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RESEARCH ARTICLE

POTENTIAL NUTRITION OF LEAVES AND FRUITS OF *DIALIUM ANGOLENSE* WELW. EX OLIV. (FABACEAE) AN ANTIMALARIAL PLANT FROM THE EASTERN OF DR CONGO

Bashige Chiribagula Valentin[1,2], Bakari Amuri Salvius[1], Okusa Ndjolo Philippe[2], Kahumba Byanga Joh[1] and Lumbu Simbi Jean-Baptiste[3]

1. Laboratoire de Pharmacognosie - Faculté des Sciences Pharmaceutiques - Université de Lubumbashi- 27, av Kato, Commune Kampemba, Lubumbashi- DR Congo.
2. Service de Chimie thérapeutique et analyse des substances médicamenteuses-Faculté de Sciences Pharmaceutiques-Université de Lubumbashi-27, av Kato, Commune Kampemba, Lubumbashi-DR Congo.
3. Laboratoire de Chimie Organique - Faculté des Sciences Université de Lubumbashi- 2 av de la Maternité, Commune de Lubumbashi - DR Congo.

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Abstract

Dialium angolense were investigated to assess to the nutritive potentiality of his leaves and fruits and their implication in curative management of malaria using Standard analytical methods. The analysis showed that the carbohydrates, proteins, lipids, macro, micronutrients, and energy in fruits were greater than leaves. These two organs have been revealed as potential sources of Na (≥71.1 ± 0.1 mg / 100 g), K (≥2.6 ± 0,3 mg / 100 g), Mg(≥45.2 ± 0.1 mg / 100 g), Fe (≥30.1 ± 0.1 mg / 100 g), Cu (≥2.0 ± 0.3 mg / 100 g), Zn (≥8.4 ± 0.2 mg / 100 g), Mn (≥0.1 ± 0.04 mg / 100 g), vitamins B1 (≥2.80 ± 0.13 mg / 100 g), B9 (≥0.20 ± 0.02 mg / 100 g) and E (≥6.40 ± 0.10 mg / 100 g) as well as flavonoids (≥ 49.51 ± 0.41 mg / 100 g).This nutritional potential hereby highlighted justifies why *D. angolense* can be used as food source and a supplementary nutriment in the management of malaria. This study suggests more extensive integration of D. angolense to reduce deficiency nutrients for the population at risk, especially when they face malaria disease.

Introduction:-

There are several benefits to the regular consumption of fruits and vegetables in the prevention of many disease (Biswas et al., 2019; Dias, 2019). In the context of developing countries like DR Congo, nutritional needs are mainly covered by the consumption of local products which are mainly fruits and vegetables (Amao, 2018; Bvenura & Sivakumar, 2017). These needs are more important in a pathological state thus requiring the association of medicinal products with a nutritional supplement (Rosenstock et al., 2019). This situation, is particularly observed during malaria disease to which the entire population of Sub-Saharan Africa is exposed, particularly the DR Congo (World Health Organization, 2019) and whose occurrence causes decreases in nutrients such as Na, K (Ndako et al., 2020),Ca, Mg (Rani et al., 2015), P (Suen et al., 2020), responsible for the worsening of the clinical status of patients. Unfortunately, with such a low review, almost the entire population is unable to cover both the need for antimalarial and adequate food. Fortunately, with food, ethnobotanical knowledge seems likely to cover these two imperatives (Birot, 2019). During this study we wanted to determine the potential nutritional of the fruits and leaves

Corresponding Author:- Bashige Chiribagula Valentin
Address**:-** Laboratoire de Pharmacognosie - Faculté des Sciences Pharmaceutiques - Université de Lubumbashi- 27, av Kato, Commune Kampemba, Lubumbashi- DR Congo.

of *Dialium angolense*, a native plant of tropical Africa, used in traditional Congolese medicine in the curative management of malaria and whose two organs are consumed by pygmies and bonobos (Ayingweu, 2014). Knowledge of this potential could help and further the understanding of the nutritional implication of those fruits and leaves in the management of malaria.

