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EVALUATION OF *Gossypium herbaceum* LEAF POWDER'S NUTRITIONAL COMPOSITION AND NUTRACEUTICAL PROPERTIES

Olugbenga David OLORUNTOLA[1]*, Simeon Olugbenga AYODELE[2], Victor Olabisi AKINDURO[3], Olatunji Abubakar JIMOH[2], Bamidele Andrew FALOWO[1], Clement Oluwafemi OSOWE[4], Fehintoluwa Stellamaris OLADEBEYE[1]

[1]*Adekunle Ajasin University, Department of Animal Science, Akungba Akoko, Nigeria*
[2]*Federal Polytechnic, Department of Agricultural Technology, Ado Ekiti, Nigeria*
[3]*Osun State University, Department of Animal Science, Osogbo, Nigeria*
[4]*Federal University of Technology, Department of Animal Production and Health, Akure, Nigeria*

Abstract: The objective of this study is to identify the proximate composition, phytochemical profile, and anti-diabetic, anti-inflammatory and antioxidant properties of *Gossypium herbaceum* leaf powder (GLP). The fresh leaves of the *G. herbaceum* were collected, cleansed with fresh water, drained and allowed to dry in the shade, ground to GLP and analysed. The crude fibre (42.93%) and nitrogen-free extract (36.46 %) have a relatively high proportion in GLP; while ash (2.47%) has the lowest proportion. The GLP has relatively high phenol (219.20 mg/g) when compared to flavonoids (81.03 mg/g), tannins (69.56 mg/g), saponins (66.67 mg/g) and alkaloids (55.80 mg/g). The α-amylase inhibition and α-glucosidase inhibition of GLP were 48.45% and 30.68%, respectively. The percentage of albumin denaturation inhibition and anti-proteinase activity of GLP was 22.88% and 43.87%, respectively. The lipid peroxidation inhibition, vitamin C, Fe chelation and 2,2-diphenyl-1-picrylhydrazyl were 35.43%, 23.87%, 11.76% and 88.16%, respectively. GLP exhibits anti-inflammatory, anti-diabetic and antioxidant properties.

Keywords: *Gossypium herbaceum*, Phytogenic supplement, Anti-oxidant, Anti-diabetic, Anti-inflammatory

***Corresponding author:** Adekunle Ajasin University, Department of Animal Science, Akungba Akoko, Nigeria
E mail: oloruntoladavid@gmail.com (O. D. OLORUNTOLA)

Olugbenga David OLORUNTOLA	https://orcid.org/0000-0002-2175-1490
Simeon Olugbenga AYODELE	https://orcid.org/0000-0003-2913-6123
Victor Olabisi AKINDURO	https://orcid.org/0000-0002-5546-8773
Olatunji Abubakar JIMOH	https://orcid.org/0000-0001-8204-5816
Bamidele Andrew FALOWO	https://orcid.org/0000-0002-4712-0398
Clement Oluwafemi OSOWE	https://orcid.org/0000-0002-2957-9824
Fehintoluwa Stellamaris OLADEBEYE	https://orcid.org/0009-0009-9195-2798

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1. Introduction

Because of an increased interest in using plants and phytochemicals to obtain additional health advantages beyond the essential nutritional value present in foods or feeds, researchers are looking at the chemical composition of botanicals (Oloruntola, 2022). As a result, there is an increase in the discovery, and production, of more plant-based food/feed supplements, additives, nutraceuticals, and similar items that can be termed functional foods or feed since they have extra physiological or health benefits beyond the basic nutritional value they offer (Nicoletti, 2012; Falowo et al., 2023).

