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Research Article

Phytochemical Screening of Food Plants Eaten by Sympatric Apes (*Gorilla beringei graueri* and *Pan troglodytes schweinfurthii*) Inhabiting Kahuzi-Biega National Park, Democratic Republic of Congo) and their Potential Effect on Gastro Intestinal Parasites

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ABSTRACT
Animals have dietary strategies that aid in the suppression or control of disease and wounds. In Kahuzi-Biega National Park, only a few plant species have been observed regularly to be consumed by apes and constitute their basic staple food. Some plants have active constituents that may play an important role in diseases treatment. Phytochemical screening was conducted on 9 plant species most common in the diets of Kahuzi apes. The presence of important bioactive chemical components, including *saponins, terpenoids, steroids, alkaloids, flavonoids, phenols, quinons and glycosids*, well known for their role in disease treatment, were isolated. Bromatological analyses of selected fruits most preferred by both apes were also conducted and some fruits were found to be rich in, important nutritional components such as lipids, proteins and carbohydrates. Intestinal parasites of these apes were also investigated. A total of 19 different parasite species were identified fresh apes fecal samples collected in their home range. The prevalence rates of *Coccidies* were 94 and 93.4 % in Gorilla and chimpanzees fecal samples, respectively in the most prevalent parasites in both sympatric ape species. Protozoa and Nematoda parasite groups were the most observed. This study suggests that fruits preferentially eaten by gorillas and chimpanzees inhabiting Kahuzi-Biega National park contain essential chemical constituents that may be effective in parasite disease control maintenance and nutrition purpose.

Key Words: Kahuzi apes, diet, gastrointestinal parasites, plant diet.

INTRODUCTION

The evidence of self-medication of apes in many forests was reported by many studies during the last decades[1-8]. The basic premise of the funding is that animals utilize plant secondary compounds or other non-nutritional substances to medicate themselves. Numbers of the plant species observed by Baker[9] to be used are known to contain secondary compounds having insecticidal, antiseptic, fungistatic, anti-inflammatory, anesthetic, and general dermatological activities. The diversity of plant taxa selected by apes for possible self-medication is likely to be influenced by the ecological and geographical diversity of the habitats represented, yet a pattern emerges from the species known to be selected by apes across Africa for bitter pith chewing and leaf swallowing[6].

Animals use (intuitively and instinctively) plants, not only for their nutrition, but also for healing some diseases[10,11]. They have developed strategies of self-medication using a variety of plant species with the potential for suppressing or controlling a variety of diseases, including parasites and pathogens[12]. Most studies reported cases of self-medication on primates distinguish two types of behaviors wild animals use to fight against parasites, including rubbing plants on the wounded part and consuming leaves. The latter method is subject to detailed observations[6,7]. Behavioral, ecological and pharmacological studies have also shown the great ape diet to contain a variety of plant parts of no apparent nutritional significance that may be consumed because of their secondary compounds[13-16].

In Kahuzi-Biega where two African ape species (*Gorilla beringei graueri* and *Pan troglodytes schweinfurthii*) coexist, self-medication seems to be practiced by both species treating themselves with the leaves of *Baseia multifora* used by chewing the leaves and then licking wounds received either accidently or during a fight (personal observation). The plant is likely to have useful

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active constituents for healing wounds. Basabose[17] reported that in Kahuzi, both gorilla and chimpanzees swallowed leaves of two species of *Commelinaceae* family (*Commelina cecilae and C. diffusa*) without chewing. Entire leaves of these plants are regularly found in their feces, so it seems that the apes deliberately swallowed them for non-nutritional benefit. This behavior has been proposed to control intestinal parasites[18]. Though further observation of leaf-swallowing in relation to intestinal parasites is needed in order to test the hypothesis of self-medication at Kahuzi, the regularity of this behavior at Kahuzi suggests that the apes may swallow the leaves for medical purposes, as reported in other populations[6]. A number of plants are regularly consumed by apes[17,19], among which some are used for both nutrition and potentially as medicine. Some of these plants contain chemical constituents well known plants for their effectiveness in treating diseases using the traditional African pharmacopeia[20,21]. This validates the scientific, socio-economic and ecological importance of these plants. From the scientific point of view, they can play an important role in medical research, in designing and producing medicine as well as providing a deeper understanding of disease etiology. On the ecological and socio-economic point of view, they are important to maintain apes survival in Kahuzi, where both gorilla and chimpanzee constitute an important resource of income through ecotourism. While feeding on these plants, apes contribute to their spreading and maintenance across their home range by seed dispersal mechanism.

