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Hemodynamic and Antioxidant Effects of Gelatin-encapsulated Peptide from African Oil Bean Seeds in L-NAME-Induced Hypertensive Rats

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ABSTRACT

Hypertension has been a major global health problem, often linked to oxidative stress and impaired vascular function. This study investigated the hemodynamic and antioxidant effects of gelatin-encapsulated peptides from African oil bean (AOB) (Pentaclethra macrophylla) seeds in L-NAME-induced hypertensive rats. African oil bean seeds were sorted, cooked, and turned into a fermented condiment. Thereafter, the condiment was dried, soluble peptides extracted, and the resulting solution was lyophilized and subsequently encapsulated. Adult male Wistar rats were grouped randomly into five groups: 1 (normal control group), 2 (hypertensive induced group), 3 (hypertensive + lisinopril 10mg/kg b.wt), 4, and 5 (hypertensive + 1 mg/kg and 2 mg/kg dose/b.wt, respectively). N-nitro-L-arginine methyl ester (L-NAME) and treatment were administered orally via gavage concurrently to all animals for 10 days. The blood pressure was measured using tail-cuff plethysmography. Thereafter, the animals were sacrificed by cervical dislocation, and the plasma enzymatic and non-enzymatic antioxidants were determined. The results showed that L-NAME administration significantly ($p< 0.05$) elevated systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP), ROS and TBARS levels were also significantly increased, while GSH, GST, total thiol, GPx, SOD, and catalase levels were reduced. Treatment with gelatin-encapsulated peptide from AOB significantly ($p< 0.05$) normalized the blood pressure and restored antioxidant status. These findings suggest that gelatin-encapsulated peptide from AOB possesses antihypertensive effects and enhances the body's antioxidant defense mechanism. This study highlights the therapeutic potential of African oil bean-derived bioactive peptides as natural, functional agents for hypertension management and cardiovascular protection.

Key words: Hypertension, Hemodynamic, Antioxidant, Gelatin, Peptide, Blood pressure.

INTRODUCTION

Hypertension or high blood pressure, is a significant worldwide risk factor for cardiovascular diseases such stroke, renal failure, and premature mortality (WHO, 2023). The World Health Organization estimates that over one billion adults worldwide suffer from hypertension, which is a major cause of premature death. The number of adults with hypertension has increased significantly in recent decades and is still poorly controlled in many regions (WHO, 2021).

Vascular tone, blood volume, and cardiac output are all controlled by intricately interrelated

systems that regulate blood pressure (Kulyk *et al*., 2024). The renin-angiotensin-aldosterone system (RAAS) is a major regulator. Clinical antihypertensive therapy relies heavily on medications that block the angiotensin-converting enzyme's (ACE) conversion of angiotensin I to angiotensin II, which results in a strong vasoconstrictor and increases the release of aldosterone (Thakkar *et al.,* 2025). However, in many low- and middle-income settings, long-term pharmacotherapy may be linked to side effects and access/cost issues, which encourages the use of complementary strategies, such as dietary approaches, nutraceuticals, and functional foods, to prevent or manage hypertension (Zhang and Chang, 2019).

Food-derived bioactive peptides have gained particular attention because of their ability modulate blood-pressure regulatory pathways via inhibiting ACE (Gochhi *et al.,* 2025), or through antioxidant (Zhou *et al*., 2024), anti-inflammatory (Zhao, *et al*., 2024) as well as endothelial-protective effects (Zhou *et al*., 2024), while being derived from commonly consumed proteins and therefore having potential as safe, food-based interventions (or nutraceutical ingredients). Peptides released from plant proteins (legumes and oil seeds) by enzymatic hydrolysis or microbial fermentation often include low-molecular-weight sequences with measurable ACE-inhibitory activity *in vitro* and blood-pressure-lowering effects in animal models (Poddar, 2024).

Many traditional condiments in sub-Saharan Africa are made by fermenting protein-rich seeds in the wild, which produces peptide-rich products with bioactive and nutritious qualities (Arouna*et al*., 2023). African oil beans (*Pentaclethra macrophylla* Benth) are a common tropical oil seed used in West African cooking and condiments. Traditionally, the high-protein seeds are fermented to make condiments like ugba (*P. macrophylla*). These seeds may also be sources of antihypertensive peptides since fermentation releases peptides and other metabolites that have been linked in early research to antioxidant, blood pressure-lowering, and other health-promoting effects (Olasupo *et al*., 2016; Ademiluyi *et al*., 2025).

According to Zhang and Chang (2019) and Zabot *et al*. (2022), encapsulation is a viable technique that can be used to protect peptides from degradation during food processing and gastrointestinal passage, thereby controlling their release and improving bioavailability, making them valuable for developing useful functional food products or nutraceuticals. Nevertheless, there is a dearth of information in the literature regarding the encapsulation of peptides from underutilized tropical oil seeds and how they are released. Therefore, in rats with L-name-induced hypertension, this work aims to examine the hemodynamic and antioxidant effects of gelatin-encapsulated peptides from African oil bean (AOB) seeds.

