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Influence of anti-sickle cell medicinal plants (*Carica papaya* and *Ipomoea batatas*) on sickle cell morphology in the Kisangani region

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Abstract

Introduction: This study focused on the influence of presumed anti-sickle cell medicinal plants (*Carica papaya* and *Ipomoea batatas*) on sickle cell morphology in the Kisangani region. It aimed to verify the corrective effect of these plants by comparing in vitro analyses of sickle cell red blood cells from the control sample with plant extracts.

Methods: The Emmel sickle cell test was the method chosen to demonstrate the activity of plant extracts on sickle cell morphology. This in vitro experiment was performed for each control sample and one test sample. The control sample was blood from a sickle cell patient, and the test sample was the one treated with the anti-sickle cell plant extract.

Results: The aqueous extract of *Carica papaya*, with 60% versus 70% for the ethanolic extract, restored red blood cells to normal shapes compared to SS blood. However, the aqueous extract compared to the ethanolic extract of *Ipomoea batatas* compared to SS blood showed that the extracts provided a correction of normal or biconcave shapes of 60% and 80%, respectively.

Conclusion: *Carica papaya* and *Ipomoea batatas* are medicinal plants that have a positive impact in the treatment of sickle cell disease. The plants tested demonstrated satisfactory anti-sickle cell activity; the ethanolic extracts demonstrated superior activity compared to the aqueous extracts.

Keywords: Influence; Medicinal Plants; *Carica papaya; Ipomoea batatas*; Anti-Sickle Cell; Morphology; Sickle Cells

1. Introduction

Sickle cell disease, or sickle cell anemia, is an autosomal inherited disease that primarily affects the Black African population and its diaspora. Molecularly, this disease is caused by the replacement of glutamic acid with valine in position 6 of the β chain of globin, the protein component of hemoglobin. This leads to structurally abnormal, poorly soluble hemoglobin, hemoglobin S, which polymerizes inside red blood cells when oxygen pressure drops. This aggregation leads to the formation of erythrocytes, responsible for many of the problems of sickle cell patients [1].

According to the WHO, sickle cell disease affects more than 50 million patients (homozygous), and there are 250 million heterozygous carriers worldwide. Furthermore, more than 330,000 children are born with this disease each year and 80% of them die before their fifth birthday if they are not medically monitored [2].

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Generally speaking, the sickle cell gene affects all countries of large black African migration: United States of America, Antilles, Brazil, etc. But it is also found, to a lesser degree, throughout the Mediterranean Basin: North Africa, the Iberian Peninsula, Sicily, Southern Italy, Greece, Turkey and the Middle East [3, 4].

Sickle cell disease is most prevalent in sub-Saharan Africa and is now a public health problem in most black African countries. In Central and West Africa, 20 to 40% of people carry the sickle cell trait. In The Democratic Republic of Congo (DRC), more than 2% of the population is affected by this disease, or nearly one and a half million individuals [5, 6].

Numerous advances in disease management have made it possible to alleviate the illnesses, but without curing them, and a basic treatment remains to be discovered. Currently, although some therapeutic methods can improve the prognosis of this disease, particularly allogeneic transplantation, these methods are very expensive and beyond the reach of the majority of populations in low-income countries such as those in Africa, as in the Democratic Republic of Congo [7]. Given the very high cost of sickle cell disease treatment, the population resorts to herbal medicine; thus several experimental proofs highlight the anti-sickle cell activity in vitro and in vivo by medicinal plants based on their active ingredients and that several plants are used in the treatment of this disease, notably sweet potato (*Ipomoea batatas* L.), papaya (*Carica papaya* L.) etc. [8, 9].

Therefore, this study aims to verify the corrective influence of *Ipomoea batatas* L. and *Carica papaya* L. on the morphology of sickle cells by comparing in vitro analyses on sickle cell red blood cells from the control sample to the sample with plant extracts in order to constitute an exploratory avenue for pharmacists in order to develop new molecules with therapeutic virtues that can effectively treat sickle cell disease.

2. Methods

2.1. Description of the research field

This study was carried out in the city of Kisangani, capital city of the Tshopo Province, precisely in the microbiology and phytopathology laboratory of the University of Kisangani, located in the commune of Makiso. The city of Kisangani is located in the northeast of the central Congolese basin, covering an area of approximately 1,910 km^2 at one time, and at an average altitude of 396 m. Its relief presents several variations, including plateaus, gentle slopes, and terraces. Its geographical coordinates are: 25°11' East longitude and 0°31' North latitude. The climate prevailing in this city is of the AF type of the Koppen classification, where the average temperature of the coldest month is above 18°C [10].