Several parasites were found in the fecal samples of chimpanzee in Kibale National Park in Uganda and in Central Africa Republic such as the trematode *(Dicromoeba),* the *protozoa* (*Entamoeba, Endoliximax, Iodomoeba, Giardia, Escherichia coli Iodomoeba buschii, Chilomostixi sp, Tricomonas sp, Tronglodyetella abrassanti, Oesophagostomun sp, Strongyloide* sp and *Entamoeba chottonii)* and helmithes (*Strongyloides, Trichuris, Strongyllates, Ascaris)*[22,23,24].

We conducted phytochemical screening of a few plants among the most preferred in the ape diet in Kahuzi-Biega National Park[17,19] to identify different chemical components that they contain and their potential impact on gastrointestinal parasites. The presence of gastrointestinal parasites in apes was also assessed by examining their fresh feces under the microscope. Nutritional value of plant was also assessed by carrying out nutritional analysis of the fruits eaten.

Description of the area

The study area is located along the eastern border of Kahuzi-Biega National Park, Democratic Republic of Congo, at an altitude of 2,050–2,500m above sea level (Figure1). The vegetation of the area consists of bamboo (*Arundinaria alpina*) forest, primary forest, secondary forest, and *Cyperus latifolius* swamps. Detailed descriptions of the vegetation are given by Casimir[25] and Yumoto *et al.*[26]. The climate is characterized by a dry season (June–August) and a rainy season (September–May). Climatological data collected over the study period showed a mean annual rainfall of 1,586mm[17]. The mean

Fig.1. Fecal of Gorilla infested by parasites

monthly temperature was 20.11°C (mean maximum: 26.41°C; mean minimum: 13.21°C).

Observations of diet were made on semi-habituated gorilla group and a unit-group of chimpanzees, both apes ranging sympatrically in an area of about 80 Km^2. There are six other primate species in the study area: *Papio anubis, Colobus angolensis, Cercopithecus mitis,Cercopithecus hamlyni, Cercopithecus l'hoesti,* and *Galago demidovi.*

Equipment and methods

Phytochemical Screening of plants fed on by gorillas

Plants collection

Leaves, bark and fruit were collected from plant species regularly eaten by apes in the study area and were taken to the Biology Department Laboratory at the Lwiro Research Center in Natural Sciences for analysis. For each plant species, we also collected a specimen of the plant on which the samples were taken for further identification. Plant specimens were identified by T. Yumoto at the National Botanical Garden in Belgium[26] and at the herbarium of the Lwiro Research Centre in Natural Sciences, where vouchers of all the specimens are kept. Selection of plant used in this study was done based on previous studies on both ape diets conducted in the same area[17,19].

Extraction

Preparation of the extracts

The collected samples (leave, bark, and fruit) were dried in the open air, then pounded in a mortar and reduced to soft powder after being sifted. To obtain aqueous and organic extracts, 30g of powder of each pounded sample was mixed with 250ml of unionized water and organic solvent respectively[27].

Aqueous extracts

30g powder of each sample was weighed by means of AND – HL 400 scale and put in an Erlenmeyer where 250ml of distilled water was added using a graded stalk. We stirred strongly so as to get a good mixture and then we settled it for 24 hours. Afterwards we filtered and got an extract with active constituents which were to be identified. The extract obtained allowed us to identify the presence or absence of different chemical compound groups.

The aqueous extracts were tested for the presence of *alkaloids, flavonoids carotenoids, tannoids, glycosides,*

saponins, steroids, terpenoids lipoids and quinons, following standard procedures[28,29].

Ethanol extract

Organic extracts were obtained by steeping 30g of powder of each plant sample in 250ml of 70% Ethanol. After 24 hours of steeping, the mixture was filtered. The product of the filtration was dried out by evaporation to remove the alcohol. A brown filtrate was obtained. The residue was then dissolved in distilled water.

Benzene extract

10g of each plant (powder from leaves) were weighed and steeped in 100 ml of benzene for 24 hours. After filtration, we obtained an extract we submitted to analyses. This extractive method allowed identifying the quinon group.