MATERIALS

Sample Collection

African oil bean (*Pentaclethra macrophylla* Benth), which is widely utilized in Nigerian fermented condiment production, was purchased from an agricultural settlement near Akure, Nigeria. The seeds were used to make the condiments after being processed to get rid of the stone and dirt.

Chemicals/Reagents

Except where otherwise noted, all of the chemicals and reagents used were of analytical grade and cone product of Sigma Aldrich Ltd. and BDH Chemicals Ltd., Poole, England. Acetylthiocholine iodide, 5-,5-dithiobis (2-nitrobenzoic acid), reduced glutathione, 2-,7-dichlorofluorescein diacetate, 1-chloro-2,4-dinitribenzene (CDNB), and thiobarbituric acid (TBA) purchased from Sigma Aldrich Co. (St. Louis, Missouri, USA). The supplier of trichloroacetic acid (TCA) was Sigma Aldrich, Chemie GmbH in Steinheim, Germany. BDH

Chemicals Ltd. (Poole, England) provided the hydrochloric acid, sodium lauryl sulfate, potassium phosphate buffer, methanol, acetic acid, gallic acid, aluminum chloride, and hydrochloric acid. The substrate hippurylhistidylleucine (Bz-Gly-His-Leu) is a product of Sigma-Aldrich Chemie GmbH, Steinheim, North Rhine-Westphalia, Germany.

Production of Fermented Underutilized Oilseed Condiment

A modified method described by Obizoba and Atu (1993) and Ademiluyi *et al*. (2015) was used to produce the condiment. In short, African oil bean seeds were pressure-boiled for three hours, manually dehulled, and then cooked for an additional hour. The condiment was then made by spreading the cooked seeds in a container, covering them with blanched banana leaves, and allowing them to ferment at room temperature for 96 hours. Before analysis, the condiment was kept in the refrigerator (Oboh *et al*., 2008).

Extraction of Water-Soluble Peptides from the Fermented Oil Seed Condiments

The peptide from the fermented condiment was extracted according to Verdini *et al.* (2004) with little modification. A beaker containing 200g of the fermented condiment was dissolved in 1000ml of distilled water. The beaker was placed on a magnetic stirrer at 40 °C and stirred for 1 hour (Verdini *et al*., 2004). Then, the mixtures were placed in tubes and centrifuged at 3500g using a refrigerated centrifuge for 30 minutes at 4 °C. The supernatant was filtered through No. 42 filter paper and through a 0.45µm membrane filter. The supernatant was separated by centrifugation at 4000g at 4 °C for 30 minutes to obtain a purer aqueous extract. Then, the aqueous extracts were freeze-dried to obtain the peptides (Verdini *et al*., 2004), which were stored for further biochemical analysis.

Peptides Encapsulation

The lyophilized peptide powder was mixed with a food-grade excipient (soluble corn starch) and encapsulated in a gelatin matrix.

Experimental Design

For this investigation, 200-220g Wistar Albino rats were employed. Rats were kept in a 12-hour light/dark cycle at 25 °C. Before the experiment, they were acclimated to these conditions for two weeks. The rats had unrestricted access to food and water. International guidelines for the care and use of laboratory animals were followed in the handling and use of the animals.

Institutional ethical approval (FUTA/ETH/22/68) of the Federal University of Technology, Akure, was obtained for this study. The rats were randomly divided into five groups (n = 5). L-NAME, distilled water, drugs (Lisinopril), and encapsulated peptide were administered orally via gavage.

Grouping and Treatment

Rats were treated as follows:
Group 1 = Normotensive control group administered with distilled water only
Group 2 (negative control) = L-NAME (40 mg/kg) only
Group 3 (positive control) = L-NAME (40 mg/kg) + Lisinopril (10mg/kg)
Group 4 = L-NAME (40 mg/kg) + African oil beans (AOB) peptide (1mg/kg/b.wt)
Group 5 = L-NAME (40 mg/kg) + African oil bean peptide (AOB) (2mg/kg/b.wt)
The hypertensive groups received L-NAME (40 mg/kg/day) orally by gavage for ten days simultaneously, while the rats were fed the different pre-treatment diets for two weeks (Akinyemi *et al*., 2015).

Determination of Hemodynamic Parameters

A Kent Scientific tail-cuff plethysmography device was used to measure the systolic and diastolic blood pressure (SBP and DBP) in conscious rats. The same operator consistently

took blinded measurements prior to, during, and following the experimental period (Oboh *et al.*, 2021).

Blood Collection and Preparation

At the end of the experimental period, rats were sacrificed by cervical dislocation. Blood was collected from the inferior vena cava into EDTA and lithium heparin tubes, centrifuged at 5000 rpm for 15 minutes (Beckman Coulter MSC bench centrifuge), and plasma was collected for analysis.

