



# A Review on *Gongronema latifolium*, an Extremely Useful Plant with Great Prospects

Olugbenga Morebise<sup>1\*</sup>

<sup>1</sup>Faculty of Basic Medical Sciences, All Saints University School of Medicine, Roseau, Commonwealth of Dominica, West Indies.

## Author's contribution

The sole author designed, analyzed, interpreted and prepared the manuscript.

## Article Information

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## ABSTRACT

*Gongronema latifolium* is a plant that has a wide range of nutritional and ethnomedical uses in different tropical African communities. Scientific reports on the chemical composition and bioactivity (anti-inflammatory, antimicrobial, antidiabetic, antioxidant, anticancer and allelopathic properties) of the plant material by different authors are discussed in this review. Future prospects of the plant extracts in the areas of herbal formulations, food preservation, alcoholic fermentation and beer production, drug discovery and allelopathy are also highlighted.

**Keywords:** *Gongronema latifolium*; diabetes mellitus; anti-inflammatory; antidiabetic, anti-microbial; antioxidant; anticancer; allelopathy; olugbenga morebise.

## 1. INTRODUCTION

*Gongronema latifolium* Benth belongs to the family Asclepiadaceae. It is an edible nutritional/ medicinal plant mostly found in the rain forest zones in Nigeria and other tropical African

countries [1,2]. The plant produces white latex and yellow flowers [1] and can be propagated by seed or stem cuttings [3]. *G. latifolium* is known by the Ikales of Ondo State of Nigeria as Iteji [4,5]. The Ibos call the plant Utazi, the Efik/ Ibibio call it Utasi while the Yorubas call it Arokeke [3].

\*Corresponding author: E-mail: [olugbengamorebise@gmail.com](mailto:olugbengamorebise@gmail.com);

To the Akan-Asantes of Ghana, *G. latifolium* is known as Kurutu Nsurogya; the Serers of Senegal call it Gasub while to the Kissis of Sierra Leone it is known as Ndodo-Polole [3].



Fig. 1. The *Gongronema latifolium* plant

## 2. NUTRITIONAL USES OF *Gongronema latifolium*

The leaves of *G. latifolium* are used as vegetables in preparation of soups to which they add a bitter-sweet flavor [4,6]. The leaves are also sometimes used to spice locally brewed beer [3]. The soft stem is used as chewing stick in Sierra Leone [7].

## 3. ETHNOMEDICAL USES OF *Gongronema latifolium*

There have been reports of various uses of *Gongronema latifolium* in folklore medicine by different ethnic groups. Morebise and Fafunso [4] and Morebise et al. [5] reported that the leaves of this plant are used by the Ikaes of Ondo State of Nigeria to treat malaria, nausea and anorexia. Edet et al. [8] also reported that the leaf extract of *G. latifolium* is commonly used by the Efik and Quas tribes of Cross River state of Nigeria to treat malaria, diabetes, hypertension and constipation.

Mosango [7] reported that *G. latifolium* is used in some West African communities to treat cough, intestinal worms, dysentery, dyspepsia and malaria. He reported that in Sierra Leone, an infusion or decoction of the stems with lime juice is taken to treat colic and stomach aches, while in Senegal and Ghana, *G. latifolium* leaves are rubbed on joints of children to help them walk while the boiled fruits of this plant are eaten as a

laxative [7]. Essien et al. [9] reported that *G. latifolium* is used to treat cough in Nigeria. Asthmatic patients can chew the fresh leaves of *G. latifolium* to relieve wheezing while a cold maceration of the roots of the plant can be consumed as treatment for asthma [7,9]. Mosango [7] also reported the use of this plant in some communities to treat viral hepatitis, bilharzia and other microbial infections.

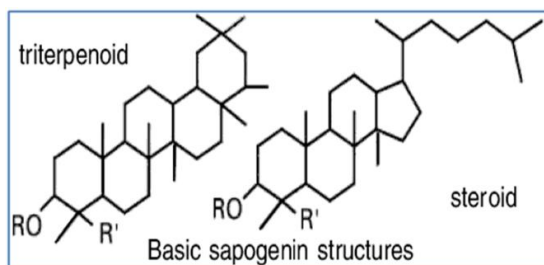
Iwu [6] and Oliver-Bever [10] reported that the leaves of *G. latifolium* are used in some local communities as a vermifuge and stomachic. Owu et al. [11] reported that the leaves are also used to treat dyspepsia in some local communities. Essien et al. [9] reported that the leaves of *G. latifolium* are used to treat fowl cough in Nigeria.