Evaluation of the presence of active constituents

The presence or absence of a given chemical constituent in the tested samples was confirmed according to the type of chemical reaction observed in presence of an appropriate reagent. When there was no active constituent in the analyzed extract (-) no change of coloration nor precipitate was observed, whereas when there is a formation of slight opacity, appearance of weak furtive coloration following by a weak precipitation, we concluded that the reaction was slightly positive (+). A turbidity or pure coloration also corresponded to positive reaction (++); and a remarkable precipitation, a flocculation or deep coloration marked a strongly positive reaction (+++) attesting a high presence. To decide on the presence level of an active constituent from a given plant, we took the mean of the different contents observed, according to the reagents used, by summing up the different contents and dividing them by the number of reagents used[27,30].

Nutritional analyses

In this part, we were interested in evaluating the quantity of nutritive substances (lipids, proteins and carbohydrates) contained in fruits most frequently eaten by apes in Kahuzi Biega National Park.

Search for lipids

Detection of lipids was based on the mixture of solutions of toluol ($C_6H_5CH_3$) and dry matter. We weighed 3g of dry matter of fruit from a given species and steeped it in 30ml of toluol for 24 hours. By filtering the mixture, we obtained an organic extract. We weighed the Erlenmeyer empty beforehand and then used it for extraction[31]. The extract prepared was introduced into the Erlenmeyer and then heat evaporated the solvent using a burner: a residue remained in the bottom after having cooled it down. The difference between the weight of the empty Erlenmeyer and that of the residue was the weight of lipid residue. To calculate the percentage of lipid contained in the residue, we proceeded with the formula below[32].

$$\% L = \frac{Px100}{PE}$$

Where % L = Percentage of lipids

P = Weight of lipid residue

PE = Weight of the sample used.

Search for carbohydrates

Identification of carbohydrates was obtained by mixing the extract of the plants to be analyzed with chloroform ($CHCl_3$) and methanol (CH_3OH) in the proportion of 1/3. We weighed 3 g of the dry matter from the plant and mixed it with 4ml of chloroform and 12ml of methanol. We settled the mixture for 24 hours before filtering it. An Erlenmeyer was weighed so as to know its weight before adding the plant extract to be analyzed. We evaporated the product in the Erlenmeyer and then cooled down the residue. The residue obtained was the mixture of proteins and carbohydrates. The weight of carbohydrates was obtained by calculating the difference between the weight of the residue and that of proteins, which we determined by the Kdjedah method[32].

Search for proteins

We obtain the quantity of protein contained in the sample residue by proportioning nitrogen. The transformation is done by multiplying the contents of nitrogen by 6.25 (a factor of conversion of nitrogen into protein). The proportioning of nitrogen is done by the Kdjedah method. We introduced 3g of powder mixed with 0.5g of $CuSO_4$; 5g of K2SO4 and 20ml of concentrated H_2SO_4, into a balloon flask with a 250ml neck. We lengthened the neck of the balloon flask with a funnel which served as a condenser of H_2SO_4 vapor. After heated the liquid at boiling point for 3 hours, we completely cooled the mixture and added some distilled water before decanting it all into a 100 ml flask. We then cooled the obtained solution before adding in distilled water up to the 100 ml level, by stirring. We put the contents into a PARNAS and WAGNER distillation apparatus. We then added 2 drops of phenolphthalein and of NaOH at 30%, up to alkalinization. Swept along the current of water vapor, the NH_3 released was collected in a gauge containing 20 ml of HCl 0.01N and 2 drops of methylated spirit. We then heat titrated acid NaOH 3N until reaching equivalence point, and the volume was read. After all these steps were complete, calculations were made using the following formula32.

$$\% N = \frac{N.V.0.0014V}{Vp.100} X\ Pe$$

Where

% N = Percentage of nitrogen

N = Normality of NaOH (here 3N)

V = Volume of NaOH used (titrated) for getting the equivalence point.

