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A Review of Taxonomy, Distribution, Utilization, Bioassays and Phytochemistry of Selected Kenyan Gladioli

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Abstract

The genus *Gladiolus* commonly referred to as Gladioli belongs to the family Iridaceae. Members of this genus are herbaceous and cormous with conspicuously showy flowers, the main part for identifying the different species. They are wide spread in Eurasia, South Africa and Tropical Africa where they are utilized as ornamentals, in floriculture industry, as food, in traditional medicine and in social functions amongst others. Although earlier reports indicate that there are six species in Kenya, only four species have been regularly encountered. This article is a review of taxonomy, distribution, utilization, bioassays and phytochemistry of selected four *Gladiolus* spp. found in Kenya.

Keywords: *Gladiolus*, Taxonomy, Distribution, Utilization, Bioassays, Phytochemistry

1. Introduction

The genus *Gladiolus* consist of about 260 species and is the second largest in the family Iridaceae after the genus *Iris.* Out of these, 250 species are native to South and Tropical Africa whereas only 10 species are spread in Eurasia (Ameh et al., 2011). The species vary with small to spectacular giant colourful flowers. They are mainly herbaceous in growth habit, consist of rounded corms, which are symmetrical and are enveloped in layers of fibrous tunics. They have unbranched stems from which arise linear- sword shaped simple leaves enclosed in a sheath (Agnew, 2013; Ochepke et al., 2009; Agnew and Agnew 1994). *Gladiolus* are monocotyledonous angiosperms that belong to the Kingdom plantae; Division Tracheophyta, order asparagales; and family Iridaceae. The four species of *Gladiolus* commonly found in Kenya are; *Gladiolus watsonoides, G. ukambanensis, G. goetzenii* and *G. newii* . The aerial parts, especially the flowers are vital in differentiating between the species (Agnew and Agnew 1994). Recently, it has been established that even the corms are useful in differentiating the species (Odhiambo, 2024) especially during dry seasons when the plants are not in flower. In many parts of the World where they occur, Gladioli have been used in traditional medicine, as food, as ornamental plants, as well as in floriculture industry.

2. Taxonomy and distribution

Members of this genus have a single unbranched stem with one to nine narrow sword shaped leaves which are longitudinally grooved and enclosed in a sheath. The inflorescence are spikes which large and appear with perfect bisexual flowers each subtended by two leathery green bracts. The stigmas are three-lobed, perianth almost similar in appearance. Perianth forms a tube-shaped structure. The dorsal tepal is the

largest arching over the three stamens. Outer three tepals are narrower. The funnel shaped perianth has stamens attached to the base. Anthers are arrow shaped at the base. The fruit is a capsule with many seeds which are flattened. The flowers are showy with various colourations such as white or cream with red centers, orange to red, uniformly bright red, yellow or orange with streaks or markings (Agnew, 2013; Ochekpe *et al.*, 2009; Agnew and Agnew, 1994).

***Gladiolus watsonoides* Baker** is a medium to high about (0.5-1m) herb with leafy stems which end up in a spike of up to 15 uniformly bright glossy red flowers which are funnel shaped. They have sword shaped leaves, which are about five to seven per stem. The stem is mostly unbranched and hairless. At the base of the stem are fleshy corms which are flattened and surrounded by a soft to firm fibrous and membranous tunic (Agnew 2013; Agnew and Agnew 1994 ; https://en.wikipedia.org/wiki/Gladiolus_watsonioides).They are distributed in wet bamboo alpine zones of 2400-4200m above sea level. Specific places in Kenya are Aberdare ranges and Mount Kenya (Agnew 2013 ; Agnew and Agnew 1994) . other places are Mount Kilimanjaro, Mount Meru and Mount Hanang of Tanzania (Agnew 2013; Agnew and Agnew 1994; https://en.wikipedia.org/wiki/Gladiolus_watsonioides).

***Gladiolus ukambanensis* Baker** are herbs of about 20-40cm in height. Stems unbranched. Leaves 2-3 all basal and narrowly lanceolate in shape. Spike consists of 2-6 flowers which are pure white in colour and sweet scented. Flowers up to 15 cm long with long perianth tube. They are distributed in grassland areas with black cotton soil at altitudes of 100-2100m above sea level. The corms are globose in shape, tunics firm to papery and membranous (Odhiambo, 2024). In Kenya, these herbs are found in Aberdare ranges, Narok, Rift valley, Nanyuki, Embu, Kajiado, Machakos- Konza area along Nairobi-Mombasa highway. They are also found in Somalia, Djibouti, Southern parts of Ethiopia, Northern Tanzania and parts of Oman. *Gladiolus candidus* (Rendle) Goldblatt is a synonym of this plant. (https://plants.jstor.org/compilation/Gladiolus.ukambanensis; Agnew 2013; Agnew and Agnew 1994)