## 4. PHYTOCHEMICAL AND NUTRITIONAL COMPOSITION

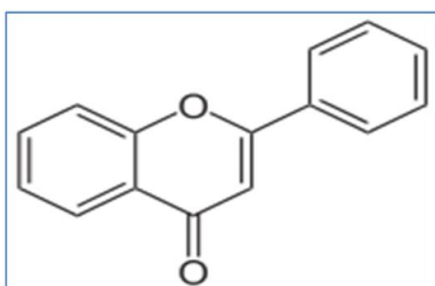
Iwu [6] reported flavones and sterols as active constituents of *G. latifolium*. Morebise and Fafunso [4] reported the presence of saponins and flavonoids in the methanolic extract of *G. latifolium* leaves. Eze and Nwanguma [12] reported the occurrence of tannins in the leaves of the plant. B-Sitosterol, lupenyl esters, pregnane ester and essential oils have also been reported to be present in the body parts [13,14].

Saponins are bioactive glycosides of steroids or triterpenes [15,16]. The triterpene or steroidal rings are usually referred to as sapogenins or aglycones [15,17]. The saponins are known to have a bitter taste, form stable foams in aqueous solutions, interact with cholesterol, bile acids and other 3- $\beta$ -hydroxy steroids to form mixed micelles, and to exhibit some cytotoxicity [15,16,18]. Apart from *G. latifolium*, many other medicinal plants are also known to be rich in the saponins. Examples are *Panax ginseng*, Liquorice, *Bupleurum falcatum* and *Vernonia amygdalina* [19,20].

Flavonoids are widely distributed and form major colouring components of plants. They are a large group of phenolic compounds and are responsible for a variety of pharmacological activities [21-23]. They exist as aglycones, glycosides and methylated derivatives and can be further divided into different groups like the flavones, flavonols and flavanones [21]. Some plant flavonoids have been shown to exhibit protective effects against infectious, cardiovascular, carcinogenic and age-related diseases [22,23].

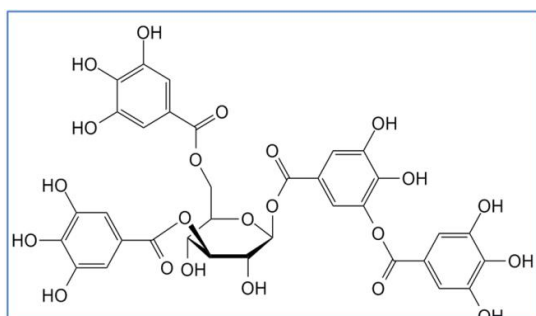


**Fig. 2. Basic saponenin structure**



**Fig. 3. Flavone backbone (2-phenyl-1,4-benzopyrone)**

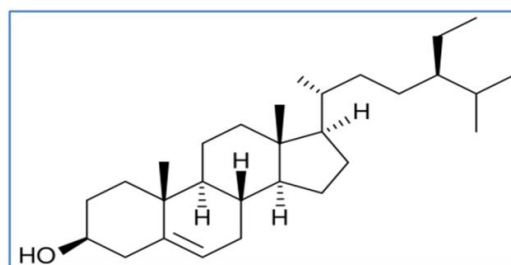
Tannins are large polyphenolic compounds that contain many hydroxyl and other groups, such as carboxyls, which usually form strong complexes with various macromolecules. Tannins possess astringent and medicinal properties [24]. The structure of tannic acid, a tannin, is shown below.



**Fig. 4. Tannic acid**

B-Sitosterol is a plant sterol (phytosterol). Phytosterols are known to have beneficial effects in helping to reduce cholesterol absorption in the intestines [25].

It is hoped that in future the actual saponins, flavonoids and tannins present in *G. latifolium* leaves would be isolated, purified, characterized and subjected to bioactivity evaluations.



**Fig. 5. B-Sitosterol**

Eleyinmi [26] did nutritional analysis of the *G. latifolium* leaves and reported that the crude protein content was 27.2 %, dry weight, while the lipid extract, ash, crude fibre and nitrogen free extractives were 6.07%, 11.6%, 10.8%, and 443.3% dry matter, respectively. He reported that leucine, valine, phenylalanine, aspartic acid, glutamic acid and glycine were abundant in the plant material, with aspartic acid, glutamic acid and glycine having 13.8%, 11.9%, and 10.3%, respectively of the total amino acid composition. Likewise, saturated and unsaturated fatty acids were 50.2% and 39.4% of the oil, respectively. He also reported occurrence of minerals in the plant material [26].