The diversification of the active compounds caused by the intrinsic factors, such as the plant part used, the harvest season and the geographical origin, and extrinsic factors, such as the additive production technique forms the basis for several biological properties and activities possessed by the botanicals or their phytochemicals and their use as growth promoters, antioxidant, antimicrobial, anti-stress, and immunity booster in human and animal nutrition (Bahadoran et al., 2013; Ganguly, 2013; Valenzuela-Grijalva et al., 2017). As an illustration, antioxidant, antidiabetic and anti-inflammatory properties of phytogenic supplements such as *Dysphania ambrosioides* (L.) and *Crassocephalum crepidioides* leaf meal (Falowo et al., 2023), *Juglans regia* kernel meal (Oloruntola, 2022), *Justicia carnea* leaf powder (Oloruntola et al., 2022) and fig tree leaves (Osowe et al., 2021) were reported.

Gossypium herbaceum, a typical wild plant in Nigeria, is said to have some medicinal qualities. According to Larayetan et al. (2021), *G. herbaceum* leaf may offer novel plant-derived therapeutic compounds that are efficient in treating infectious disorders brought on by numerous drug-resistant bacteria and are a target in the management of oxidative stress. Comparing *G. herbaceum*

leaf meal to other phytogenic supplements from botanicals with significant nutraceutical value, however, there is not enough data on its nutritional and health benefits.

Recently, it was revealed that there was a need for ongoing and additional research or characterisation of the bioactive content profile of phytogenic supplements or phytochemicals (Oloruntola et al., 2022). As a result, the goal of this research is to determine the proximate and phytochemical compositions, anti-diabetics, anti-inflammatory, and antioxidant properties of *G. herbaceum* leaf meal.

2. Materials and Methods

2.1. *Gossypium herbaceum* Leaf Powder and Reagent

The fresh leaves of the *Gossypium herbaceum* were collected from a farm in Ado Ekiti, Nigeria. A Crop scientist from the Department of Agricultural Technology at The Federal Polytechnic in Ado Ekiti, Nigeria, validated the plant. After being thoroughly cleansed with fresh water, the samples were drained and allowed to dry in the shade for 14 days. Having been grounded into *Gossypium herbaceum* leaf powder (GLP), they were stored at 4°C until analysis. The parameters were examined in three copies. For each parameter, three iterations of analyses were performed on the GLP samples. All of the chemicals of the analytical reagent grade used for chemical analysis were purchased from Sigma-Aldrich.

2.2. *Gossypium herbaceum* Leaf Powder Proximate and Phytochemical Analysis

Using the AOAC method, GLP was assessed for moisture, crude fat, crude fibre, crude protein, ash, and nitrogen-free extract (AOAC, 2010). Oloruntola et al., (2022) reported the methods for determining alkaloids, saponins, flavonoids, tannins, and phenols.

2.3. *Gossypium herbaceum* Leaf Powder Antidiabetic properties

The procedures for determining the α-amylase inhibition (Wickramaratne et al., 2016) and α-glucosidase inhibitory activity (Dej-adisai and Pitakbut, 2015) of GLP were recently published by Oloruntola et al. (2022).

2.4. *Gossypium herbaceum* Leaf Powder anti-inflammatory properties

The methods for evaluating albumin denaturation inhibition (Osman et al., 2016) and antiproteinase activity (Rajesh et al., 2019) of GLP were recently published by Oloruntola et al. (2022).

2.5. *Gossypium herbaceum* Leaf Powder anti-oxidant activities

The procedures for determination of lipid peroxidation inhibition (Bajpai et al., 2015), ferrous chelation (Ebrahimzadeh et al., 2008) and 2,2-diphenyl-1-picrylhydrazyl (DPPH) (Otles and Yalcin, 2012) were recently published by Oloruntola et al. (2022).

Using the Benderitter et al. (1998) method published by Oloruntola (2021), the vitamin C content of the GLP was determined. 270 mg copper sulphate ($CuSO_4$. $5H_2O$), 75 µl DNPH solution (i.e. 2 g dinitrophenyl hydrazine, and 230 mg thiourea in 100 ml of 5 ml/L H_2SO_4) was introduced to 500 µl extract mixture (300 µl of an adequate dilution of the extract with 100 µl 13.3% trichloroacetic acid and water). After that, the reaction mixture was incubated for three hours at 37°C before adding 0.5 ml of 65 percent H_2SO_4 (v/v) to the medium and measuring the absorbance at 520 nm with a UV spectrophotometer. The level of vitamin C in the GLP was then determined using ascorbic acid as a reference substance.

