



Great Apes Plant Foods As Valuable Alternative Of Traditional Medicine In Congo Basin: The Case Of Non-Human Primate Bonobos (*Pan paniscus*) Diet at Lomako Fauna Reserve, Democratic Republic of the Congo

Koto-te-Nyiwa Ngbolua^{1,4*}, Mathieu Bolaa Bokamba², Pius T. Mpiana³, Elumba G. Ekutsu^{1,4}, Masengo C. Ashande⁴, Damien S.T. Tshibangu³, Virima Mudogo³, Dorothee D. Tshilanda³, Roger K. Kowozogono.⁵

¹Department of Biology, Faculty of Science, University of Kinshasa, P.O. Box 190 Kinshasa XI, Democratic Republic of the Congo.

²Biodiversity Team Leader, Mai-Ndombe REDD+ project, Ecosystem Restorate Associate, Wildlife Works, Inogo, Democratic Republic of the Congo.

³Department of Chemistry, Faculty of Science, University of Kinshasa, P.O. Box 190 Kinshasa XI, Democratic Republic of the Congo.

⁴Scientific Committee for Research, Conservation and the Development of Biodiversity, Faculty of Science, University of Kinshasa, Democratic Republic of the Congo.

⁵ISP Yakoma, District of Nord Ubangi, Province of Equateur, Democratic Republic of the Congo.

INDIA*Corresponding author: Dr. Koto-te-Nyiwa Ngbolua, Tel.: +243 81 68 79 527, E-mail: jpngbolua@unikin.ac.cd

Received: February 19, 2015, Accepted: May 4, 2015, Published: May 4, 2015.

ABSTRACT

Great apes are a good model for human pathology and physiology. Great apes eat several plant species claimed by traditional healers to treat various ailments in folk medicine. Some of the items consumed by great apes have low nutritional value suggesting that health might be improved or regulated by such ingestion as previously postulated. Among the inventoried plant species known to be eaten by bonobos at Lomako Fauna Reserve, at least nine (30%) are used in African Traditional Medicine and scientifically validated as antisickling, anti-parasitic, anticonvulsant, analgesic, vasorelaxant, antimicrobial or hepato-protecting medicinal plants. Zoo-pharmacognosy approach may therefore serve as a new complementary/alternative of ethno-pharmacology method in selecting plants for biopharmaceutical research, especially as source of antisickling new hits. The fact that the permanent access of these vegetarian primates to plants as preventive medication in order to maintain a low level of pathogens and a sub-clinical health status, indicate that bonobos plant foods could serve as a valuable alternative of traditional medicines of pharmacological relevance for human health in Congo basin. It is therefore suggested that great apes plant foods could protect human sickle erythrocyte against hemolysis by inhibiting the polymerization of sickle hemoglobin and radical oxygen species formation within sickle erythrocyte as it does for *Plasmodium falciparum* infected erythrocytes in bonobos.

Keyword: *Bonobos, Zoo-pharmacognosy, Pharmacophagy, Medicinal foods, Folk medicine, Democratic Republic of the Congo.*

INTRODUCTION

Humans and great apes (bonobos, chimpanzees, gorillas, and orangutans) share a common gut anatomy. Although, some diseases that cause countless deaths in humans are ineffective or have minor non disturbing effects in apes. Because of their phylogenetic closeness and common neural pathways of chemosensory perception, humans and great apes, when displaying symptoms of illness could alter their foraging to ingest non-nutritive chemical as diet (pharmacophagy) (Ngbolua et al., 2014a, b, c, d).

In the case of malaria infections, the animal self-medicative behavior aid in the control of malaria by inhibiting erythrocytes hemolysis. So malaria does not seem cause any harm or illness to the great apes like bonobos (*Pan paniscus*, figure 1b) (Krief et al., 2010).

It is well-known that, the high frequency of SCD gene occurred in tropical regions (figure 1d) where malaria is endemic (figure 1c) (Pagnier et al., 1985). Thus, in such regions (including Lomako Fauna Reserve), the great apes especially bonobos, endemic to Democratic Republic of the Congo, control the *Plasmodium falciparum* infections through their diet. The control of a hemolytic disease such as malaria by the non human primates through medicinal plants based diet indicates that the plants consumed by these animals would be displayed anti-hemolytic and anti-inflammatory effects and could be beneficial for people suffering from SCD (Ngbolua et al., 2014a, b, c, d). Since great apes (bonobos) are infected by malaria parasite but they cannot develop malaria disease, it was therefore, hypothesized that great apes plant foods could protect sickle erythrocyte against hemolysis by inhibiting the

polymerization of sickle hemoglobin and radical oxygen species formation within sickle erythrocyte as it does for *Plasmodium falciparum* infected erythrocytes in bonobos (Ngbolua et al., 2014d).