## 5. SCIENTIFIC REPORTS ON *G. latifolium* PLANT EXTRACTS

### 5.1 Anti-inflammatory Activity

Morebise et al. [5,27-29] reported the anti-inflammatory activity of the leaf extracts of *G. latifolium*. Both aqueous and methanolic extracts of the leaf significantly ( $P=0.05$ ) inhibited the carrageenan-induced rat paw oedema in a dose-related manner [27]. The extracts also significantly inhibited the acetic acid-induced vascular permeability and the leukocyte migration assay conducted on experimental mice. The carrageenan-induced rat paw oedema test is an established protocol to test for acute inflammation [30,31] while the leukocyte migration assay and acetic acid-induced vascular permeability experiments are additional established anti-inflammatory tests [32,33]. Morebise et al. [28] also reported that the methanolic extract of the plant leaf material significantly inhibited the nystatin-induced rat paw oedema and also significantly stabilized erythrocyte membrane subjected to heat- and hypotonic solution-induced lyses.

To test for possible anti-inflammatory property of the plant in chronic inflammatory conditions, arthritis was induced in experimental rats and *G.*

*latifolium* extracts were found to significantly and dose-dependently inhibit the arthritis formation and to lower the serum levels of Gamma-glutamyl transferase, alanine aminotransferase and aspartate aminotransferase [29]. The total serum protein and the globulin fraction were significantly ( $P=0.05$ ) raised while the albumin fraction and the serum glucose were significantly reduced [29].

## 5.2 Antimicrobial Activity

Morebise and Fafunso [4] reported the antimicrobial action of the saponin fraction obtained from the methanolic extract of *G. latifolium* leaves. The fraction strongly inhibited the human pathogenic microbes that were tested, including *Bacillus cereus*, *Staphylococcus aureus*, *Candida albicans* and *Aspergillus niger*. Eleyinmi [26] reported that the methanolic extract of the plant leaves showed inhibitory activity against *Salmonella enteritidis*, *Salmonella choleraesuis* ser *typhimurium*, *Pseudomonas aeruginosa* and *Listeria monocytogenes* while the aqueous extract showed inhibitory activity against *E. coli* and *P. aeruginosa*. Edim et al. [3] gave a review of reports on inhibitory effects of *G. latifolium* plant extracts on *Staphylococcus aureus*.

Adeleye et al. [34] reported that the aqueous and ethanolic extracts together with the essential oil from *G. latifolium* leaves were evaluated for inhibitory activity against bacteria isolated from HIV patients in Lagos, Nigeria. They found out that the essential oil and the extracts showed moderate inhibitory activity against *Staphylococcus* sp., *Escherichia coli*, *Shigella* sp., *Salmonella* sp., *Klebsiella pneumonia*, *Pseudomonas aeruginosa*, *Onchrobactrum anthropi*, and *Candida albicans*. The inhibitory effects were comparable to those of Ampicillin but less than those of Ciprofloxacin and Chloramphenicol in the study [34]. Enyi-Idor et al. [35] also reported the antibacterial activity of the leaf extracts of *G. latifolium* on *Staph. aureus* and *E. coli*. Essien et al. [9] reported the antioxidant and antitussive effect of *G. latifolium* leaf extracts on Hubbard broilers and concluded that their findings confirmed the antitussive use of *G. latifolium* leaves to treat fowl cough in Nigeria.

## 5.3 Antidiabetic Activity

There have been several reports on the antidiabetic activity of the leave extracts of *G. latifolium*. In the study conducted by Sylvester et

al. [36], experimental rats were subjected to Streptozotocin-induced diabetes mellitus and then treated with *G. latifolium* leaf extracts. They reported that the extracts significantly ( $P=0.05$ ) lowered the blood glucose of the diabetic rats by 66.34%. They also reported that diabetic induction caused significant ( $P=0.05$ ) increases in total cholesterol (TC) and LDL cholesterol (54.42% and 55.0%, respectively), compared with the normal control (NC). Treatments with the extracts significantly decreased these by 58.70% (TC) and 71.70% (LDL), respectively. The levels of AST and ALT enzymes were significantly lowered in the extract-treated animals compared with the diabetic control [36].