2.2. Study Material

Carica papaya L. and *Ipomoea batatas* L. constituted our plant material, harvested in the morning during hot, dry weather from healthy plants in uncrowded areas, in accordance with Debuigne's principle [11]. Red blood cells from sickle cell patients obtained from the Gracia Foundation Center, which specializes in the screening, treatment and care of people with sickle cell disease, served as human material for this study.

2.3. Procedures

2.3.1. Preparation of Plant Extracts

The leaves of various plants that were the subject of this study were collected in the morning during warm, dry weather from plants in uncrowded areas. They were then initially dried at room temperature (25°C) in the microbiology and phytopathology laboratory for 48 hours in a Pasteur oven.

After drying, these leaves were ground in a mortar and then sieved to obtain a fine powder, which was stored in a bag and placed in a cabinet.

To macerate the powder, 10 g of plant powder were taken and weighed using a precision balance, then mixed with 100 ml of distilled water or ethanol. These mixtures were then left to incubate for 48 hours at room temperature in the laboratory before being filtered using filter paper to extract the concentrated juices, which were then placed in an incubator at 37°C for 72 hours [12].

2.3.2. Study of the anti-sickle cell biological activity of plant extracts

The sickling test using the Emmel technique is the method chosen to demonstrate the activity of plant extracts on the morphology of sickle cells. To carry out this in vitro experiment, a control sample and a test sample were carried out for each control sample. The control sample was the blood of a sickle cell patient and the test sample was the one treated with the anti-sickle cell plant extract [12, 13].

2.3.3. Sickle Cell Test before Treatment or Control

- A drop of blood is placed in the middle of the slide, a drop of saline solution is added, then the slide is covered, and the preparation is waxed with paraffin;
- Incubate this preparation at room temperature for 24 hours. Observation was made under a light microscope using a 40X objective. The abnormal red blood cells or sickle cells took on a sickle or banana shape, sometimes with fringed edges like holly leaves.

2.3.4. Sickle Cell Test after Treatment

- A drop of blood is placed in the middle of the slide, along with a drop of the plant extract. The two drops are gently mixed, and the preparation is covered with a coverslip.
- Wax the preparation with paraffin and incubate at room temperature for 24 hours. - Observation was made under an optical microscope with a 40X objective, and the abnormal red blood cells or sickle cells take the shape of a sickle or banana, sometimes with fringed edges like a holly leaf, and the abnormal red blood cells (sickle cells).

3. Results and discussion

The results obtained during our research focused on the influence of some presumed anti-sickle cell plants, *Carica papaya* and *Ipomea batatas*, on the morphology of sickle cells in sickle cell blood.

3.1. *Carica papaya* L

The anti-sickle cell activity of aqueous and ethanolic extracts of *Carica papaya* L. tested in vitro for its anti-sickling active ingredient, obtained after treatment of SS blood.

3.1.1. Aqueous extract compared to the control

The results obtained by applying the aqueous extract of *Carica papaya* compared to the control SS blood show a very strong anti-sickle cell activity of the aqueous extract of the latter. If we compare the shapes of the control red blood cells, we can see that on average 60% of the sickle cells are normalized compared to the control sample. It emerges from this observation that *Carica papaya L*. possesses anti-sickle cell activity.

Although aqueous extracts of *Carica papaya* exhibit anti-sickle cell activity, Makelele [12] obtained higher activity than we did with the plant *Ricinodendron heudelotii*.

This difference in activity may be due to the difference in the plant and the study period. Indeed, it is well known that gene expression, and in particular the content of enzymes catalyzing the biochemical pathways for the synthesis of secondary metabolites in plants is regulated by abiotic factors such as climate, the geological environment of the harvest site, and the harvest period of the plant samples [8].

3.1.2. Ethanolic Extract Compared to the Control

The results obtained by applying the ethanolic extract of *Carica papaya* compared to the control SS blood reveal that the anti-sickle cell activity of the ethanolic extract on red blood cell morphology is at least 70% of the blood cells restored to normal compared to the control. It can be stated that the anti-sickle cell activity is intrinsic to the plant. Indeed, all *Carica papaya* L. extracts produced satisfactory improvement.

Our results corroborate those of Makelele [12], who obtained a normalization rate of sickle red blood cells in the range of 70%-75% for all plants tested.