This approach also known as zoo-pharmacognosy constitutes an alternative and valuable therapy strategy for identifying effective medicinal plants as revealed by our research bio-prospection program (Kambale et al., 2013). The convergence of use of such plants as well by the human and non human primates constitutes thus an indication of the relevance of their pharmacological properties. The aim of the present study was to inventory the plants consumed by bonobos *in situ* and to show their convergence of use by the human ones in traditional medicine.

MATERIALS AND METHODS

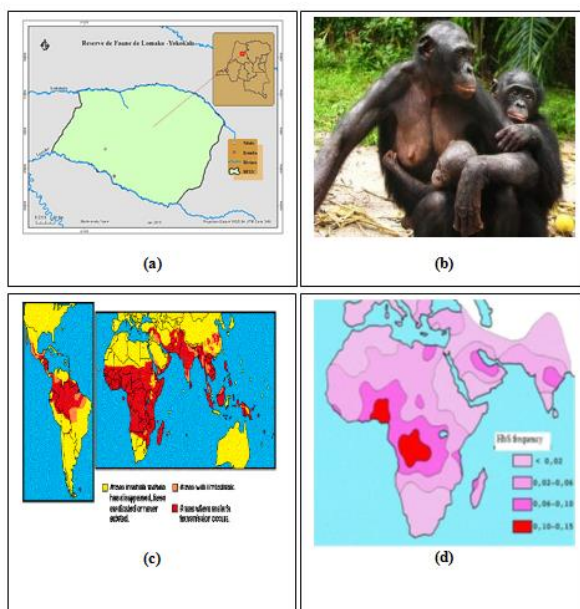


Figure 1. (a) Study site: Lomako Fauna Reserve, (b) Pan paniscus, (c) Malaria endemic regions, (d) Sickle cell disease endemic regions.

The study area (Lomako Fauna Reserve, figure 1a) is located at 00°55'21.4" N and 021°06'03.8" E. Zoo-pharmacognosy surveys were carried out through habituation technique as previously reported (Tetsuya et al., 2012). The habituation procedure involved identifying unit-groups (or communities)

and their ranges by finding footprints and food remnants, making and maintaining observation trails in the ranges, following one or two target groups on a daily basis and identifying individuals in the bonobo groups. Bonobos plant foods were harvested and identified first with the help of the field assistants, then compared to herbarium specimens at Eala botanical garden (Mbandaka, Province of Equateur). Scientific names were verified at <http://www.theplantlist.org/>.

RESULTS AND DISCUSSION

The survey has led to the identification of 30 plant species eaten by Bonobos presented in Table 1. The inventoried bonobo food flora is found in 20 families and 29 genera which belong to the Magnoliophyta taxonomic group.

As shown in Table 1, several plant species eaten by bonobos at Lomako are used as traditional medicines in Africa. Great apes use plant species rich in phytochemicals to improve their comfort or their health, supporting thus the hypothesis that plant secondary metabolites help animals to combat or control diseases (Krief et al., 2005)

According to the WHO report, about 75 to 80% of developing world populations relies on plants/Traditional Medicine for their primary healthcare (Pousset, 2004). Information obtained from search engines (PubMed, PubMed Central, Google Scholar) and a library search for articles published in peer-reviewed journals reveal that some of cited plants (bonobos diet) are also known to treat various ailments elsewhere (Neuwinger, 2000; Betti et al., 2013). The frequency of plant use citations by both traditional healers and literature is an indication of the pharmacological relevance of the plant. Some of listed plants were scientifically validated as analgesic (*Uapaca guineensis*), anti-parasitic (*Polyalthia sauveolens*), antimicrobials (*Anonidium mannii*, *Irvingia gabonensis*, *Scorodophloeus zenkeri*), anticonvulsant (*Antiaris toxicaria*), vaorelaxant and antihypertensive effects (*Mammea africana*), hepato-protecting effect (*Musanga cecropioides*) or anti-sickle cell disease (*Garcinia puctata*) (Ngbolua et al., 2014; Ntie-Kang et al., 2013; Djeussi et al., 2013; Mante et al., 2013; Nguetefack-Mbuyo et al., 2012; Fankam et al., 2011; Kuete and Efferth, 2010; Adeneye, 2009). So, if a plant is employed as remedy in different countries where each people have specific medicinal practices, there is strong evidence that the biological activity should be effective.