Dialium angolense Welw. ex Oliv. (Fabaceae)[synonym *Dialium evrardii* Steyaert] belongs to the Family Fabaceae, subfamily Dialioideae and genus Dialium (LPWG, 2017). In DR Congo, several names are assigned to it according to the ethnicity, notably *kizimya* (shi), *mulandege* (swahili), *bindula* (fulero), *kabalala* (bemba) or *muputa mupia* (tabwa). Other names are more related to region where the plant is located. In Gabon, it is called *eyoum* and in Angola, *baboen* (Bondjengo et al., 2017; Meerts & Hasson, 2017). It is found in Angola, Congo-Brazzaville, DR Congo, Equatorial Guinea, Gabon, South of Central African Republic, Zambia, and Zimbabwe (Bondjengo et al., 2017; Meunier, 2015).

Material and Methods:-

Plant material:

Figure 1:- Dialium angolense leaves and fruits collected in Bagira.

Leaves and fruits of *Dialium angolense* were collected in Bagira (2 ° 28’12.9’’S; 28 ° 49’18’’E; 2,883.1 m) in Bukavu city (RD Congo) in July 2015. The plant was identified and located at Lwiro herbarium (IL1087) and another specimen was deposited at Meise herbarium (BR0000018879285). After drying at room temperature, the sample was ground (Electric stainless-steel mill: Plymix PX-MFC 90 D, Belgium) and 350 g of powder have been macerated in 1 L of methanol (67-56-1 Sigma aldrich, Belgium) for 72 hours in a room temperature (25 °C) then filtered (filter paper: 172.000002.05 Whatman, USA) and concentrated (Büchi R-210, Switzerland) at 180 mbar and 40 °C.

Determination of Proximate Composition:

The air-dried samples were analyzed for proximate composition, dry matter (MS), ash (CT), crude fat (MG), crude fiber (FB), and crude protein contents (PT), total carbohydrate (ST), using the methods of Association of Official Analytical Chemists (AOAC, 2004). The dry matter content was determined by drying a known weight of the homogenized sample at 105 ^oC in an oven, until a constant weight was reached. For the total ash determination, the samples were weighed and converted to dry ash in a muffle furnace at 550 ^oC. The fat content was obtained by extraction with petroleum either using a Soxhlet apparatus. Kjeldahl method was used for crude protein determination while the total carbohydrate was estimated by phenol-sulfuric acid method (Masuko et al., 2005).The gross energy content (kcal/100 g) was calculated multiplying the percentages of the crude protein, crude fat, and carbohydrate contents by 4.0, 9.0 and 4.0, respectively (Adinortey et al., 2012).

Minerals determination:
Mineral analysis was performed following the procedure describe by previously (Dos Santos et al., 2016). Briefly, 500 mg were incinerated for 24h at 550 °C (Muffle Furnace mLs1200, Thermo Scientific, Madrid, Spain), weighed and desilicated with 3 mL of 40% HCl (Sigma– Aldrich, Saint-Quentin Fallavier, France) and 1 mL 70% HNO_3(Sigma– Aldrich, Saint Louis, USA). The obtained solution was then evaporated at 90 °C to dryness. The residue was mixed with 50 mL distilled water followed by filtration. Detection of Sodium, Potassium, Calcium, Magnesium, Phosphorus, Copper, Zinc, and Iron, Manganese, Cadmium, Chrome, Nickel, Vanadium were realized using inductive coupled plasma atomic emission spectrometry (ICP-AES, Varian Vista) with coupled charge device detector (Agilent France, Massy). All the standards were obtained from Fisons Scientific Equipment (Loughborough, England). Quantification of element concentrations was done using specific calibration of 5 points for each element in the range 0–1000 mg/L. The limits of quantification (LOQ) related to samples were 0.0500 mg/ 100 g for Ca, K, Na, Mg P and 0.0010 mg/100 g for Fe, Zn, Mn, Cu, Cr, Ni, V.