2.6. Statistical Analysis

Each assay was carried out three times, and the results' average mean was provided. To better comprehend the average mean, bar graphs were made in Excel.

3. Results

The proximate composition of GLP is shown in Figure 1. The crude fibre (42.93%) and nitrogen-free extract (36.46 %) have a relatively high proportion in GLP; while ash (2.47%) has the lowest proportion. The GLP has relatively high phenol (219.20 mg/g) when compared to flavonoids (81.03 mg/g), tannins (69.56 mg/g), saponins (66.67 mg/g) and alkaloids (55.80 mg/g) (Figure 2).

The anti-diabetics properties of *Gossypium herbaceum* leaf powder was depicted in Figure 3. The α-amylase inhibition and α-glucosidase inhibition of GLP were 48.45% and 30.68%, respectively.

Figure 4 shows the anti-inflammatory properties of *Gossypium herbaceum* leaf powder. The percentage of albumin denaturation inhibition and anti-proteinase activity of GLP was 22.88% and 43.87%, respectively. The anti-oxidant properties of *Gossypium herbaceum* leaf powder are shown in Figure 5. The lipid peroxidation inhibition, vitamin C, Fe chelation and DPPH were 35.43%, 23.87%, 11.76% and 88.16%, respectively.

4. Discussion

Quantifying the proximate amounts of a typical feed/food ingredient or supplement is essential to demonstrate its nutritional profile and determine the right amount to add to a compounded feed/food (Oloruntola, 2022). The relatively high crude fibre content of GLP could be of nutraceutical importance. For instance, dietary fibre is a component of plant matter that is resistant to enzymatic digestion and has a good impact on health because it has been linked to a reduction in the incidence of some diseases (Dhingra et al., 2012). High-fibre diets are advantageous because they increase faecal bulk, shorten intestinal transit time, lower cholesterol and glycaemic levels, trap substances that can be harmful to the human body (such as mutagenic and carcinogenic agents), and promote the growth of the intestinal flora, among other things (Heredia et al., 2002). Consequently, dietary fibre is being employed in a variety of functional meals, including baked goods, beverages, meat products, and drinks (Chau and Huang, 2003; Dhingra et al., 2012).

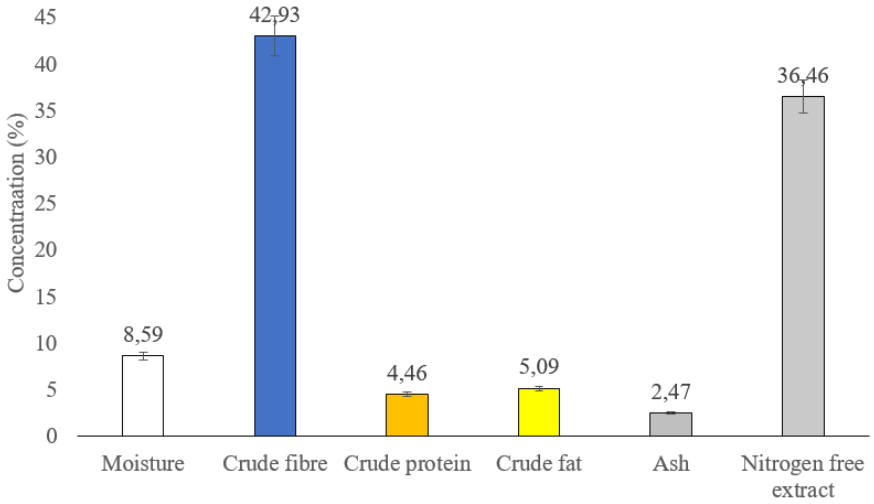

Figure 1. Proximate composition of *Gossypium herbaceum* leaf powder.