Determination of tissue ROS Level

In brief, 50 µL of plasma was transferred to test tubes, and 700 µL of sodium acetate (CH3COONa) buffer was added (Zapolska-Downar *et al.,* 2002). The mixture was then incubated at 37°C for 5 minutes, after which 500 µL of a reagent mixture containing n-diethyl-para-phenylenediamine (DEPPD) and 4.37 µM ferrous sulfate dissolved in 0.1 M sodium acetate buffer (pH 4.8) (6 mg/mL DEPPD with 4.37 µM ferrous sulfate) was added. The absorbance was measured at 505 nm using a spectrophotometer. Reactive oxygen species (ROS) levels were calculated and expressed as units per mg protein.

Determination of tissue TBARS Level

The plasma TBARS level was determined by the thiobarbituric acid reactive substances measurement method as previously described (Ohkawa *et al.,* 1979), with a few modifications. In brief, the reaction mixture contained 200 µL of plasma, 0.2 mL of 8.1% sodium dodecyl sulfate (SDS), 750 µL of acetic acid solution (2.5 M HCl, pH 3.5), and 750 µL of 0.8% TBA. The mixtures were heated at 95°C for 90 minutes. After centrifugation at 1700 × g for 5 minutes, the absorbance was measured at 532 nm. Plasma TBARS levels were expressed as mmol MDA/mg protein.

Determination of tissue Total thiol Level

Total thiol content of the plasma was determined by the method of Ellman *et al.* (1959). Briefly, the total thiol concentration was measured in a reaction mixture containing 100 µL of plasma and 1000 µL of Ellman's reagent, which was incubated at 37°C for 30 minutes at room temperature. The absorbance was then measured at 412 nm. The total thiol content was subsequently calculated and expressed as mmol/mg protein.

Determination of tissue GSH Level

Reduced glutathione (GSH) concentration was determined by a modification of the method of Ellman (1959). Briefly, 250 µL of plasma was treated with 125 µL of Ellman's reagent (19.8 mg of 5,5'-dithiobisnitrobenzoic acid (DTNB) in 100 mL of 0.1% sodium citrate) and 750 µL of 0.2 M phosphate buffer (pH 8.0). The absorbance was read at 420 nm using a spectrophotometer. Reduced glutathione concentration was expressed as µmol/mg protein.

Determination of tissue Glutathione-*S*-transferase (GST) activity

The assay was performed according to a modification of the method of Habig *et al.* (1974). Initially, the reaction mixture containing 500 µL of 0.1 M phosphate buffer (pH 6.5), 50 µL of 30 mM 1-chloro-2,4-dinitrobenzene (CDNB), and 350 µL of distilled water was pre-incubated at 37°C for 5 minutes. The reaction was initiated by the addition of 50 µL of plasma and 50 µL of 30 mM glutathione (GSH) as the substrate. Absorbance was read at 1-minute intervals for 3 minutes at 340 nm using a spectrophotometer. GST activity was calculated and expressed as µg/mg protein.

Determination of tissue Glutathione Peroxidase (GPx) activity

Briefly, 100 µL of 0.1 M phosphate buffer (pH 6.9), 50 µL of 10 mM sodium azide, 100 µL of plasma, 100 µL of 10 mM GSH, and 50 µL of 0.2 mM H_2O_2 were pipetted into a test tube.

The reaction mixture was incubated at 37°C for 10 minutes; thereafter, 200 µL of 10% TCA was added. The resulting mixture was then centrifuged at 2000 g, and 250 µL of the supernatant was transferred into another test tube. Subsequently, 125 µL of Ellman's reagent and 750 µL of 0.2 M phosphate buffer (pH 8.0) were added to the supernatant (Habig *et al*., 1974). The absorbance was then read at 412 nm. Glutathione peroxidase activity was calculated and expressed as units/mg protein.

Determination of tissue Superoxide Dismutase (SOD) activity

The SOD activity was measured according to a modification of the method of Jewett and Rocklin (1993). Briefly, 1 mL of concentrated adrenaline was diluted with 600 µL of 50 mM sodium carbonate buffer (pH 10.2) for use in the assay. The reaction mixture consisted of 50 µL of tissue, 1000 µL of 50 mM sodium carbonate buffer (pH 10.2), and 17 µL of adrenaline (0.6 mg/mL). The absorbance was measured at 15-second intervals for 2 minutes at 480 nm using a spectrophotometer. SOD activity was calculated and expressed as units/mg protein.

Determination of tissue Catalase activity

Determination of catalase activity in plasma samples was carried out according to the method of Shina *et al*. (1972). In brief, 25 µL of each tissue homogenate sample was reacted with 100 µL of 2 M H_2O_2 in the presence of 250 µL of 0.01 M phosphate buffer (pH 7.0). The reaction was stopped by the addition of 500 µL of dichromate acetic acid, and the absorbance was read at 30-second intervals for 3 minutes at 620 nm using a spectrophotometer. Catalase activity was thereafter calculated and expressed as nmol H_2O_2/min/mg protein.