Determination of Vitamins Contents:
Vitamin cotenant were determined by spectrophotometric method: Vitamin A was performed by β-carotene assay (Aremu & Nweze, 2017) using a factor 1μg of β-carotene = 0.167 μg of ERE (retinol equivalent), Thiamine (B1) by 7-chloro-4-nitrobenzoxadiazole (NBD-Cl) assay (Ahmed Elbashir, 2016), Pyridoxine (B6) by diazotized p-nitroaniline assay (Kadir, 2010), folic acid (B9) by 1, 2-Naphthoquine-4-Sulphonate (NQS) assay (Al-Araji et al., 2017), Ascorbic Acid (C), by2,6-dichlorophenolindophenol (DCPIP) assay (Alagendran et al., 2019), Tocopherol (E), by 2, 2′-dipyridyl reagent assay (Devi et al., 2016).

Total acidity, Malic and Citric Acid determination:
Total acidity was performed by volumetric method by titration of 1 mL (0,1 %) of sample by NaOH 0,1N. Malic and Citric acid were carried using the Acid malic kit (K-LMALAF-58A, MEGAZYME, USA) and Citrate Assay Kit (ab83396, UK) (Charnock & McCleary, 2005).

Determination of total phenol, flavonoidand tanin content:
Total phenolic contents of each sample were measured by the Folin–Ciocalteu method (Fu et al., 2011). Total phenolic content was expressed as milligrams gallic acid equivalents per 100 gram of dry plant extract (mg GAE/100g DE) through the calibration curve of gallic acid ($y = 0,012x + 0,0023$, $r^2 = 0,997$) that its linearity range was from 1.0–200.0 mg. L^{-1}.

Total flavonoid content was determined using aluminum trichloride assay (Koolen et al., 2013). Total flavonoid content was expressed as milligrams quercetin equivalents per gram of dry plant extract (mg QE/g DE) through the calibration curve of quercetin, that its linearity range was from 0.1 to 150 mg/mL ($y = 0,008\ x + 0,0012$, $r^2 = 0,998$).

Total tanins were determined by vanillin method (De Britto Policarpi et al., 2018). Total tanin content was expressed as milligrams gallic acid equivalents per 100 gram of dry plant extract (mg GAE/100g DE) through the calibration curve of gallic acid ($y = 0,006\ x + 0,0011$, $r^2 = 0,997$) that its linearity range was from 1.0–100.0 mg. L^{-1}.

Statistical analysis:
All the tests were carried out in triplicate and the results are expressed as mean ± Standard deviation. In bivariate analysis, the T Student Test was used and in multivariate analysis, the one-way ANOVA test. The significance level of the test was set at 95%.

Results:-

Organic elements:
In Overall, organic matter is more abundant in fruit than in leaves ($p < 0.01$) except in fat. In leaves, the amounts of these organic materials vary between 3,02 ± 0,40mg / 100g (FB) and 73.21 ± 0.42 mg / 100g (ST). The reducing sugars (18.06 ± 0.11 mg / 100g) and the total proteins (17.5 ± 0.11 mg / 100 g) are in the same proportions. This similarity is not observed in fruits where SR is abundant than PT ($p < 0.001$). The organic acids (3.12 ± 0.21 mg / 100g) and fatty acids (2.04 ± 0.42 mg / 100 g) are in the same proportions (Table 1).

Table 1: Energetic organic matter of leaves and fruits of Dialium angolense

Organ	Unit	Leaves	Fruits
Crude fiber (FB)	mg/100g	2,02 ± 0,40[a]	5,40 ± 0,10
Fat (MG)	mg/100g	5,04 ± 0,43[a]	2,04 ± 0,42
Total protein (PT)	mg/100g	17,5 ± 0,11[a]	21,20 ± 0,41
Reducing sugars (SR)	mg/100g	18,06 ± 0,11[a]	32,06 ± 0,10
Carbonhydtate (ST)	mg/100g	73,21 ± 0,42[a]	121,01 ± 0,43
Energetic value	Kcal	42,6 ± 0,2	61,22 ± 0,2
Results expressed as mean ± standard deviation; n = 3; 95% confidence interval; analysis of variances: a if p <0.01; b if p <0.001; c if p <0.0001; Carbohydrates: 4 kcal / g; Polyol: 2.4 kcal / g; proteins: 4 kcal / g; lipids: 9 kcal / g; Ac. Organic: 3 kcal / g; dietary fiber: 2 kcal / g according to the standard: ECEC0925387A.			