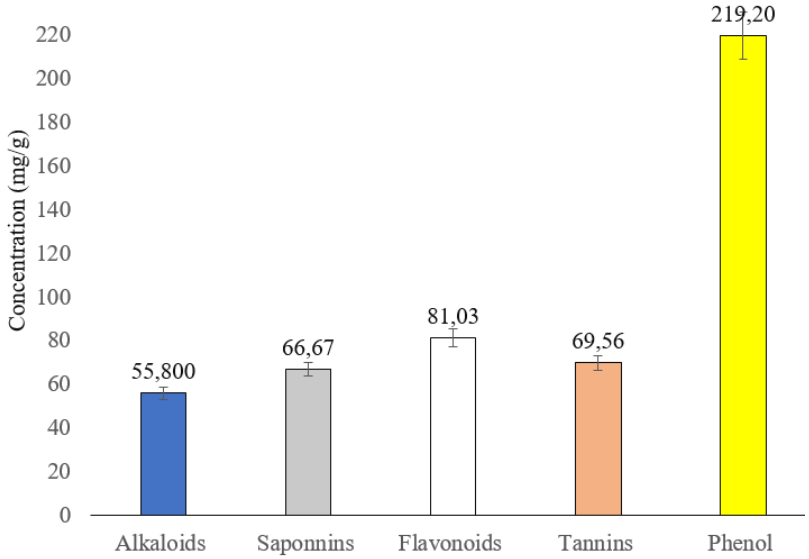

Figure 2. Phytochemical composition of *Gossypium herbaceum* leaf powder.

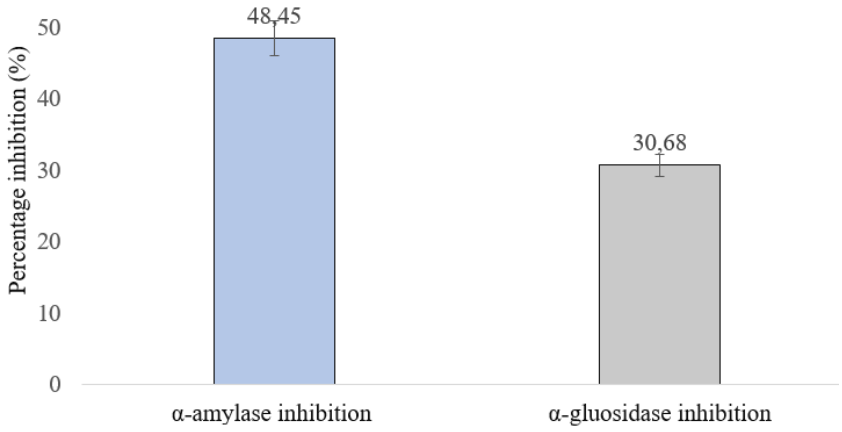

Figure 3. Antidiabetic properties of *Gossypium herbaceum* leaf powder.

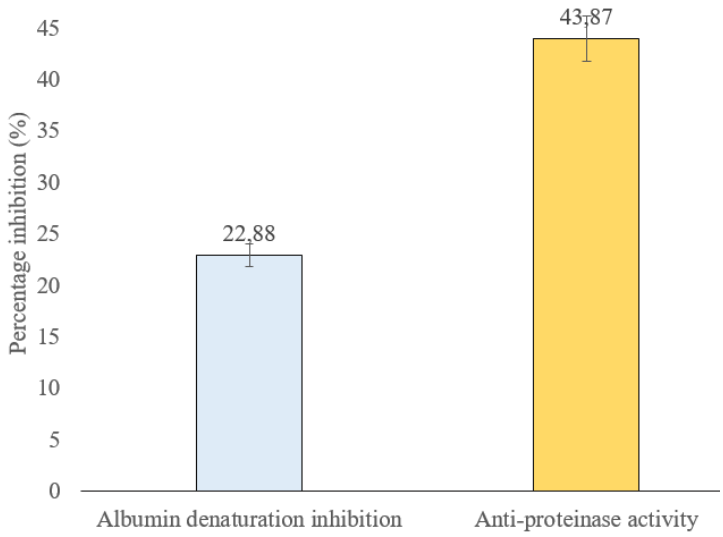

Figure 4. Anti-inflammatory properties of *Gossypium herbaceum* leaf powder.