Vt = total volume of the mixture of the solution (here 100 ml)

Vp = Volume considered for proportioning (10ml of the solution)

Pe = Weight of the sample

Thus,

$$\% PB = \% Nc\ X\ 6.25$$

Where

% PB = Percentage in protein at raw state

% Nc = Calculated percentage of nitrogen

6.25 = factor of conversion of protein nitrogen

Search for carbohydrates

Table 1. List of plants studied and the part analyzed

Plants	Family	Part analyzed
Aneilema aequinoctiale	Commelinaceae	Leaves
Syzygium guineense	Myrtaceae	Leaves and fruit
Viscum congolense	Loranthaceae	Leaves and fruit
Myriathus holstii	Moraceae	Leaves and fruit
Chrysophylum africanum	Sapotaceae	Leaves
Ficus natalensis	Moraceae	Bark and fruit
Allophylus africanus	Sapindaceae	Leaves and fruit
Ekebergia capensis	Meliaceae	Leaves
Tabernamontana johnstonii	Apocynaceae	Leaves and fruit

After having found the percentages of lipids and proteins contained in the different analysed fruits, the percentage of carbohydrates and other compounds (water, fiber…), were found by proceeding as follows:

%GL =%100 - (% L + % PB)

Where

% GL = percentage of carbohydrate and other compounds

% PB = Percentage in protein at raw state

% L = percentage of lipids

Parasitological survey of apes

Apart from young apes, sleeping beside their mothers, all weaned apes build new nests every evening at new places and defecated in or near them before leaving in the morning. To determine the parasites of free-ranging apes, samples of fresh fecal matter were collected from a family of gorillas *(Gorilla beringei graueri)* and a community of chimpanzees *(Pan troglodytes schweinfurthii)* monitored since 1991[17,33]. A total of 100 fresh fecal samples of gorillas was collected over a period of 6 months (December 2004, January, April, May and June 2005) and 91 fresh fecal samples of chimpanzees were also collected over a period of 4 months (November, December 2004, May and June 2005).

In the field, fecal samples for the two species was packs in plastic vials with 10% neutral buffered formalin and kept in a cooler with frozen gel before analyzed at the Laboratory of Primatology of Centre de Recherche en Sciences Naturelles of Lwiro, DRCongo For each sample, we processed 2 g of wet feces using flotation with a sodium chloride solution (NaCl sp. gr. 1.20)[34,35]. We systematically scanned one slide per sample for parasite eggs or cysts.We identified parasites to genus level using parasite egg size, color, and morphology[36]. Further, we opportunistically collected live adult helminths from the fresh fecal samples and preserved them in 70% alcohol for later taxonomic identification to the genus and species level. The gorilla samples belong to Ganywamulume family with 13 members, whereas chimpanzee samples were collected from the Kaboko group, estimated to have 32 members. From the nest of each individual, we collected a small quantity of fresh feces that we put in a designated glass tube. Only fresh feces were collected (1 day old). In each tube we added some drops of physiological water to preserve freshness of the samples which were carried to the laboratory immediately for parasite examination. Adult worms found in fresh dung were kept in a tube containing alcohol at 60% for better preservation, before identification was made.

Parasite prevalence was calculated using the following formula:

$$\text{Prevalence} = \frac{\text{Number of positive samples}}{\text{Total number of examined samples}}$$

RESULTS AND DISCUSSION

Phytochemical Screening

The phytochemical screening of 9 plants studied revealed the presence of important chemical groups as presented in Table 2. Leaves of *Aneilema aequinoctiale, Syzygium guineense, Viscum congolense, Chrysophalum africanum, Allophylus africanus, Ekebergia capensis* and *Tabernamontana johnstonii* and the bark of *Myriathus holstii* and *Ficus natalensis* were analyzed according to the preference diet of sympatric apes. Alkaloids were present in five plant species (*Viscum congolense*; *Myrianthus holsthii*; *Chrysophylum africanum*, *Allophylus africanus* and *Tabernamontana johnstonii*). Alkaloids play a protective role for plants against insects and other herbivores[37]. They are noted for their narcotic, stupefying, anesthetic, antimicrobial, and hypertensive properties. Plants rich in alkaloids usually have a bitter taste and are endowed with extraordinary pharmacodynamic properties. Some alkaloids have an affect on muscles, blood vessels, and the respiratory system, digestive system (Emetine against dysentery) while others have an anti-venom or poisoning prophylactic properties[38].

Terpenes were identified in three species (*Myrianthus holsthii, Chrysophylum africanum* and *Allophylus africanus*). They are excellent purgative agents and have antiseptic, bactericidal, adhesive and anti-helmintic properties[39]. Others have anti-inflammation properties[40]. Four plants (*Viscum Congolense*; *Myrianthus Holsthii*, *Fiscus natalensis* and *Allophylus africanus*) were identified to be rich in steroids. Steroids have anti-rickety and anti-inflammatory properties. They also play an important role in the production of sexual hormones (androgen and estrogen), and in metabolism control of glucose, proteins and lipids.