Data Analysis

Data are expressed as mean ± standard deviation (SD). Statistical differences among groups were analyzed using one-way ANOVA, followed by Tukey's post-hoc test for multiple comparisons (GraphPad Prism 10). Significance was set at $p< 0.05$."

RESULTS

The effect of the encapsulated peptides from African oil bean seeds (AOB) on haemodynamic parameters and enzymatic and non-enzymatic antioxidants was investigated in L-NAME-induced hypertensive rats. The effect of the encapsulated peptide on haemodynamic parameters of the hypertensive rats is presented in Fig. 1. The systolic blood pressure (SBP) (A) and diastolic (B) blood pressure (DBP) as well as the mean arterial pressure (MAP) (Fig. 2) of the hypertensive rats, were increased significantly ($p<0.05$) compared to the normal control group. However, treatment with the encapsulated peptide from AOB and the standard drug (Lisinopril), significantly ($p< 0.05$) normalized the blood pressure when compared to the hypertensive control group.

The plasma reactive oxygen species (ROS) level (Fig.3A) was observed to increase significantly in the L-NAME-induced hypertensive rats when compared with the normal control group (NC) ($p<0.05$). However, treatment with Lisinopril (LIS + HYP) and the encapsulated peptide decreased ROS level when compared to the hypertensive group ($p<0.05$). The plasma TBARS level in (Fig.3B) was observed to be significantly ($p<0.05$) increased in the L-NAME-induced hypertensive rats when compared to the normal control group. Treatment with the encapsulated peptide decreased the TBARS level when compared to the hypertensive group ($p<0.05$). Moreover, thiol level was significantly reduced ($p<0.05$) in L-NAME-induced hypertensive rats compared to the normal control and treated groups. However, treatment with the encapsulated peptides from AOB reversed the alterations to levels close to those of the control groups, as shown in Figure. 3C.

Furthermore, the reduced glutathione (GSH) (Fig.3D) level was determined in the plasma of the experimental animals. The plasma GSH level was significantly reduced (p<0.05) in L-NAME-induced hypertensive rats compared to the normal control. However, in rats treated with the encapsulated peptide from AOB, there was a significant increase in the GSH level, and this competed favorably with the control group.

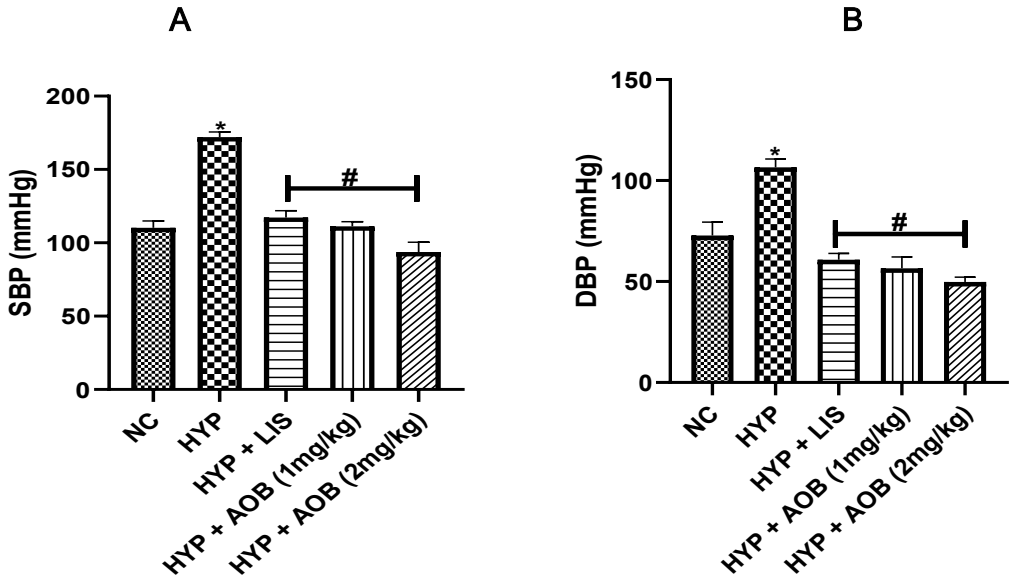

Fig. 1. Effect of gelatin-encapsulated peptide from African oil bean (AOB) on (A) Systolic blood pressure (SBP) and (B) Diastolic blood pressure (DBP) in L-NAME- induced hypertensive rats. Bars represent the mean ± SEM (n = 5). Values are significantly different *p<0.05 versus NC, #p<0.05 versus Hyp. NC: Normal control; Hyp: Hypertensive; Hyp + Lis: Hypertensive + Lisinopril; Hyp + AOB: Hypertensive + African oil bean seeds