Gladiolus goetzenii Baker are herbs which are 60-90cm in height. The flowering and the leafy stems are separate. Leaves produced after flowering, those on the flowering stem short and sheathing. Leaves narrowly lanceolate in shape. Spike are 3-9 flowered and the flowers are bright orange with markings (https://plants.jstor.org/stable/10.5555/al.ap.flora.ftea003813?searchUri=qtype%3Dall%26query%3Dgladiolus%2Bpauciflorus). They are distributed in common grasslands to montane forests in altitudes of 1200-3100m above sea level. In Kenya, they are found in Mount Elgon, Tinderet hills, Mau, Loita, Mount Kenya, Kitale, Mumias, Trans-Nzoia, Kisii, Narok, Embu, Nanyuki, Machakos, Nairobi, Kajiado, Cherenganyi, Laikipia district, Kwale- Shimba hills, Kakamega forest, Olkalau-Nyahururu. Other areas where they are distributed include districts of Mengo, Kampala, Kakinzi of Uganda, Songea, Biharamulo and Morogoro Districts of Tanzania. Also found in Zaire, Rwanda, Burundi, Angola, Zimbabwe, Malawi and Mozambique.

Gladiolus goetzenii Baker is synonym to *Gladiolus dalenii* Van Geel subsp *andongensis* (Baker) (Agnew 2013; Agnew and Agnew 1994; Goldblatt 1996; https://plants.jstor.org/stable/10.5555/al.ap.flora.ftea003813?searchUri=qtype%3Dall%26query%3Dgladiolus%2Bpauciflorus)

***Gladiolus newii* Baker** are herbs with stems moderately stout and 1-1.5ft long which bears 1 reduced leaf. Flowering and leafy stems are not separate. Spikes are few flowered and the flowers bright yellow to yellow orange without markings. Corms of this plants are globose in shape and medium in size. They are distributed in grasslands from savanna edges to montane forests in altitude zones between 1200-3100m

above sea level. In Kenya, they are found in following localities Found in Mount Elgon,Tinderet hills, Mau, Loita, Mount Kenya, Kitale, Mumias, Kisii, Narok, Nanyuki, Embu, Machakos, Nairobi, Kajiado, Cherenganyi, Laikipia district, Olkalau- Nyahururu. Also found in Mozambique and Mount Kilimanjaro of Tanzania.

G.newii Baker is a synonym to *Gladiolus dalenii* Van Geel subsp. *dalenii* Van Geel (Agnew 2013; Agnew and Agnew 1994; Goldblatt1996; https://powo.science.kew.org/results?q=Gladiolus%20newii)

3. Utilization

Ethnomedicine and food

Many cultures and communities have used members of this genus in a number of ways to manage various health conditions and ailments as well as food. The part used are mostly the corms and the flowers. Various species are used to manage gut, skin infections, urinogenital tracts, upper respiratory system, constipation, dysentery, meningitis and malaria. Preparation involves pounding fresh corms, drying then powdering the corms, burning the corms, and boiling in water to get the decoction. Administration includes mixing with water or other herbal plants and concoction drunk, powdered corms are sniffed, burnt corms are inhaled to treat colds and headaches and decoction of corms drunk to treat rheumatic pains, headaches, hemorrhoids, epilepsy, convulsions, remedy for impotency and dysmenorrhea (Ameh et al., 2010; Odhiambo et al., 2010 ; Yineger et al., 2008 ; Tadese, 1994; Burkill , 1985 ; Hutchings & Staden 1994). Other ailments and health conditions managed by *Gladiolus* spp. are endometriosis, sterility, placenta passage, chest ailments, earaches, wounds, eyes, asthma, internal parasites, hypertension, gastric upsets, snake bite, sores in the tongue, gonorrhea and to calm patients with mental disorders. Flower petals crushed and rubbed on nails for strength, infusion from flower petals used to offer soothing wash to fatigued feet (Munyamana, 2013; Mensah et al., 2009; Arnold and Gulumian, 1984 ; Adjanohoun et al., 1991 ; Gonzalez-Tejero et al., 1995 and Defour, 1994).

As food, corms are used to make a sweet or sour non-alcoholic drink made from cereal (Ameh et al., 2010). Corms are edible and eaten raw or cooked, also used in soup, may also be mixed with other plant parts for use as a purge, or boiled before consuming (Delfeld and Delfeld , 2007). Flowers also used as food, raw or cooked, added to salads or used as boiled vegetables.