Macro and micro-elements:

The *Dialium angolense* leaves contains macro-elements whose values vary between 2.6 ± 0.3 mg / 100 g (K) and 71.1 ± 0.1 mg / 100g (Na). Its micro-elements vary between 0.1 ± 0.4 mg / 100g (Mn) and 30.1 ± 0.1 mg / 100g (Fe). For the macro-elements, fruits are richer than leaves (p <0.00001) except potassium for which the contents are in the same proportions. The same is true for micro-elements for which the contents are higher in the fruit than the leaves (p <0.00001) except for the iron concentrations for which the situation is reversed (p <0.001).The concentration of metals is generally the same between the leaves and the fruits.One hundred grams of the leaves or fruits of *Dialium angolense* can cover the daily requirements of K, Mg, Fe (leaves), Cu, Zn, Mn (fruits), Ni, V in an adult weighing 70 kg (Table 2).

Table 2:- Mineral elements and some metals in leaves and fruits in *Dialium angolense*

	AJR (mg)	Leaves	Fruits
Macro-elements			
Na	2500	71,1 ± 0,1[d]	90,12 ± 0,1
Ca	800	16,3 ± 0,2[d]	32,58 ± 0,1
P	700	10,1 ± 0,2[d]	90,1 ± 0,1
K	2	2,6 ± 0,3[c]	4,81 ± 0,2
Mg	375	45,2 ± 0,1[d]	97,45 ± 0,2
Micro-elements			
Fe	14	30,1 ± 0,1[d]	4,47 ± 0,2
Cu	1	2,0 ± 0,3[c]	4,58 ± 0,3
Zn	10	8,4 ± 0,2[d]	17,67 ± 0,1
Mn	2	0,1 ± 0,02[d]	10,35 ± 0,04
Cd		0,001 ± 0,0001	0,001 ± 0,0001
Cr	0,03-0,1	0,002 ± 0,001[b]	0,0026 ± 0,0002
Ni	0,001	0,0012± 0,0001	0,0015 ± 0,0001
V	0,1	0,5± 0,01[c]	1,32 ± 0,09
AJR: daily intake in an individual of 70 kg, Results expressed as Average ± SD, n = 3, comparison between leaves and fruits by T test with a if p <0.01, b if p <0.01, c if p <0.01 , d if p <0.01.			

Vitamines:

In *D. angolense*, vitamins vary between 0.20 ± 0.02 mg / 100g (B9) and 17.20 ± 0.10 mg / 100g (vitamin C) in the leaves and from 0.61 ± 0.03 mg / 100 g (B9) at 24.10 ± 0.31 (vitamin C) in fruits. Overall fruits contain higher amounts of vitamins than leaves (p <0.01). Both, the leaves and the fruit, 100 g can cover the daily needs in humans of vitamins A, B1, B6 and B9. Fruits can also cover daily vitamin E requirements; for vitamin C requirements, 5 times more leaves and three times more fruit would be required (Table 3).