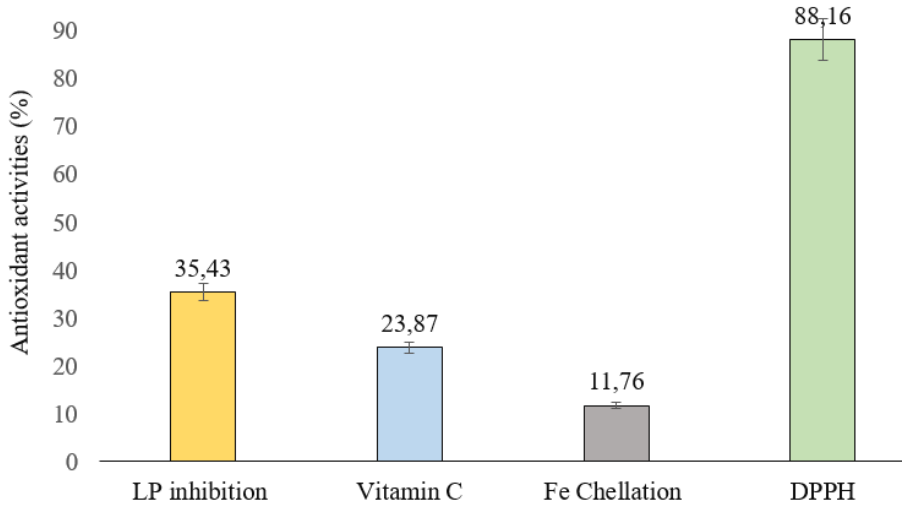

Figure 5. Anti-oxidant properties of *Gossypium herbaceum* leaf powder: LP= lipid peroxidation, DPPH= 2,2-diphenyl-1-picrylhydrazyl.

The nitrogen-free extract (NFE), the second-highest proximate component of GLP and purportedly representing the soluble carbohydrates of the GLP, is similarly beneficial nutritionally because, by implication, GLP could be useful as a source of energy for animals and humans (Bach Knudsen et al., 2013). The crude fibre (42.93%) and NFE (36.46%) of GLP in this study are at variance with the 16.95% and 49.58%, respectively reported for *Anacardium occidentale* leaf (Oloruntola 2021).

The identification of botanicals' phytochemical components gives scientific support for their use as dietary supplements or foods with medicinal properties (Muhammad et al., 2014, Falowo et al., 2023). The amount of GLP's detectable alkaloids (55.80 mg/g), flavonoids (81.03 mg/g), and phenol (219.20 mg/g) in this investigation further reveal the potential antioxidant function it might have when used as a supplement or ingredient. The significant antioxidant activity of alkaloids generated from natural sources indicates that these bioactive substances inspired by natural products may have a huge positive impact on both human health and the food processing industry (Atpadkar et al., 2023); while almost all flavonoids (a class of organic compounds with varying phenolic structures) have antioxidant properties and the most effective flavonoids for defending the body against reactive oxygen species, according to reports, are flavones and catechins (Panche et al., 2016). In addition, plant phenolics are regarded as an essential dietary component and have numerous health advantages in addition to their powerful antioxidant activity (Kumar and Goel, 2019).