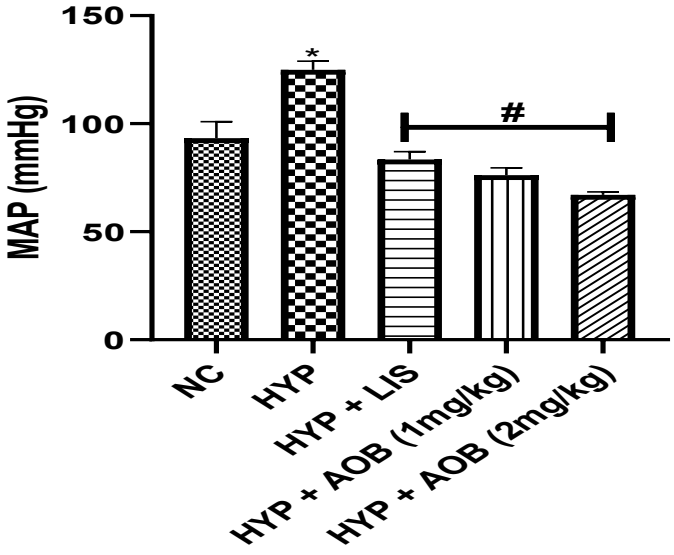

Fig. 2. Effect of gelatin-encapsulated peptide from African oil bean (AOB) on mean arterial pressure (MAP) in L-NAME- induced hypertensive rats. Bars represent the mean ± SEM (n = 5). Values are significantly different *p<0.05 versus NC, #p<0.05 versus Hyp. NC: Normal control; Hyp: Hypertensive; Hyp + Lis: Hypertensive + Lisinopril; Hyp + AOB: Hypertensive + African oil bean seeds.

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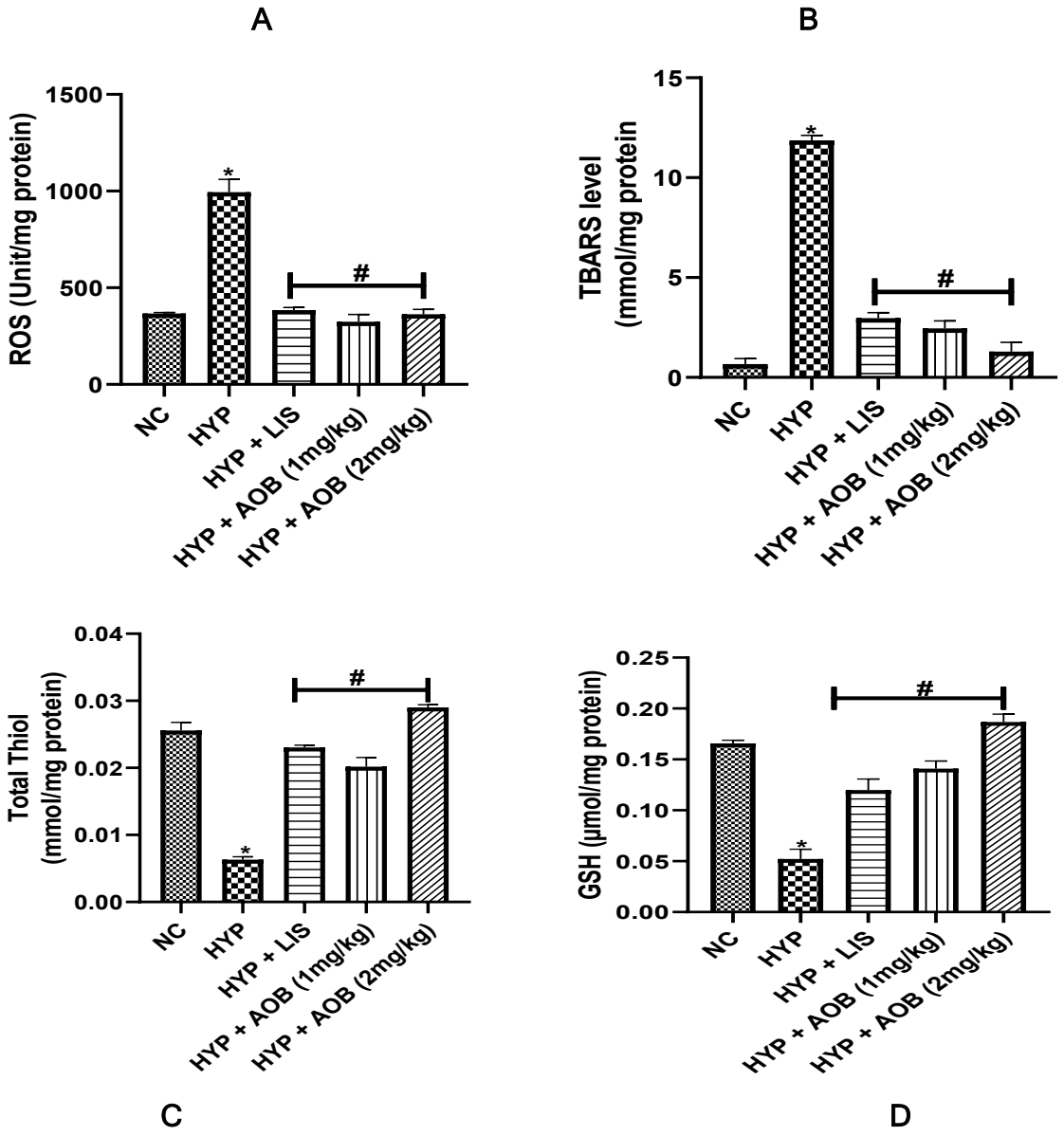