It would be possible that in-depth analyses could lead to effective relief treatment. Indeed, in addition to sickling, it is also well established that SS red blood cells contain a relatively high proportion of methemoglobin than normal red blood cells, and this increase reduces the affinity of hemoglobin for oxygen, and iron in the oxidized state is unable to bind this molecule, which is essential for life. The oxidation of hemoglobin (Fe^{+2}) into methemoglobin (Fe^{+3}), which is due to significant oxidative stress in sickle cells [14].

To this end, a plant that reduces the methemoglobin profile would therefore have an antioxidant effect on sickle cell red blood cells; Our results indeed indicate that ethanolic extracts of *Carica papaya* L. would prevent sickling of sickle cell erythrocytes as well as the oxidation of hemoglobin in vitro and, therefore, would show an advance in the search for an anti-sickle cell therapy because anti-sickle cell plants would possess drugs active on the morphology of sickle cell erythrocytes [15].

3.2. *Ipomoea batatas* L.

The anti-sickle cell activity of aqueous and ethanolic extracts of *Ipomoea batatas* tested in vitro for its anti-sickle cell active ingredient, obtained from SS blood.

3.2.1. Aqueous Extract of Ipomoea batatas

According to the observation made from the point of view of the microscopic appearance and behavior of SS blood in the presence and absence of aqueous extract of *Ipomoea batatas* during the Emmel test, it was observed that 60% of erythrocytes had regained their normal or biconcave shapes.

Our results show an anti-sickle cell activity superior to Acacia kirkii which had only shown an average activity of 50% of normal sickle cells [12]. Our results contradict those of Mulungulungu N, and al [16] who obtained in Kinshasa 14.2% of erythrocytes which had regained their normal or biconcave shapes in the presence of aqueous extracts of *Ipomoea batatas*.

The observed difference in the biological activity of this plant could be due to the quality or quantity of extracts in bioactive secondary metabolites, making the anti-sickle cell activity of the tested plants closely dependent on the geographical area of harvest [8].

The use of plants to treat sickle cell disease is a hope in The Democratic Republic of Congo thanks to its mega biodiversity, accessibility to plants is easy while many proposed drugs are expensive, toxic and often ineffective against sickle cell disease for example phenothiazines inhibit sickling in vitro, but at doses higher than therapeutic doses [17].

And that the phylogenetic proximity of the population to medicinal plants increases its use in pharmacopoeia in ethnomedicine which can constitute a safety from a toxicological point of view for humans; because these plants would be the basis of the survival of certain populations in a hostile environment such as the forest of the central Congolese basin [18].

3.2.2. Ethanolic Extract of Ipomoea batatas as a Control

Microscopic observation of SS blood after Emmel test treatment with ethanolic extract of *Ipomoea batatas* showed that 80% of blood cells had returned to their normal or biconcave shapes. The ethanolic extract demonstrated greater activity than the aqueous extract.

Orsot Bosson and al [19] found the ethanolic extract to be inhibitorier to both mycelial growth and sclerotial germination of the two phytopathogenic strains of *Sclerotium rolfsii*. This explains why there is currently a renewed interest in medicinal plants in the treatment of sickle cell disease, making herbal medicine the only alternative capable of providing relief to sickle cell patients, with several experimental proofs highlighting the in vitro anti-sickle cell activity of plants [20].

The search for new sources of anti-sickle cell compounds uses the pharmacopoeia of non-human primates (Zoopharmacognosy), which is an original approach, allowing the development of nutraceuticals for better management of chronic diseases such as sickle cell disease [18]. They consume certain plants for the apparently non-food purpose, would benefit from the pharmacological activity of the active ingredients of substances primarily selected during evolution based on the chemical protection they confer on the organisms that synthesize them [21]. According to the pharmacopoeia, the bark of the trunks of the plants were the most used parts, followed by the leaves, and that the kneading of the fresh organs was the most used method of preparation because the activity of a plant substance depends on its concentration better the active principles than the total aqueous extract [22].

3.3. Aqueous and Ethanolic Extract of *Carica papaya*

The results obtained by comparing the aqueous extract of *Carica papaya* reveal that the two extracts are not equal in terms of correctional activity and normalization in anti-sickle cell activity. The aqueous extract of *Carica papaya*, with

60% versus 70% for the ethanolic extract, recovered red blood cells, compared to SS blood, which regained their normal shape. Although the difference in proportion is not very pronounced, the superiority of the ethanolic extract is evident.

