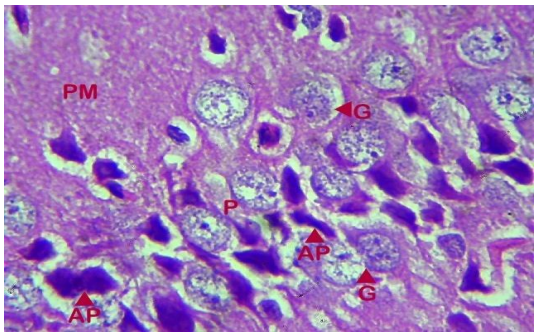

Plate 3. Photomicrograph of a section of hippocampus from group III treated with SHB and 875mg/kg body weight of *Telfairia occidentalis* showing atrophied pyramidal cell, numerous neuropils, glia cells and cell membranes were not clearly defined

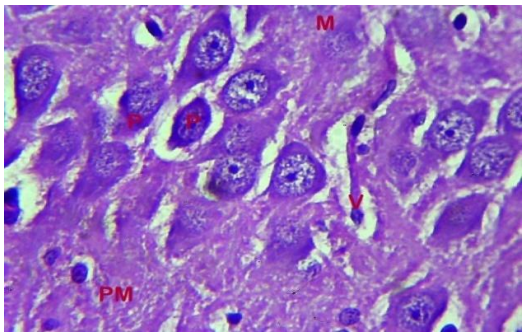

Plate 4. Photomicrograph of a section of hippocampus from group IV treated with SHB and 1750mg/kg body weight of *Telfairia occidentalis* showing normal pyramidal cell, Polymorphic and molecular layers, normal glia cells and blood vessels and abundant neuropils

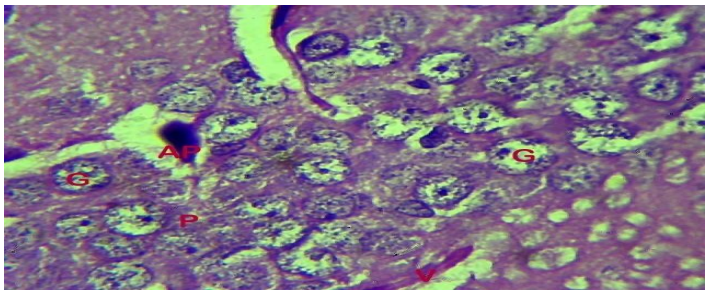

Plate 5. Photomicrograph of a section of hippocampus from group V treated with SHB and donepezil showing kayorrhectic and atrophied pyramidal cell with hyperchromatic staining. Majority of the cell membranes were not clearly defined

various degenerative changes occur due to either obstruction in blood flow causing ischemia and hypoxia, crushing of nerve fibres and injection of toxic substances or chemicals (Abbas and Nelson, 2004). In the hippocampus, CA1 and CA3 subfields are vulnerable

to cell injury George et al. [24] which is in line with the pyramidal cells in group II, III and V that showed atrophied pyramidal cells, loss of plasma membranes and pale staining cytoplasm of the glial cells (Plates 2, 3 and 5).

This study also confirmed the involvement of pyramidal cells found in the pyramidal layer as degenerative changes observed in the hippocampus were predominantly evident mostly in the experimental groups treated with 1mg/kg body weight of SHB. These degenerative changes may lead to dysfunction of the hippocampus characterized by inability to establish new long-term memory. Furthermore, the distorted cytoarchitecture of the hippocampus observed was mild in the experimental group III and V (Plates 3 and 5) compared to the positive control group (Plate 2). The observed result showed dose related pattern of cellular repair with group IV exhibiting the most ameliorative potentials from aqueous extract of *T. occidentalis* seed on the hippocampal pyramidal cells which may enhance learning and memory in line with Owoeye and Gabriel [25] who reported that aqueous extract of *T. occidentalis* possess potential effects against $HgCl_2$-induced oxidative stress and histological changes of rat hippocampus and cerebellum. This ameliorative potential of the plant may be attributed to the high polyphenols (antioxidants) content which according to Pharm-Huy et al. [26] may help neutralize the excess free radicals, protect the cell against their toxic effect as well as prevent further damage from the SHB as well as providing enabling environment for cells and tissues survival.

4. CONCLUSION

From the present study, aqueous extract of *T. occidentalis* seed possess the ability to reduce cellular damage caused by scopolamine hydrobromide in hippocampus of adult Wistar rats.

CONSENT

It is not applicable.

ETHICAL APPROVAL

All authors hereby declare that principles of laboratory animal care (NIH publication NO. 85-23, revised 1985) were followed, as well as specific national laws where applicable. All experiments have been examined and approved by the Faculty Animal Research Ethics Committee (FAREC-FBMS) with approval number 042ANA3719.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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