Of the Kenyan Gladioli reported in this article, only *Gladiolus dalenii* subsp. *dalenii* Synonymous to *G.newii* and *G. ukambanensis* have reports on ethnomedicinal usage . *G. dalenii* subsp. *dalenii* is used by communities in the Lake Victoria Basin in Western Kenya to treat meningitis, malaria, ulcers, diarrhoea and HIV related infections (Odhiambo et al., 2010). Decoction from corms drunk to treat ulcers, dried corm powder sniffed to treat meningitis while concoctions from a pinch of the same drunk to manage malaria and diarrhoea (Odhiambo et al., 2010). Corms of *G. ukambanensis* are edible and used as a remedy to snake bites in the Northern parts of Kenya (https://plants.jstor.org/compilation/Gladiolus.ukambanensis).

4. Bioassay activities

In order to validate claims on the usage in ethnomedicine, bioassay tests have been conducted on a number of *Gladiolus* spp. *G. dalenii* has been reported to have antibacterial activity against *Bacillus subtilis* and *staphylococcus aureus;* antifungal activity against *Candida albicans* and *Aspergillus niger* (Odhiambo et al., 2010; Fawole et al., 2008). Moundipa et al., 2005 reported that this plant has anti-amoebic activity. *G.*

gregasius was found to be active against *A. niger*, *Candida* spp. and *Pseudomonas aeruginosa* (Ameh et al., 2011; Nguedia et al., 2004).

Odhiambo 2015 reported that crude extracts of corms of the selected four Kenyan Gladioli were more active compared to the aerial parts when tested against *C.albicans*, *A. niger* and *Cryptococcus neoformans.* *G. watsonoides* showed the highest antifungal activity (Odhiambo et al., 2014), followed by *G. goetzenii*, then *G. newii* while *G. ukambanensis* showed the least antifungal activity. Seven Semi purified fractions extracted using 100% hexane, hexane: dichloromethane (1:1), 100% dichloromethane, dichloromethane: ethyl acetate (1:1), 100% ethyl acetate, ethyl acetate: methanol (1:1) and 100% methanol had antifungal activities ranging from slight to high (Odhiambo, 2015).

Cytotoxicity tests carried against freshly hatched brine shrimp- *Artemia salina* larvae (nauplii) showed that the crude extracts from the aerials and corms showed that corms showed high toxicity compared to the aerial parts. *G. watsonoides* were strongly toxic throughout (Odhiambo et al., 2014), *G. newii* and *G.goetzenii* showed strong to moderate toxicity while aqueous aerial extracts of *G. ukambanensis* were not toxic but the organic extracts were strongly toxic to the nauplii. Also, water extracts of corms of *G.ukambanensis* were weakly toxic (Odhiambo, 2015).

5. Phytochemistry

A lot of secondary metabolites have been reported from many members of this genus. Notably, *G. dalenii* corms have been reported to have alkaloids (Odhiambo et al., 2010; Burkill, 1985). Anthraquinones, saponins, tannins, iridoids, terpenoids, and flavonoids amongst others have also been reported (Munyemana 2013; Ameh et al., 2011; Ameh et al., 2010; Ngamga et al., 2007). *G. gregasius* has saponnins, glycosides, steroids, alkaloids, triterpenes and phenols (Assob et al., 2011; Nguedia et al., 2004). *G. imbricatus* contain flavonones, quinines and carbohydrates (Krvavych et al, 2014). *G. gandavensis* posess anthraquinones whereas *G.segetum, G. atroviolaceus and G.illyricus* have flavonoids, fatty acids, saponins, lipid, steroid, chromone, cinnamic acid and furfural amongst others (Wang' et. al., 2003; Mohamed 2005; Wubert et al., 1996; Ali et al., 1989; Viladomat et al., 1986 and Ali et al., 1985).

In the selected Kenyan species, *G. watsonoides* was found to have flavonoids, saponins, alkaloids, terpenes, tannins, anthraquinones and glycosides (Odhiambo et al., 2014; Odhiambo, 2015). *G.newii* was reported to possess flavonoids, saponins, alkaloids, terpenes, tannins and glycosides (Odhiambo 2015). *G.goetzenii* contained flavonoids, saponins, alkaloids, terpenes, tannins and glycosides while *G.ukambanensis* was reported to have flavonoids, saponins and tannins (Odhiambo, 2015).

6. Conclusion

Although *Gladiolus* spp. have been utilized in various ways and contributes to the economy of many countries as cut flowers in flouriculture industry, the Kenyan Gladioli are largely underutilized in my view. There was no reports of their usage as ornamental flowers leave alone in horticulture and flouriculture industries. There was no report of domestication. Only two species; *G. newii* (*G. dalenii subsp dalenii*) and *G.ukambanensis* have been utilized in ethnomedicine by certain cultures in Kenya.