Edet et al. [8,37] also reported their findings on alloxan-induced diabetic rats treated with *G. latifolium* leaf extracts. In their 2009 report [37], the extracts lowered the serum activities of the following enzymes: creatine kinase (CK), CKMB isoform, lactate dehydrogenase, alanine aminotransferase (ALT) and aspartate aminotransferase (AST), compared with control. They concluded that the *G. latifolium* extracts may have protective effects on both heart and skeletal muscles during cardiac and skeletal muscle diseases. In their 2011 report [8], *G. latifolium* leaf extracts reversed the alterations in haematological indices (WBC counts, haemoglobin count, packed cell volume) and weight loss caused by alloxan-induced diabetes in male Wistar rats. Owu et al. [11] also reported the antidiabetic and antiulcerogenic effects of *G. latifolium* leaf extracts on Streptozotocin-induced diabetic rats. They also reported that the extract significantly reduced the blood glucose of the diabetic animals to levels similar to the nondiabetic control [11].

## 5.4 Antioxidant Activity

Numerous reports have shown that *G. latifolium* leaf extracts exhibit antioxidant property. Ugochukwu and Babady [38] reported that oral administration of aqueous and ethanolic extracts of *G. latifolium* leaf to Streptozotocin-induced diabetic rats significantly raised the activity of superoxide dismutase, glutathione reductase, glutathione peroxidase and glucose-6-phosphate dehydrogenase (G6PD). The level of reduced glutathione was increased while lipid peroxidation was decreased. They concluded that *G. latifolium* leaves could exert their antidiabetic activity through their antioxidant properties [38].

Nwanjo et al. [39] reported the anti-lipid peroxidative property of the aqueous extract of *G. latifolium* leaves in experimental rats subjected to Streptozotocin-induced diabetes. They found out that the extract significantly increased the activity of superoxide dismutase and lowered the level of the plasma lipid peroxidation product, malondialdehyde.

Eze and Nwanguma [12] reported the antioxidant activity of the tannin extract from *G. latifolium* leaves on partially purified lipoxygenase from *Cucumeropsis manii* seeds. The inhibitory effects of the tannin extract and of two known antioxidants: ascorbic acid and propyl gallate, on the partially purified lipoxygenase was investigated. The extract significantly inhibited the lipoxygenase and this inhibitory activity compared well with those of ascorbic acid and propyl gallate. They suggested that the extract could be included in food processing to hinder the deteriorative effects of lipoxygenase [12].

### 5.5 Anticancer Activity

*G. latifolium* leaf extracts were reported by Iweala et al. [40] to exhibit strong inhibitory activity against human lung carcinoma and human breast adenocarcinoma *in vitro*. The extracts also exhibited free scavenger scavenging activity against 1,1-Diphenyl-2-picrylhydrazyl (DPPH) *in vitro*. Previous reports have indicated that phytochemicals could prevent cancer and other chronic diseases by their antioxidant activity as free radical scavengers [41-43].

### 5.6 Allelopathic Activity

Morebise and Fafunso [4] reported the phytotoxic activity of saponin extracts from *G. latifolium* leaves. The saponin extract showed strong inhibitory activity against the germination of bean and maize seeds, and against the growth of their seedlings. Inhibition of root and shoot lengths was concentration-dependent and the roots were more sensitive than the shoots to the effect of the extract [4].

### 5.7 Beer Production

Adenuga et al. [44] conducted an experiment in which sorghum beer was brewed with the extracts of *G. latifolium*, *Vernonia amygdalina* and *Garcinia kola* to impart bitter taste and flavor as substitutes for hops used for beer production. Sensory evaluation of the beer samples was

done by trained panelists. The panelists adjudged the *G. latifolium* flavoured beer as better than the other samples and that it compared favourably with hopped beer in terms of flavor and taste.

### 5.8 Toxicological Study

Interestingly, Sylvester et al. [36] reported that acute toxicity of the ethanolic extract of the plant on mice showed 0% lethality when administered intraperitoneally at 1000 mg/kg body weight, but 100% mortality when administered at 2000 mg/kg. This clearly suggests that the plant material is not toxic at the safe doses being consumed. More research is needed in this area.

## 6. GENERAL DISCUSSION

The reports by the different authors highlighted in this review have justified the ethnomedical uses of *G. latifolium* plant material. The antihyperglycemic and antihyperlipidemic activity of the leaf extracts together with their raise of antioxidant enzymes and lowering of lipid peroxidation products in diabetic rats, as shown in the bioactivity reports, suggest possible mechanisms of action of the plant material in alleviating diabetic condition; this confirms the traditional use of the plant to treat diabetes mellitus. The anti-inflammatory, antioxidant and antimicrobial properties of this plant also support its use to treat various ailments including malaria, pains, nausea, intestinal discomforts, cough and other disorders. Inflammation and oxidative stress have been implicated in a host of disorders [45-47]. The *Gongronema latifolium* plant has been described as a reservoir of many natural antioxidants [48].