Table 1. Checklist of Some plant species consumed by the non human primate Bonobo (*Pan paniscus*) at Lomako Fauna Reserve (Democratic Republic of the Congo)

Botanical accepted name	Vernacular name	Family
<i>Aframomum laurentii</i> De Wild	Mbole (Lomongo)	Zingiberaceae
<i>Anonidium mannii</i> (Oliv.) Engl. & Diel	Bonenge (Lomongo)	Annonaceae
<i>Anthoclitandra robustior</i> (K. Schum.) Pichon	Botofe (Lomongo)	Apocynaceae
<i>Antiaris toxicaria</i> Lesch.	Linkoko (Lomongo)	Moraceae
<i>Austranella congolensis</i> (De Wild.) A.Chev.	Linkoko (Lomongo)	Sapotaceae
<i>Celtis mildbraedii</i> Engl.	Bolole (Lomongo)	Cannabaceae
<i>Cola griseiflora</i> De Wild.	Lonyama (Lomongo)	Malvaceae
<i>Crudia laurentii</i> De Wild.	Esenge (Lomongo)	Leguminosae
<i>Dialium pachyphyllum</i> Harms	Elimilimi (Lomongo)	Leguminosae

<i>Diospyros alboflavescens</i> (Gürke) F.White	Ilo (Lomongo)	Ebenaceae
<i>Ficus ottoniifolia</i> (Miq.) Miq.	Likumu (Lomongo)	Moraceae
<i>Chrysophyllum lacourtianum</i> De Wild.	Bofambu (Lomongo)	Sapotaceae
<i>Garcinia punctata</i> Oliv.	Bosefe (Lomongo)	Clusiaceae
<i>Grewia louisii</i> R.Wilczek	Bofumbo (Lomongo)	Malvaceae
<i>Haumania liebrechtsiana</i> (De Wild. & Th. Dur.)J. Leonard	Bokombe (Lomongo)	Marantaceae
<i>Irvingia gabonensis</i> (Aubry-Lecomte ex O'Rorke) Baill.	Bofalanga (Lomongo)	Irvingiaceae
<i>Landolphia congolensis</i> (Stapf) Pichon	Bosale (Lomongo)	Apocynaceae
<i>Landolphia</i> sp	Bonongo (Lomongo)	Apocynaceae
<i>Mammea africana</i> Sabine	Bokoli (Lomongo)	Calophyllaceae
<i>Musanga cecropioides</i> R.Br. ex Tedlie	Bomambo (Lomongo)	Urticaceae
<i>Palisota hirsula</i> (Thunb.) K. Schum.	Litentele (Lomongo)	Commeliaceae
<i>Pancovia laurentii</i> (De Wild.) Gilg ex De Wild.	Botende (Lomongo)	Sapindaceae
<i>Maranthes glabra</i> (Oliv.) Prance	Bofale (Lomongo)	Chrysobalanaceae
<i>Parinari</i> sp	Luedja (Lomongo)	Rosaceae
<i>Polyalthia sauveolens</i> Engl. & Diels	Bolinda (Lomongo)	Annonaceae
<i>Scorodophloeus zenkeri</i> Harms	Bopili (Lomongo)	Leguminosae
<i>Strombosia glaucescens</i> Engl.	Djuwe (Lomongo)	Olaceae
<i>Strombosiopsis</i> sp	Efondo (Lomongo)	Olaceae
<i>Treculia africana</i> Decne. ex Trécul	Boingo (Lomongo)	Moraceae
<i>Uapaca guineensis</i> Müll.Arg.	Boonga (Lomongo)	Phyllanthaceae



Annonidium manii (annonaceae)



Annonidium manii (annonaceae)



Pancovia laurentii (Sapotaceae)



Treculia africana (Moraceae)

CONCLUSION

Great apes like bonobos are a good model for human pathology and physiology. The present investigation revealed that their diet includes several plant species of pharmacological relevance for human health. The fact that the permanent access of these vegetarian primates to plants as preventive medication in order to maintain a low level of pathogens and a sub-clinical health status, indicate that bonobos plant foods could serve as a valuable alternative of traditional medicines in Congo basin.