As for tannins, they are predominantly present in two plants studied (*Allophyles africanus* and *Ekebergia capensis*) and almost absent in the other plant species. Tannins have an astringent effect: they are used to stop diarrhea and leucorrhoea. They are great anti-hemorrhagic and antiseptic agents. Plants with tannins are used for treating open wounds, because they allow wounds to heal quickly. Plants with tannins are used as anti-venin and anti-hemorrhoid agents[38].

Saponins were identified in great amounts in only one plant (*Viscum congolensis*). They are hemolytic, toxic for

Table 2: Phytochemical screening of 9 plant species among the most preferred eaten by apes of Kahuzi Biega National Park

Content	*Aneilema aequinoctiale*	*Syzygium guineense*	*Viscum congolense*	*Myriathus holstii*	*Chrysoph. Africanum*	*Ficus natalensis*	*Allophylus africanus*	*Ekebergia capensis*	*Tabernamontana johnstonii*
Alkaloids	++	+	+++	+++	+++	++	+++	++	+++
Terpenoids	-	++	+	+++	+++	-	+++	++	+
Stéroids	+	+	+++	+++	+	+++	+++	+	+
Saponins	+	+	+++	+	-	+	+	-	++
Flavonoides	++	+++	+++	+++	++	+++	+++	+++	++
Phenols	+++	+++	+++	+++	+++	+++	+++	+++	
Quinones	-	+++	-	+	+	-	+++	+++	
Glycosides	-	+++	+++	+++	-	++	++	+++	+++
Tanoides	-	-	-	-	-	-	+++	+++	+

-: absent ; + : slightly present; ++ : present; +++ : highly or strongly present.

Table 3: Results of bromatological analyses of apes most preferred fruits

Plant	% of lipids	% of proteins	% of carbohydrates and others related compounds
M. holstii	2,2,	4,75	93,05
S. guineense	1,5	7,81	90,69
F. natalensis	3,9	1,68	94,42
A. africanus	3,5	4,76	91,74
T. johnstonii	6,6	3,43	89,97

animals especially fish to which they cause paralysis of branchia. Further more, they have insecticidal, anti-helmintic, diuretic properties and are used as a disinfectant.

Flavonoids were identified in six plant species *(Syzygium guineense, Viscum congolense, Myrianthus holsthii, Allophylus africanus* and *Ekebergia capensis)* They provide vitamins, antiseptic, antispasmodic and produce estrogens. They are also diuretics and anti oxidants.

Phenols, which are powerful antibiotics, were present in considerable quantity, in almost all plant species analyzed, except in *Tabernamontana johnstonii* where they were totally absent.

Quinons were identified in large quantities in three plant species *(Syzygium guineense, Allophylus africanus* and *Ekebergia capensis)*. They are powerful antimicrobials, purgative, fungicidal, antihelmintic and provide vitamin K.

Glycosides were found in five plants *(Syzygium guineense; viscum congolense; Myrianthus, holsthii, Ekebergia capensis* and *Tabernamotana johnstonii).* They are energetic substances and provide the greatest part of calories that the body needs for it's functioning.

As the results of the analyses highlight, four species of plants *(Viscum congolense, Myrianthus holsthi, Allophylus africanus,* and *Ekebergia capensis)* seemed to be the most important as far as the presence of important quantities in chemical substances are concerned.

Bromatological analyses

Bromatological analyses of fruits of some plants eating by the apes in Kahuzi Biega National Park are present in table 3.

Tabernamatona johnstonii fruit is richer in lipids than other plants, with a percentage of 6.6%, while fruit from *Syzygium guineense* is richer in protein (7.81%) (Table 2). As expected from fruit, all the analyzed fruits are rich in carbohydrates and other related compounds with over of 90 % found in all five species. Most of the fruits can provide necessary energy to apes while also reinforcing production of antibodies necessary for fighting toxins produced by a diverse variety of microbes present in the habitat.