Given the results obtained, we believe that the active ingredients are ethanol-soluble molecules, which could be terpenes, alkaloids, or vegetable oils; and the best solvent was ethanol, which better concentrates the active ingredients of certain plants [23]. Although not related to red blood cells, Bagre I. and al [23] revealed that the ethanolic extract allowed an 8-fold improvement in antifungal activity by *Moringa morindoides* on *Cryptococcus neoformis*, making its active ingredient a function of the soluble molecules in the ethanolic extract.

This medicinal plant could be considered as an advance in research against sickle cell disease because the main therapies proposed to date have no direct effect on the morphology of sickled erythrocytes; however, it should be noted that the list of phytochemical compounds has not been isolated from the anti-sickle cell plants tested [24].

3.4. Aqueous and Ethanolic Extract of *Ipomoea batatas*

The results obtained by applying the aqueous extract compared to the ethanolic extract of *Ipomoea batatas* compared to SS blood showed that the extracts provided a correction of normal or biconcave shapes of 60% and 80%, respectively.

This result contradicts that of Mulungulungu DN [16], who obtained 14.2% anti-sickle cell activity for the aqueous extracts versus 7.98% for the ethanolic extract of *Ipomoea batatas*. This difference could be due to the use of the grains in depleted soils of Kinshasa or a low concentration of the extract. Indeed, high concentrations of plant extracts are required for some species before reaching the minimum concentration for normalizing blood cells, while other anti-sickle cell species achieve a high normalization rate with a low concentration. Ngbolua KN & al [8] and Makelele KL [12] found that the anti-sickle cell activity of *Duvernoya splendens* extracts is zero on the morphology of sickle cells; after treatment with extracts, more than 75% of sickle cells remained sickle-shaped.

These results indeed indicate that ethanolic extracts of *Ipomoea batatas* prevent the sickling of sickle cell erythrocytes, as well as the oxidation of hemoglobin in vitro [8].

However, the different proportions of biconcave erythrocytes according to the decreasing order of aqueous and ethanolic extracts confirm the superior activity. *Alkaloids, flavonoids, tannins, quinones, leucoanthocyanins, saponins* and *terpenoids* have been highlighted in the leaves of *Ipomoea batatas* during chemical screening and several studies carried out on secondary metabolites that can normalize the shape of SS globules, have shown that anthocyanins are able to normalize the shape of globules in vitro [14].

4. Conclusion

Focused on the influence of presumed anti-sickle cell medicinal plants (*Carica papaya* and *Ipomoea batatas*) on sickle cell morphology in the Kisangani region, the study aimed to verify the corrective effect of these plants by comparing in vitro analyses of sickle cell red blood cells from the control sample with plant extracts.

Medicinal plants are plants that contain one or more substances or properties that can be used for therapeutic purposes. Maceration, infusion, and decoction are extraction methods for preparing products intended for phytotherapy.

The positive impact of medicinal plants in the treatment of sickle cell disease is now well established.

After analyzing the results, the following conclusions emerge: the plants tested demonstrated satisfactory anti-sickle cell activity; Ethanolic extracts demonstrated greater activity than aqueous extracts.

Ultimately, we suggest that researchers evaluate the anti-sickle cell effects of other plants, conduct studies comparing the activity of different plants and their mixtures, and test the action of plants against the methemoglobin profile.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that there is no conflict of interest in the conduct of this study.

Author Contributions

Christelle Moluawe Solo conducted the design and data collection; the other authors contributed to laboratory sample analysis and data processing.

References

[1] Quevauvilliers, & al (2017). Medical dictionary. Elsevier Masson, Paris.

[2] World Health Organization (2023). Anemia. Available on https://www.who.int/fr/news-room/fact-sheets/detail/anaemia, OMS, Geneva, consulted on 9/03/2025 at 2:35 p.m.

[3] Toutain, Le Gall, & Gandemer (2021). Iron deficiency in children and adolescents: a continuing problem. Pediatrics Archives, Vol. 19, Issue 10, October 2021, Pages 1127-1131

[4] Lutz, L (2020). Sickle cell disease, health magazine, pediatrics department (genetic diseases).

[5] Mbiya Mukinayi B, Kalombo Cibeyibeyi G., Disashi Tumba G & Gulbis B (2021). Sickle cell disease in The Democratic Republic of Congo: what are the obstacles to treatment with hydroxyurea? The Pan African Medical Journal, Janvier 2021

[6] Kambale JK & al (2013). In vitro evaluation of the antisickling activity and antioxidant effect of extracts of Upaca hendelottii baill (euphorbiaceae) in Int J. Biol. Chem. Sci. 7(2):523-534, Avril 2013 http://www.ajal:info/ndex.Php/ijbcs, consulted on 03/15/2025 at 2:10 p.m.