## 7. FUTURE PROSPECTS

### 7.1 Isolation and Characterization of Active Products

In view of the vast array of bioactivity reports on *G. latifolium*, there is the need to focus research on the isolation and characterization of some of the individual active compounds and their use in the pure form for bioactivity studies. Hopefully, therapeutic drugs could be derived from the plant just as other plants have yielded some important drugs. For example, Quinine is obtained from the Cinchona plant, Artemisinin from *Artemisia annua* and Vincristine from *Catharanthus roseus* [49,50]. A large percentage of Orthodox drugs in

clinical management of cancer have their roots in plants and other natural products [51] while more than 60% of cancer patients still resort to use of herbs to manage the disease [52].

## 7.2 Herbal Supplements/ Formulations

Researchers should look into the possibility of using *G. latifolium* leaf extracts as approved medicinal formulations or supplements, especially for diseases like diabetes mellitus, sickle cell disease, malaria and other disorders for which the plant is being used ethnomedically. During the past decades, the World Health Organization (WHO) and several Governments in the developing countries have campaigned for the promotion and integration of herbal remedies in healthcare delivery as supplementary contributions to modern medical facilities [53].

## 7.3 Food Production and Preservation

Based on the research findings highlighted in this review, commercial application of *G. latifolium* extracts as alternative to hops in beer production should be looked into. Also, commercial use of the extracts as food supplements or for food preservation is an interesting area which researchers can focus on.

## 7.4 Allelopathy

Allelopathy is an emerging approach to agricultural issues like inter-cropping, pest management, crop rotation and growth enhancement [54]. A lot of research has been done to explore the inhibitory potential of different allelopathic crops and trees for weed management [55-58]. The inhibitory property of allelochemicals has been attributed to the blockage or cessation of important physiological and metabolic processes of plants [54]. Since allelochemicals do not have residual toxic effects, they are better alternatives to synthetic herbicides [59].

Allelopathic property of *G. latifolium*, if properly utilized, could be effective in weed control, plant selection, herbicidal application and crop rotation. This should be another area of research focus.

## 7.5 Novel Research in Fermentations

*G. latifolium* leaf extracts were reported to increase the levels of reduced glutathione,

glucose-6-phosphate dehydrogenase and the antioxidant enzymes in both experimental animals and *in vitro* studies (see notes on antioxidant activity). Can *G. latifolium* extracts do same in fermentations? Since alcohol is toxic because of its generation of free radicals that cause oxidative stress thereby destroying cells and tissues [60], increase in reduced glutathione, glucose-6-phosphate dehydrogenase (G6PD) and the antioxidant enzymes by *G. latifolium* extracts would boost the performances of the microorganisms being used for the fermentation process. Most yeast cells can tolerate between 10 and 15% alcohol in the fermenter depending on the yeast strain and environmental conditions [61]. Rossi et al. [62] suggested that the use of genetically modified *Saccharomyces cerevisiae* that produces high quantities of G6PD in ethanol production would have a positive effect on distillery profits. This is because G6PD would produce NADPH that would increase the amount of reduced glutathione. In the same vein, if *G. latifolium* can increase the levels of G6PD, reduced glutathione and superoxide dismutase in fermentation (just like it did in the animal and *in vitro* studies mentioned in this review) that would lead to more profits for brewery and other fermentation industries. Novel experiments are needed to be designed and conducted in this direction.

## 7.6 Mechanisms of Action of Isolated and Characterized Compounds

Several possible mechanisms of action of the extracts have been suggested by the authors of the articles that were reviewed. However, as active compounds are isolated from the plant and are characterized, researchers should do studies on the molecular mechanisms of action of the characterized compounds. For instance, what is the action of the compound on cyclooxygenase (COX)? Is there any inhibitory preference for COX-1 or COX-2? How does the compound interact with G6PD, superoxide dismutase, lipoxygenase or any other enzyme? What are the molecular mechanisms of the anticancer, antimicrobial and phytotoxic properties of the drugs? These are further areas of research to look into.

## 8. CONCLUSION

The research reports highlighted in this review have tremendously justified the ethnomedical uses of *Gongronema latifolium* plant. The plant

material also has great prospects as highlighted in the review.

## CONSENT

It is not applicable.

## ETHICAL APPROVAL

It is not applicable.

## COMPETING INTERESTS

The author here by declares that no competing interest exists.

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