Coproscopical analysis

A total of 19 different parasites were identified in ape fecal samples collected in the Kahuzi Biega National Park; including 6 *protozoa*, 9 *nematodes*, 2 trematodes, and 2 cestodes (Table 4). Four kinds of protozoa *(Coccidies, Balatiduim, Giardia, Entamoeba and cysts of amoeba)* nine kinds of nematoda *(Hoemonchus, Strongyloides, Ascaris, Trichostrongylus, Cooperia, Trichuris, Oxyure, Chabertia* and *Oestratagia,* two kinds of trematoda *(Fasciola and Schistosoma)* and two kinds *of* cestodes *(Monieza and Teania)* were identified in the fecal matter of gorillas. *F*our protozoa *(Coccidie, Trichomonance, Entamoeba* and *Giardia),* eight kinds of nematoda *(Strogyloids, Hoemonchus, Ascaris, Trichuris, Oxyure, Oestertagia, trichostrongylus, Cooperia)* a kind of trematoda *(Fasciola)* and two kinds of cestodes *(Monieza and Taenia)* were identified in fecal matter of chimpanzees.

For the two apes *Coccidie* was the most prevalent parasite. *Coccidie* is a *sporozoa* habitually a parasite of epithelial cells in animals, but rarely in humans where they would be accidental parasite infections, even though chances for infestation multiplies high[41]. *Coccidie* has a weak pathogenic role in human beings, but in some animals (birds, rabbits) it decimates flocks and herds. As apes are physiologically close to humans, it is possible for *Coccidies* to be less virulent to gorillas and chimpanzees. The presence of *Entemoeba histolistica* and *Balatidium coli* should interest us and an epidemiological follow up of the parasites proves to be indispensable, in Kahuzi

Table 4: Gastro-intestinal parasites identified in apes at Kahuzi.

Species of parasites	% parasite in Gorilla (N=100)	% parasites in Chimpanzees (N= 91)
Protozoa		
Coccidies	94	93,41
Entamoeba coli	3	2,19
Entamoeba histolistica	2	3,9
Trichomonas	-	5,49
Balatidium coli	2	-
Giardia	2	2,19
Nématoda		
Hoemonchus	33	21,78
Strogyloides sp	26	36,28
Ascaris sp	11	10,98
Chabertia sp	3	-
Trichuris trichiura	8	6,59
Ostertagia sp	1	3.29
Trichostrogylus sp	10	6.59
Coperia sp	-	1.09
Oxyres	7	5.49
Trematoda		
Fasciola sp	16	3.23
Schistosoma sp	38	-
Cestodes		
Monieza sp	20	18,68
Taenia sp	11	13,19

Biega National Park, to avoid an eventual proliferation of the pathogenic agents in the population of apes of the park. Meanwhile, gorillas seem to be more infested with *Trematodea* than chimpanzees. The rate might be influenced by the fact that gorillas, more than chimpanzees, frequently visit humid and marshy areas, favorite sites for that kind of parasite. It is possible that gorillas get infected by the parasites of the kind of *Schistosoma* while visiting marshes in search of *Cyperus spp*, very often during the season when fruits are rare in the habitat.

CONCLUSION AND RECOMMANDATION

In this short report on a phytochemical analysis of plants eaten by apes in Kahuzi Biega National Park, our study consisted of determining active constituents contained in 9 key plants whose fruits are among the most frequently consumed, namely *Aneilema aequinoctiale*, *Syzygium guineense*, *Viscum congolense*, *Myrianthus holstii*, *Chrysosphylum africanum*, *Ficus natalensis*, *Allophylus africanus*, *Ekerbergia capensis* and *Tabernamotana johnstonii*. We also carried out nutritional analysis of these fruits to provide information on their nutritious value and their potential importance in the ape diet.

Our tests were carried out on different extracts, including aqueous, ethanol and benzene extracts. The obtained results suggest that these plants contain active constituents which wild apes could potential use for their health and nutrition. Also, the apes are infested with several parasites that might sometimes induce ill health, which symptoms might be mitigated through the consumption of some of these plant consitutents.

We cannot pretend to have approached all the aspects of the problem area of chemical substances contained in the plants analyzed. More detailed analyses should deal with extraction of different active constituents contained in the plants in order to evaluate their therapeutic role in different species of parasites infecting wild animals in the park. More detailed nutritional studies on plants eaten by gorillas and chimpanzees are needed in order to elucidate their specific role in the diet of apes at Kahuzi Biega National Park.

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