[7] Kilesi Nzanda H (2024). Sickle cell screening among schoolchildren in the city of Kinshasa, PAMJ-Clinical, Avril 2024

[8] Ngbolua & al (2017). Antisickling activity of plants used against sickle cell disease in traditional Congolese medicine. European Journal of Medicinal Plants 2017;3(4):540-548.

[9] Moswa, & al (2017). Plants as an important source of iron for the treatment of anemia: Case of Justicia secunda. 11th NAPRECA Symposium Report, Antananarivo, Madagascar.

[10] Stephen Smith, The Congo River, Arles, Actes Sud, September 2003, 108 p. (ISBN 978-2-7427-4362-9 et 2-7427-4362-6), p.75-76.

[11] Debuigine G (2009). Petit Larousse of Medicinal Plants. Larousse, 2009 ; Paris, p. 383

[12] Makelele KL (2008). Medicinal plants used against sickle cell disease in Kisangani and Babangombe (DRC): contribution to the inventory and study of the activity of plant extracts on the morphology of sickle cells. Specialization thesis in Biodiversity Management, Faculty of Sciences, University of Kisangani.

[13] Caquet R (2014). Laboratory tests, Masson, Paris, 2014.

[14] Mpiana PT, Tshibangu DST, Shetonde OM, Ngbolua KN (2007). In Vitro Anti drepanocytary Activity (Anti-Sickle Cell Anaemia) of Some Congolese Plants. 2007;14:192-195.

[15] Mpiana PT, Ngbolua, KN, Sha Tshibey D. Tshibangu (2016), Functional Foods and Sickle Cell Disease: A Mini-Review, Report, Elsevier, 2016, Volume 19, issue 7.

[16] Mulungulungu DN, & al (2015). Study of the anti-sickle cell activity and thermos degradation of crude aqueous, methanolic and ethanolic extracts of *Ipomoea batatas*, an edible plant with therapeutic properties. 2015.

[17] Charmot G, Reynaud R. (1958). Trials of treatment of sickle cell anemia with acetazolamide. About 10 observations. Bull. Soc ; Exol., 51 : 438-443.

[18] Krief S, Huffman MA, Sévenet, T, Hladik CM, Grellier P, Loiseau PM, & Wrangham RW (2006). Bioactive properties of plant species ingested by chimpanzees (*Pan troglodytes schweinfurthii*) in the Kibale National Park, Uganda. Am J Primatol, 2006;68(1):51-71. doi: 10.1002/ajp.20206.

[19] Orsot, Bosson AMB (2016). Botany Laboratory; UFR Biosciences; Félix Houphouët-Boigny University, Abidjan, Ivory Coast. European Scientific Journal, ESJ Vol 12 No 6 (2016): ESJ February Edition - Articles

[20] Mbembe D, and al (2025). Ethnobotanical study of some plants used in traditional medicine in the western part of the Democratic Republic of Congo (Gemena and Mbuji-Mayi). Congolese Journal of Science and Technology Articles, Vol. 4 No. 2 (2025)

[21] Morrogh-Bernard H (2008). Fur-Rubbing as a Form of Self-Medication in Pongo pygmaeus. International Journal of Primatology 2008 ;29(4):1059-1064 DOI:10.1007/s10764-008-9266-5

[22] Calderon (2017). Phytochemical study of plants from Panama: Henriettella fascicularis, (SW.) C. Wright, and *Miconia serrulata* (DC.) Naud (*Melastomaceae*) and chemotaxonomic comparison of *Justicia species (Acanthaceae)*, Doctoral Thesis, Faculty of Science, University of Lausanne, Switzerland.

[23] Bagre I. & al (2017). Antifungal Activity of Aqueous Extracts of *Calendula officinalis L*, *Urginea maritima* (L.) Baker and *Chenopodium ambrosioides L*. European Scientific Journal, 2017

[24] Brugnara C, Schiller B, Moran J (2006). Reticulocyte hemoglobin equivalent (Ret He) and assessment of iron-deficient states. Clin Lab Haematol. 2006;28(5):303-8. doi: 10.1111/j.1365-2257.2006.00812. x. DOI: 10.1111/j.1365-2257.2006. 00812.x