The antisickling screening evaluations to ascertain 'red blood cells hemolytic control suggesting hypothesis' of these bio-resources are in progress.

ACKNOWLEDGEMENTS

The authors are indebted to the "Lomako Fauna Reserve" and Eala botanical garden staff members for their valuable assistance. Invaluable support and logistical assistance for field research work were provided by the Africa Wildlife Foundation (AWF)

REFERENCES

1. Adeneye, A.A., 2009. Protective activities of the stem bark aqueous extract of *Musanga cecropioides* in carbon tetrachloride- and acetaminophen induced acute hepatotoxicity in rats. *Afr. J. Trad. CAM* 6(2): 131-138.
2. Betti, J.L., Yongo, O.L., Mbomio, D.O., Iponga, D.M., Ngoye, A., 2013. An ethnobotanical and floristical study of medicinal plants among the Baka Pygmies in the periphery of the Ipassa-Biosphere reserve, Gabon. *European Journal of Medicinal Plants* 3(2): 174-205.
3. Djeussi, E.D., Noumedem, A.K., Seukep, A.J., Fankam, G.A., Voukeng, K.I., Tankeo, B.S., Nkuete, H.L., Kuete, V., 2013. Antibacterial activities of selected edible plants extracts against multidrug-resistant Gram-negative bacteria. *BMC Complementary and Alternative Medicine* 13:164.
4. Fankam, G.A., Kuete, V., Voukeng, K.I., Kuate, R.J., Pages, J.M., 2011. Antibacterial activities of selected Cameroonian spices and their synergistic effects with antibiotics against multidrug-resistant phenotypes. *Complementary and Alternative Medicine* 11:104, <http://www.biomedcentral.com/1472-6882/11/104>.
5. Huffman, M.A., 2001. Self-medicative behavior in the African great apes: An evolutionary perspective into the origin of human traditional medicine. *Bioscience* 51(8): 651-661.
6. Kambale, J.K., Ngbolua, K.N., Mpiana, P.T., Mudogo, V., Tshibangu, D.S.T., Wumba, R., Mvumbi, L.G., Kalala, L.R., Mesia, K.G., Ekutsu, E., 2013. Evaluation in vitro de l'activité antifalcémiant et effet antioxydatif des extraits d'*Uapaca heudelotii* Baill. (Euphorbiaceae). *International Journal of Biological & Chemical Sciences* 7(2): 523-534, <http://www.ajol.info/index.php/ijbcs>
7. Krief, S., Escalante, A.A., Pacheca, M.A., Mugisha, L., André, C., 2010. On the diversity of malaria parasites in African apes and the origin of *P. falciparum* from bonobos. *PLoS Pathog.*, 6(2): e1000765.
8. Krief, S., Hladik, C.M., Haxaire, C., 2005. Ethnomedicinal and bioactive properties of plants ingested by wild chimpanzees in Uganda. *Journal of Ethnopharmacology* 101: 1-15.
9. Kuete, V., Efferth, T., 2010. Cameroonian medicinal plants: pharmacology and derived natural products. *Frontier in Pharmacology* 1(123): 1-19. DOI: 10.3389/fphar.2010.00123.
10. Mante, P.K., Adongo, W.D., Woode, E., Kwami, E.K., Ofori A.E., 2013. Anticonvulsant Effect of *Antiaris toxicaria* (Pers.) Lesch. (Moraceae) Aqueous Extract in Rodents. *ISRN Pharmacology*, Article ID 519208, <http://dx.doi.org/10.1155/2013/519208>.
11. Neuwinger, H.D., 2000. *African Traditional Medicine: A dictionary of plant use and applications*, Mepharm Scientific Publisher, Stuttgart: Germany.
12. Ngbolua, K.N., Bishola, T.T., Mpiana, P.T., Mudogo, V., Tshibangu, D.S.T., Ngombe, K.N., Tshilanda, D.D., Baholy, R., 2014a. In vitro antisickling and free radical scavenging activities of *Pentaclethra macrophylla* Benth. (Fabaceae). *Journal of Advancement in Medical and Life Sciences* VII2. DOI: 10.15297/JALS.VII2.03, <http://scienceq.org/Journals/JALS.php>.