With regard to bioassays, only *G. newii* (*G. dalenii subsp dalenii*) has been tested against a wide range of pathogenic microorganisms. The other three have been tested against *C.albicans*, *A. niger* and *Cryptococcus neoformans* only hence more needs to be done. Also, cytotoxicity tests were found against brine shrimp larvae only.

While the secondary metabolites of *G. newii* (*G. dalenii subsp dalenii*) and *G.watsonoides* had been reported earlier, those of *G. goetzenii,* and *G. ukambanensis* are reported here in a journal for the first time.

The Kenyan Gladioli have a potential to improve the Kenyan economy if their value is recognized in floriculture industry and proper commercialization strategies put in place.

7. Conflict of interest

Author has none to declare

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9. Reference

1. Adjanohoun, E., Ahyi, M. R. A., Ake-Assi, L., Elewude, J. A., Dramane, K., Fadoju, S.O., Gbile, Z. O., Goudole, E.,. Johnson, C. L. A, Keita, A., Morakinyo, O. , Ojewole, J. A. O. , Olatunji, A. O. and Sofowora, E. A. (1991) Traditional medicine and pharmacopoeia. Contribution to ethnobotanical floristic studies in Western Nigeria, Pub. Organization of African Unity, Scientific Technical and Research Commission Lagos, Nigeria. 420p
2. Agnew A.D.Q., (2013) Upland Kenya wild flowers and Ferns, 3rd Ed pg 379. East Africa Natural History Society
3. Agnew, A.D.Q., Agnew, S., (1994). Upland Kenya wild flowers, 2nd Ed. East Africa Natural History Society
4. Ali, A.A., Abdalla O.M., Steglich W. (1989). Anthraquinone derivatives from *Gladiolus Segetum. Phytochemistry* 28 (1): 281-282
5. Ali A.A., El-Shanawany M.A., Mesbah M.K., Ross S.A., (1985). Pharmacognostical study of *Gladiolus segetum* Ker-Gawl, cultivated in Egypt. *Bulletin of Pharmaceutical Sciences Assuit University* 8(1):102-126
6. Ameh S., Obodozie O., Olorunfemi P., Okoliko I., Ochepke N., (2011). Potentials of corms as antimicrobial agents in food processing and traditional medicine. *Journal of Microbiology and Antimicrobials* 3 (1): 8-12
7. Ameh S.J., Ochepke N.A., Okoliko E.I., Olorunfemi P.O., (2010). Basis for ethnomedicinal use of corm (Family: Iridaceae) in West Africa. *Asian Journal of Experimental Biological Sciences* 1 (4): 902-906
8. Arnold H.J., & Gulumian M., (1984). Pharmacopoeia of traditional medicine in Venda. *Journal of Ethnopharmacology* 12: 35-74.
9. Assob C.N.J., Kamga F.L.H., Nsagha S.D., Njunda L.A., Nde F.P., Asongalem E.A., Njouendou J.A., Sandjon B., Penlap B.V., (2011) Antimicrobial and toxicological activities of five medicinal plant species from Cameroon traditional medicine. *BMC Complementary and alternative medicine* 11:70
10. Burkill, H.M., (1985). The useful plants of West Tropical Africa. Royal Botanic Gardens, Kew 2
11. Defour G., (1994). Plantes medicinales traditionnelles au Kivu (Republic du Zaire). Documentation du Sous-Reseau prelude.