Table 3:- Vitamins in the leaves and fruits of *Dialium angolense.*

Vitamins	BJ	DMJ	Leaves	Fruits
	mg/70 kg		mg/100g de MS	
A	0,8	4,68	0,91 ± 0,03d	2,30 ± 0,21

B1	1,4	100	2,80 ± 0,13d	5,21 ± 0,32
B6	2	98	1,80 ± 0,11d	4,12 ± 0,31
B9	0,2	0,6	0,20 ± 0,02d	0,61 ± 0,03
C	80	1900	17,20 ± 0,10d	24,10 ± 0,31
E	10	100	6,40 ± 0,10d	12,92 ± 0,30
BJ: daily requirements; DMJ: maximum daily dose; MS: dry matter, Results expressed as Average ± SD, n = 3, comparison between leaves and fruits by T test with a if p <0.01, b if p <0.001, c if p <0.0001 , d if p <0.00001.				

Organic acids and polyphenols:

In *Dialium angolense* organic acids are in the same proportions in the leaves as in the fruits and vary between 0.22 ± 0.11 mg and 0.73 ± 0.11 mg per 100g of dry matter. Total polyphenols, total flavonoids and total tannins are more abundant in fruits than in leaves (p <0.00001) and vary between 13.30 ± 0.11 mg EAG and 161.21 ± 0.12 mg EQC per 100 g of material dried (Table 4).

Table 4:- Organic acids and polyphenols in the leaves and fruits of *Dialium angolense.*

	Leaves	Fruits
Citric acid (mg/100g)	0,22 ± 0,11	0,41 ± 0,12
Malic acid (mg/100g)	0,53 ± 0,13	0,73 ± 0,11
Total Flavonoids (mg EQC/100g)	49,51 ± 0,41[d]	101,12 ± 0,41
Total polyphenols (mg EAG/100g)	121,21 ± 0,11[d]	161,21 ± 0,12
Total tannins (mg EAG/100g)	22,11 ± 0,12[d]	13,30 ± 0,11
Results expressed as Average ± SD, n = 3, comparison between leaves and fruits by T test with a if p <0.01, b if p <0.001, c if p <0.0001, d if p <0.00001.		

Dry matter, Ash, total acidity:

In *Dialium angolense* the total acidity is less than 0.4 molar. It has the same amplitude as much in the leaves as in the fruits. Total ash and dry matter have higher contents in the fruits than in the leaves (p <0.0001 and p <0.00001) where they oscillate respectively around 9.1% and 89.9% (Figure 5).

Table 5:- Moisture, ash and acidity in the leaves and fruits of *Dialium angolense.*

	Leaves	Fruits
Total titratable acidity (molarity)	0,3 ± 0,1	0,4 ± 0,1
Hydrochloric ash % (m/m)	0,6 ± 0,1	0,4 ± 0,1
Sulfuric ash % (m/m)	1,2 ± 0,4	1,6 ± 0,1
Total ash % (m/m)	9,1 ± 0,1[d]	15,5 ± 0,4
Dry matter % (m/m)	89,9 ± 0,4[c]	92,2 ± 0,1
Results expressed as mean ± standard deviation; n = 3; 95% confidence interval; analysis of variances: a if p <0.01; b if p <0.001; c if p <0.0001; IS: saponification index; MS: dry matter; AT: Titratable acid.		

Discussion:-

In this study, we provide the first data on the nutrients of *Dialium angolense,* a plant used in the eastern DR Congo in the management of malaria; at the same time, we present a path of reflection on the likely implication of its nutrients during the management of this parasitosis.

Nutritional values:

Dialium angolense leaves are richer in macronutrients (table 2) than many vegetables consumed in Sub-Saharan Africa. Indeed, they are rich in total sugar (73.21 ± 0.42 mg) than the leaves (51.95 mg) of *Ipomea batatas* (Ndibualonji et al., 2016; Sun et al., 2014); richer in total protein (17.5 ± 0.1 mg) than leaves (2.94 g) of *Moringa oleifera* (Gopalakrishnan et al., 2016; Khalid Abbas et al., 2018). Its energy value (42.6 ± 0.1 Kcal) is higher than leaves of *Gnetum africanum*:10.3 Kcal (Ali et al., 2011) or *Amaranthus spinosus*: 13.84 Kcal (Srivastava, 2017). Fruits of *Dialium angolense* are richer in protein (21.2 ± 0.4 mg / 100 g), in Fat (2.04 ± 0.4 mg / 100 g), in fiber (7.4 ± 0.1 mg / 100 g); in carbohydrates (121.1 ± 0.4 mg / 100 g); in energy value (61.22 kcal) than the fruits of *Dialium guineense* (Ayessou et al., 2014; Besong et al., 2016). Leaves of *D. angolense* (100g) are richer in mineral elements than some leaves' vegetables commonly used in the normal diet in Sub-Saharan Africa. This is particularly the case for Na (71.1 ± 0.1 mg) whose values are higher than those of the leaves in *Amaranthus spinosus* or Mg (45.2 ± 0.1