13. Ngbolua, K.N., Bishola, T.T., Mpiana, P.T., Mudogo, V., Tshibangu, D.S.T., Ngombe, K.N., Ekutsu, E.G., Gbolo, Z.B., Kabena, N.O., 2014b. Ethno-pharmacological survey, in vitro antisickling and free radical scavenging activities of *Carapa procera* DC. stem bark (Meliaceae). *Nova Journal of Medical and Biological Sciences* 2(2): 01-14, <http://www.novaexplore.com>. PII: S2292793X1400008-2.
14. Ngbolua, K.N., Bishola, T.T., Mpiana, P.T., Mudogo, V., Tshibangu, D.S.T., Ngombe, K.N., Ekutsu, E.G., Tshilanda, D.D., Gbolo, Z.B., Mwanangombo, D.T., Fatiany, P.R., Baholy, R., 2014c. Ethno-botanical survey, in vitro antisickling and free radical scavenging activities of *Garcinia punctata* Oliv. (Clusiaceae). *Journal of Advanced Botany & Zoology* VII2. DOI: 10.15297/JABZ.VII2.04, <http://scienceq.org/Journals/JABZ.php>.
15. Ngbolua, K.N., Kambale Saa-Sita, D.D., Malekani, M.J., Kyungu Kasolene, J.C., Kasereka, K.O., Maloueki, U., Musuyu, M.D., Mpiana, Mudogo, V., 2014d. Phytochemical investigation and TLC screening for antioxidant activity of 24 plant species consumed by the Eastern Lowland Gorillas (*Gorilla beringei* ssp. *graueri*: Hominidae, Primates) endemic to Democratic Republic of the Congo. *Journal of Advancement in Medical and Life Sciences* VII3. DOI: 10.15297/JALS.VII3.02, <http://scienceq.org/Journals/JALS.php>.
16. Ngbolua, K.N., Mudogo, V., Mpiana, P.T., Malekani, M.J., Rafatro, H., Urverg, R.S., Takoy, L., Rakotoarimana, H., Tshibangu, D.S.T., 2013. Evaluation de l'activité anti-drépanocytaire et antipaludique de quelques taxons végétaux de la République démocratique du Congo et de Madagascar. *Ethnopharmacologia* 50: 19-24, <http://www.ethnopharmacologia.org>.
17. Nguenefack-Mbuyo, E.P., Dongmo, A.B., Nguenefack, T.B., Kamanyi, A., Kamtchouing, P., Dimo, T., 2012. Endothelium/Nitric Oxide Mediates the Vasorelaxant and Antihypertensive Effects of the Aqueous Extract from the Stem Bark of *Mammea africana* Sabine (Guttiferae). *Evidence-Based Complementary and Alternative Medicine*, Article ID 961741. DOI:10.1155/2012/961741.
18. Ntie-Kang, F., Likowo, L.L., Luc Meva'a, M.L., Nnange, E., Owono Owono, L.C., Megnassan, E., Judson, N.P., Wolfgang, S., Efang, M.N., 2013. Cameroonian medicinal plants: a bioactivity versus ethnobotanical survey and chemotaxonomic classification. *BMC Complementary and Alternative Medicine* 13:147.
19. Pagnier, J., Wajcman, H., Baudin, V., Labie, D., 1985. Genetic polymorphism of drepanocytosis. *Annals of Genetics* 28: 5-12.

20. Pousset, J.-L., 2004. Plantes médicinales d'Afrique: comment les reconnaître et les utiliser? Edisud: Aix-en-Provence. Recently Established Reserve in the Democratic Republic of Congo. Pan Africa News, 19(2): 17-19..
21. Tetsuya, S., Kasalevo, P., Bolaa, M.B., Lingomo, B., 2012. Iyondji Community Bonobo Reserve: A

Citation: Koto-te-Nyiwa Ngbolua *et al.* (2015). Great Apes Plant Foods As Valuable Alternative Of Traditional Medicine In Congo Basin: The Case Of Non-Human Primate Bonobos (*Pan paniscus*) Diet at Lomako Fauna Reserve, Democratic Republic of the Congo. J. of Advanced Botany and Zoology, V3I1. DOI: 10.15297/JABZ.V3I1.01.

Copyright: © 2015 Koto-te-Nyiwa Ngbolua. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.