Fig. 3. Effect of gelatin-encapsulated peptide from African oil bean (AOB) on (A) ROS, (B) TBARS, (C) total thiol, and (D) GSH levels in L-NAME- induced hypertensive rats. Bars represent the mean ± SEM (n = 5). Values are significantly different *p<0.05 versus NC, #p<0.05 versus Hyp. NC: Normal control; Hyp: Hypertensive; Hyp + Lis: Hypertensive + Lisinopril; Hyp + AOB: Hypertensive + African oil bean seeds

The effect of the encapsulated peptides from AOB on plasma GST activity in L-NAME-induced hypertensive rats is shown in Fig. 4A. The groups treated with the encapsulated AOB peptides showed increased GST activity (p<0.05) when compared to the L-NAME-induced hypertensive rats, to higher levels than the normal control group. However, L-NAME administration was found to reduce the plasma GST activity. Fig. 4B represents the effect of the encapsulated AOB peptide on the plasma GPx activity in the experimental animals. The result showed a significant decrease (p<0.05) in GPx activity in the hypertensive group. However, administration of the encapsulated peptide significantly reversed this alteration, even to levels above the control group. It is also noteworthy to know that the encapsulated peptide from African oil seeds with 2mg/kg dose had a more profound effect on plasma GPx activity in the rats. Furthermore, the effect of the encapsulated peptide on the plasma SOD activity in L-NAME-induced hypertensive rats

was also determined, as shown in Fig.4C. The result revealed that L-NAME administration significantly (p<0.05) reduced plasma SOD activity relative to the control group. However, following the encapsulated AOB peptide administration, the plasma SOD activity was significantly (p<0.05) increased. In addition, (Fig.4D) represents the effect of the encapsulated AOB peptide on plasma catalase activity in the L-NAME-induced hypertensive rats. The result also revealed a significant (p<0.05) decrease in the plasma catalase activity in the rats following L-NAME administration. However, exposure of the rats to the encapsulated AOB peptide significantly (p<0.05) increased the catalase activity in the plasma to levels above that of the normal control group.

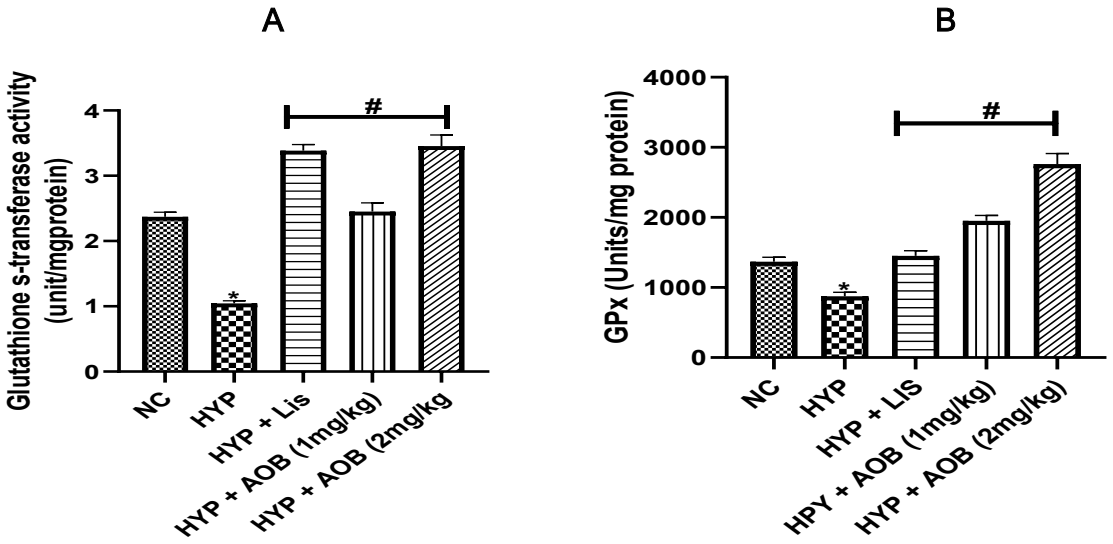

Fig. 4. Effect of gelatin-encapsulated peptide from African oil bean (AOB) on (A) glutathione-S-transferase (GST), (B) GPx activity in L-NAME- induced hypertensive rats.
Bars represent the mean ± SEM (n = 5). Values are significantly different *p<0.05 versus NC, #p<0.05 versus Hyp. NC: Normal control; Hyp: Hypertensive; Hyp + Lis: Hypertensive + Lisinopril; Hyp + AOB: Hypertensive + African oil bean seeds.