mg) whose the values are twenty times higher than those of *Hibiscus sabdarifa* (2 mg). Its iron values are higher than those of several other vegetables, *Ipomea batatas* (16 mg), *Hibiscus sabdarifa* (3.2 mg) and *Amaranthus spinosus* (12.28 mg). They are richer in Ca than *Ipomea batatas* (28 mg) and *Hibiscus sabdarifa* (2.4 mg); richer in Zn than *Moringa oleifera* (0.85 mg), *I. batatas* (0.08 mg) and *H. sabdarifa* (4.8 mg). The fruits of *D. angolense* are richer in Mg (97.45 ± 0.2 mg); Ca (325.58 ± 0.1 mg); P (90.1 ± 0.1 mg); K (8.81 ± 0.2 mg); Na (9020.12 ± 0.1 mg) and Fe (4.47 ± 0.2 mg) than *Dialium guineense* (Ayessou et al., 2014; Besong et al., 2016) and richer in Mg (10 mg), Ca (24 mg), Na (3 mg), Zn (0.088 mg), Cu (0.1 mg), Mn (0.04 mg) than *Carica papaya* (Chukwuka et al., 2013; Rajasekhar, 2017).

Other non-organic elements such as Cd, Cr, Ni and V are also found in leaves and fruits of *D. angolense* in trace amounts (Table 2). Cd has no known physiological role in humans (Godt et al., 2006) although it is accumulated by some fabaceae (Mahajan & Kaushal, 2018) but not by *D. angolense* as it has just been proven in the present study. Chromium (III)(Cr3 +) is an essential trace element, which is required for normal protein, fat, and carbohydrate metabolism (Swaroop et al., 2019) witch involved in the functioning of insulin (Cefalu & Hu, 2004) probably to improve the disease-associated disturbance of lipid profile and insulin resistance (Talab et al., 2020); but in its form Cr^{4+}or Cr^{6+},it is harmful and can cause ulcer, dermal irritations, allergies, effects on the respiratory tract, on the kidney and on the cardiovascular system, cariogenic, mutagenic, and teratogenic effects (DesMarias & Costa, 2019). In this study, we encountered it in the leaves of *Dialium angolense* in normal thresholds. It is suggested that as a trace, as in this study, Nickel is essential to the nitrogen cycle, to the production of prolactin, in the synthesis and activity of several enzymes including hydrogenases and could interfere in the oxidation of Iron (Al-fartusie & Mohssan, 2017). However, in most cases, it is more toxic than beneficial. It can cause lung cancer, pulmonary fibrosis, and even cerebral edema (Buxton et al., 2019; Genchi et al., 2020). Vanadium, in low doses, as in the doses encountered in the leaves of *Dialium angolense* during this study, is endowed with several therapeutic potentials in humans. It would prevent diabetes, has antiviral, antibacterial, and antiparasitic properties (Al-fartusie & Mohssan, 2017). At higher doses, harmful effects on the reproductive system and nephrotoxicity are reported, but natural antioxidants can play a role in reducing this toxicity (Zwolak, 2020).