The saponins and tannins found in GLP may also be useful in nutraceuticals. The health-promoting saponins may influence the immune system in ways that assist the body fight cancer, lower cholesterol, and even reduce blood glucose response. Inhibiting dental cavities and platelet aggregation, treating hypercalciuria, and serving as an antidote for acute lead poisoning are all possible uses for a high-saponin diet (Shi et al., 2004). Since

saponins are essential to both human and animal nutrition and are found in a wide variety of plants and plant-based products, many foods high in saponins are recommended as dietary supplements to individuals with diabetes and other health challenges (Sharma et al., 2023). The anticarcinogenic, antimutagenic and antimicrobial properties of tannins were also reported (Chung et al., 1998). Since moderate levels of tannin may have positive impacts on ruminant performance, health, and environmental sustainability (Adejoro et al., 2020), tannin extract used as a dietary supplement in ruminant nutrition was being promoted (Yanza et al., 2021).

Finding alternative anti-diabetic medications, especially those made from plants or herbs, is necessary due to the development of resistance and negative effects with prolonged use of synthetic diabetes medications (Alam et al., 2022). It is possible to regulate postprandial hyperglycemia and lower the risk of developing diabetes by inhibiting the activities of α-amylase and α-glucosidase (Poovitha and Parani, 2016). Therefore, the α-amylase inhibition and α-glucosidase inhibition activities recorded for GLP in this study suggest its use as a supplement could retard the digestion of carbohydrates and consequently reduce the postprandial glucose level, particularly in diabetic patients (Zhang et al., 2015a; Poovitha and Parani, 2016). This result is similar to the antidiabetic activities of mistletoe leaves from moringa and kola nut trees being recently reported (Oloruntola and Ayodele, 2022).

Since ancient times, many herbal substances have been utilised with little risk of negative effects in blocking inflammatory pathways (Maroon et al., 2020). The percentage albumin denaturation and anti-proteinase activity of GLP unveil its anti-inflammatory properties and also qualifies it as a potential phytogenic or natural anti-inflammatory feed or food supplement. These findings backed up the plant's historic use for several painful and inflammatory illnesses (Dharmadeva et al., 2018). For instance, the anti-inflammatory activity of *Ficus racemose* L (Dharmadeva et al., 2018), and *Justicia carnea* leaf powder was reported (Oloruntola et al., 2022). The biologically active components (flavonoids, tannins, phenolic compounds, and phytosterols) may work individually or in combination to provide analgesic and anti-inflammatory effects (Dharmadeva et al., 2018).

The levels of lipid peroxidation inhibition, vitamin C, Fe chelation and DPPH recorded in this study show that GLP could serve as an antioxidant phytogenic feed or food supplement. Antioxidant phytochemicals have anti-cancer, anti-inflammatory, anti-obesity, anti-diabetes, and anti-ageing properties (Zhang et al., 2015a,b). In addition, important antioxidant components found in some botanicals have the exceptional ability to treat oxidative stress-related degenerative diseases with little damage (Ozata et al., 2002) and previously, lipid oxidation inhibition capacity (Burri et al., 2020), vitamin C (Traber and Stevens, 2011), and Fe chelation property (Sudan et al., 2014) of botanicals were reported.

5. Conclusion

These findings indicated that GLP could be a source of dietary fibre and energy, and that it has anti-diabetic, anti-inflammatory, and antioxidant properties. GLP is advised for use as a dietary supplement in feeding trials with an animal model.

Author Contributions

The percentage of the author(s) contributions is presented below. All authors reviewed and approved the final version of the manuscript.

	A.D.O.	S.O.A.	V.O.A.	O.A.J.	B.A.F.	C.O.O.	F.S.O.
C	40	30			30		
D	20	20	20	20		20	
S	100						
DCP	20	20	20		20		20
DAI	20	20	20		20	20	
L	15	15	15	15	15	15	10
W	30	20	15	20			15
CR	15	15	15	25	15	15	
SR	30	20	15		20	15	

C=Concept, D= design, S= supervision, DCP= data collection and/or processing, DAI= data analysis and/or interpretation, L= literature search, W= writing, CR= critical review, SR= submission and revision.

Conflict of Interest

The authors declared that there is no conflict of interest.

Ethical Consideration

Ethics committee approval was not required for this study because of there was no study on animals or humans.

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