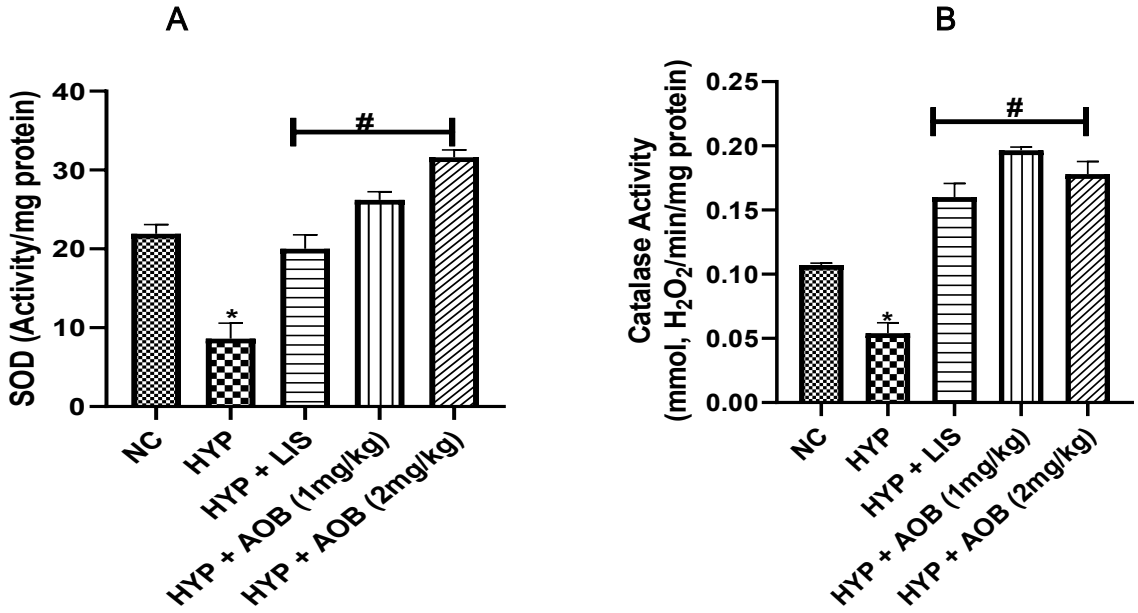

Fig. 5. Effect of gelatin-encapsulated peptide from African oil bean (AOB) on (A) Superoxide Dismutase (SOD) and (B) Catalase activity in L-NAME- induced hypertensive rats. Bars represent the mean ± SEM (n = 5). Values are significantly different *p<0.05 versus NC, #p<0.05 versus Hyp. NC: Normal control; Hyp: Hypertensive; Hyp + Lis: Hypertensive + Lisinopril; Hyp + AOB:

Hypertensive + African oil bean seeds.

DISCUSSION

According to the World Health Organization (2021), hypertension is called the "silent killer" because there are no early warning signs or symptoms. It is a constant increase in arterial blood pressure (Adedapo *et al*., 2020). The primary etiology or risk factor for the majority of hypertension cases remains unidentified; however, genetics, excessive sodium intake, and psychological factors have been associated with the condition (Ha, 2014). Many antihypertensive drugs are approved for treating high blood pressure. Recent studies have focused on creating safer agents from natural products because of their side effect profiles (Pasdaran *et a*l., 2023).For this reason, hemodynamic and antioxidant effects of gelatin-encapsulated peptide from African oil bean seed (AOB) in L-NAME ((N-nitro-L-arginine methyl ester) induced hypertensive rats are being investigated.

L-NAME has been shown to cause high blood pressure in tests on rats (Aebi and Hugo, 1974). The findings of this study, which demonstrated that the oral administration of L-NAME in rats resulted in a significant elevation of SBP, are consistent with the research conducted by Sung *et al.* (2013), which reported an increase in SBP among rats treated with L-NAME, a non-specific inhibitor of nitric oxide synthase, resulting in hypertension. Nevertheless, administration of encapsulated peptide from AOB alongside a reference drug (lisinopril) resulted in a substantial decrease in SBP in hypertensive rats. The observed reduction in SBP in this study aligns with the utilization of oilseed plants for hypertension management in traditional medicine (Okraku *et al*., 2017). The bioactive compounds in the peptide may have caused the effect seen in hypertensive rats. Also, treatment with the encapsulated peptide at both doses significantly reversed the rise in diastolic blood pressure (DBP) and mean arterial pressure in hypertensive rats. The reference drug did not significantly lower DBP when compared to the group that received the encapsulated AOB peptide.