About vitamins, the leaves of *D. angolense* are richer in Vit A (50.12 ± 0.1 mg / 100g) than the leaves of *Ipomea batatas*:15 mg / 100g (Ndibualonji et al., 2016; Sun et al., 2014), richer in vitamin B9 (100.11 ± 0.1 mg / 100g) than *Moringa oleifera* leaves with 10.8 mg / 100g (Khalid Abbas et al., 2018; Sun et al., 2014). In addition, the fruits of *D. angolense* are richer in vitamin C (17.02 ± 0.1 mg / 100 g) than *Dialium guineense*: 27.1 ± 0.13 mg / 100g (Ayessou et al., 2014; Besong et al., 2016).

In *Dialium guineense,* levels of total polyphenols of 579 ± 6.013 mg EGA / 100g and total flavonoids: 19.45 ± 3.18 mg EQ / 100 g has been reported (Ayessou et al., 2014) in leaves.Therefore, it has lower polyphenol values than *D. angolense.*Tannins are reported to be anti-nutritional factors (S. Muhammad et al., 2018). However, they have some properties such as the ability to induce a reduction in food bolus or an enzyme inhibition or the ability to promote protein digestibility. These properties may partly explain the presence of tannins in several food supplements, as reported (Sieniawska & Baj, 2017). Their presence in the leaves and fruits of *Dialium angolense* presages its food properties in this plant.

For ash (Table 5), the leaves of *Dialium angolense* have a value close to that of *Protalaria retusa* leaves : 7-8% (Alalade et al., 2019) but lower than that of *Dialium angolense* fruits (15.5 ± 0.4%). On the other hand, the ash content in *Dialium angolense* fruits is closer to that of *Cassia tora* fruits: 15,01± 0,03% (Muhammad et al., 2018b) but slightly higher than that of *Dialium guineense* fruits: 12.5% (Besong et al., 2016).

Nutrient intake of Dialium angolense leaves in the management of malaria

During *Plasmodium falciparum* infection, a disturbance in some nutrients affects the onset and course of the pathology. Indeed, while the intake of Vit A and Zn would prevent the occurrence of malaria (Darling et al., 2017), the intake of vitamins C, E and B9 would strengthen immunity and fight against malarial oxidative stress (Marwaha, 2016; Nwachukwu et al., 2016) while the intake of Cu and Mn would fight against asthenia (Van Der Kuy et al., 2002). Furthermore, not only that the fall in Na, K, Ca and Mg (Rani et al., 2015) and P (Ayoola et al., 2005), would be responsible for asthenia and dyspepsia but also the fall in vitamin A would favor the evolution of cerebral malaria (Benzecry et al., 2016). However, the intake of Na, K, P, Cu, Mn, Zn, vitamins A, B9, C and E, which can be obtained from the consumption of the leaves or fruits of *Dialium angolense*, can positively influence the outcome of a plasmodium infection provided that it has been shown during this study that the leaves and fruits of *Dialium* *angolense* constitute a source of supply of these aforementioned nutrients. This observation completes the interest of the use of natural plant extracts in the treatment of pathologies in place of pure molecules because the extracts contain, in addition to the active principle, other compounds intervening at several levels and likely to contribute to stabilize the condition of the patient.

Conclusion:-

This study has presented the first data on the nutritional and anti-nutritional components of *Dialium angolense* leaves and fruits while estimating their contribution in managing the malaria disease. This information indicates that this plant is likely to provide an important dietary supplement of carbohydrates and proteins in addition to some mineral elements and vitamins, such as Sodium, Potassium, Magnesium, Iron, Zinc, Phosphorus and vitamins: A, B6, B9, C, essential for nutritional benefits, particularly in the case of malaria. It may be considered from this study that, the integration of this plant resource, underutilized until then, into Congolese eating habits to combat food insecurity and strengthen nutritional management against malaria.

Conflicts of interest:

The authors declare that they have not known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Author contributions:

Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Software and Writing - original draft:Bashige Chiribagula valentin,Supervision: Bakari Amuri Salvius, Okusa Ndjolo Philippe, Writing - review & editing: Bakari Amuri Salvius, Okusa Ndjolo Philippe, Kahumba Byanga Joh; Lumbu Simbi Jean-Baptiste.

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