12. Delfeld M., & Delfeld N., (2007). Plants for use. http://plants for use.com, accessed on 9/6/2014.
13. Fawole, O.A., Finnie, J.F., Van Staden J., (2008). Antimicrobial activity and mutagenic effects of twelve traditional medicinal plants used to treat ailments related to the gastro-intestinal tract in South Africa. *South African Journal of Botany* 10.1016
14. Gonzalez-Tejero M.R., Molero-Mesa J., Casares-Porcel M., Lirola M.J.M., (1995). *Journal of Ethnopharmacology* 45 (3):157-163
15. Goldblatt P., (1996) Flora of Tropical East Africa 1.
16. https://en.wikipedia.org/wiki/Gladiolus_watsonioides retrieved on 6/4/2024
17. https://plants.jstor.org/compilation/Gladiolus.ukambanensis retrieved on 6/4/2024
18. https://plants.jstor.org/stable/10.5555/al.ap.flora.ftea003813?searchUri=qtype%3Dall%26query%3Dgladiolus%2Bpauciflorus retreived on 6/4/2024
19. https://powo.science.kew.org/results?q=Gladiolus%20newii retrieved 6/4/2024
20. Hutchings, A., & Staden J.V., (1994). Plants used for stress related ailments in traditional Zulu, Xhosa, and Sotho medicine. Part 1: plants used for headaches. *Journal of Ethnopharmacology* 43: 89-124
21. Krvaych A.S., Konechna R.T., Petrina R.O., Kyrka M.S., Zayarnuk N.L., Gulko R.M., Stadnytska N.E., Novikov V.P., (2014). Phytochemical research of plant extracts and use *in vitro* culture in order to preserve rare wild species of *Gladiolus imbricatus*. *Research Journal of Pharmaceutical, Biological and Chemical Sciences* 5(1):245
22. Mensah J.K. , Okoli R I., Turay ,A. A. ,Ogie-Odia E.A.,(2009) .Phytochemical Analysis of Medicinal Plants Used for the Management of Hypertension by Esan people of Edo State, Nigeria. *Ethnobotanical leaflets 13:* 1273-1287
23. Mohamed M.K., (2005). Chemical constituents of *Gladiolus segetum* Ker-Gawl. *Bulletin of Pharmaceutical sciences* 28(1):71-78
24. Moundipa P.F., Melanie K.G., Bilong B., Bruchhau I.,(2005). In vitro amoebicidal activity of some medicinal plants of Bamun Region (Cameroon)..*African Journal of Traditional, Complementary and Alternative Medicines* 2 (2): 113-121
25. Munyemana F., (2013). Qualitative phytochemical screening and antimicrobial activity evaluation of bulb extracts of *Gladiolus psittacinus* Hook (Iridaceae). *International Network Environmental Management conflicts Santa Catarina – Brasil*,2 (1): 14-31
26. Ngamga D., Awouafack M.D., Tane P., Bezabih M., Abegaz B.M., (2007). Two new anthraquinones from *Gladiolus psittascinus*. *Biochemical Systematics and Ecology* 35:709-713
27. Nguedia A.C., Etoa X.F., Beng P.V., Lontsi D., Kuete V., Moyou S.R., (2004). Anti-candidal property and acute toxicity of *Gladiolus gregasius* Baker (Iridaceae). *Pharm Med Trad Africa*13:149-159
28. Ochepke N.A., Ameh S., Okoliko I., Olorunfemi., (2009). Antimicrobial and phytochemical properties of aqueous extracts of *Gladiolus* corm (Iridaceae) from Benue State of Nigeria. *Journal of Pharmacy and Bioresources* 6(2):65-70
29. Odhiambo J.A (2024). Corms as additional features to identify Gladiolus species used in ethnomedicine. *International Journal for Multidisciplinary Research (IJFMR) 6(2)*
30. Odhiambo J.A., (2015). Antifungal activity, Toxicity and Phytochemical composition of *Gladiolus* and *Dierama* species (Iridaceae) in Kenya. Ph.D thesis, University of Nairobi, Nairobi, Kenya
31. Odhiambo J., Dossaji S., Lukhoba W., Yenesew A., (2014). Antifungal activity, brine shrimp cytotoxicity and phytochemical screening of *Gladiolus watsonoides* Baker (Iridaceae). *Journal of Pharmacy Research* 8 (9): 1218-1222

32. Odhiambo, J.A., Siboe, G.M., Lukhoba, C.W., and Dossaji, S.F., (2010). Antifungal activity of crude extracts of *Gladiolus dalenii* Van Geel (Iridaceae). *African Journal of Traditional Complementary* and *Alternative Medicine* 7 (1): 53 - 58
33. Tadesse D., (1994). Traditional use of some medicinal plants in Ethiopia ; proceedings of the 13th plenary meeting of AETFAT, Zombia, Malawi 1: 273-293
34. Viladomat F., Codina C., Llabres M.J., Bastida J., (1986). Alkaloid screening of plants of Catalonia (Spain) III. *International Journal of crude drug research* 23: 105-117
35. Wang, D.Y., Ye Q., Li B.G., Zhang G.L., (2003). A new anthraquinone from *Gladiolus gandavensis*. *Natural products Research* 17(5): 365-368
36. Wubert J., Oster U., Rudiger W., (1996) Inhibitors of chlorophyll biosynthesis from bulbs of *Gladiolus spp. Znaturforsch ser c* 51 (7/8): 548-557
37. Yineger H., Kelbessa E., Bekele T., Lulekal E., (2008). Plants used in traditional management of human ailments at Bale Mountains National Park, Southeastern Ethiopia. *Journal of Medicinal Plant Research.* 2 (6): 132-153.