One consequence of L-NAME-induced hypertension is the excessive production of reactive oxygen species (ROS) (Jan-On *et al*., 2020; Oboh *et al*., 2021) due to the inhibition of nitric oxide (NO) synthesis and availability, which subsequently disturbs the delicate equilibrium between oxidants and antioxidants in the body. Consequently, the marked increase in plasma ROS and TBARS (Thiobarbituric acid reactive substances) in the L-NAME rats corresponds with previous research (Oboh *et al*., 2021; Quasimi *et al*., 2022; Ademosun *et al*., 2023), indicating elevated oxidative stress. This oxidative attack can harm biomolecules such as proteins and lipids, which can lead to problems with the endothelium and blood vessels (Pizzino *et al*., 2017). One significant finding of this study is the significant reversal of L-NAME-induced elevation in plasma ROS and TBARS levels following administration of the encapsulated AOB peptide. This suggests that the encapsulated peptide possesses antioxidant properties, either directly scavenging ROS or enhancing the cellular antioxidant defense system.

The observed reduction in plasma total thiol and reduced glutathione levels in rats after L-NAME administration reinforces the disruption of the cellular antioxidant system in these animals. Glutathione is an important antioxidant molecule, and when it runs out, cells can't protect themselves as well from oxidative stress (Raj et al., 2021). Consequently, the noted elevation in plasma total thiol and diminished glutathione levels subsequent to the administration of the encapsulated AOB peptide offers additional understanding of the antioxidant characteristics of the encapsulated peptides. Thiols are functional groups that have a sulfur atom in them. GSH is the thiol molecule that is most common in cells. The increase in total thiol indicates a general rise in the body's antioxidant pool.potentially due to elevated GSH levels or the presence of other thiol-containing antioxidant molecules

within the AOB encapsulated peptide. This study further validates the antioxidant properties of fermented traditional oilseed condiments (Arouna *et al.,* 2023; Ghafoor *et al*., 2021; Olaitan and Fadahunsi, 2020) as well as oilseed-derived bioactive peptides (Kumari *et al*., 2022; Chourasia *et al*., 2023).

Reduced activity of antioxidants and antioxidant enzymes, along with elevated levels of reactive oxygen species (ROS) or reactive nitrogen species (RNS), including peroxynitrite, are known causes of oxidative stress. It has been suggested that one of the main causes of hypertension is increased free radical activity (Ahmed and Mohammed, 2020). The body uses antioxidant defense mechanisms to prevent the negative effects of reactive species. This study demonstrated that the administration of encapsulated peptides from fermented African oil bean seeds (AOB) significantly enhanced the activities of several key antioxidant enzymes, including catalase (CAT), glutathione-S-transferase (GST), glutathione peroxidase (GPx), and superoxide dismutase (SOD).These antioxidant enzymes play crucial roles in protecting cells against oxidative stress and toxins, neutralizing ROS, and maintaining cellular redox balance (Sachdev *et al.,* 2023). The increase in GST activity suggests improved detoxification of electrophilic compounds, while Gpx utilizes GSH to neutralize hydrogen peroxide, a reactive oxygen species, and its elevation indicates enhanced protection against lipid peroxidation (Jena *et al*., 2023). SOD converts superoxide radicals (precursor to other ROS) into less harmful molecules (Hydrogen peroxide) (Fujii *et al*., 2022) while catalase decomposes hydrogen peroxide into water and oxygen, further mitigating oxidative stress (Willemen *et al*., 2022The vasodilation and antihypertensive effects of the gelatin-encapsulated AOB peptide may be caused by the increased activities of antioxidants and enzymes after the administration of the encapsulated peptide. Additionally, the peptide may trigger signaling pathways that increase these vital antioxidant enzymes' expression and activity. (Lv *et al.,* 2022; Tonolo *et al*., 2020).

CONCLUSION

This study showed that a gelatin-encapsulated peptide made from fermented tropical oil seeds (African oil bean seeds) has strong antioxidant and blood pressure-lowering properties. Its increased activity has been linked to the development of hypertension in rats with L-NAME-induced hypertension. Gelatin-encapsulated peptides from African oil seeds (AOB) at 1 and 2 mg/kg body weight were found to significantly lower blood pressure and improve the body's antioxidant defense system; however, among both doses and concentrations, the encapsulated peptide from AOB at 2 mg/kg body weight had a greater mitigating effect on blood pressure and antioxidant indices. To separate and refine the bioactive substances responsible for the hemodynamic and antioxidant properties of African oil bean seed, more research is required, which could help in the development of novel drugs and nutraceuticals for the management of hypertension

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