

## **Original Research Article**

### **Nutritional value of underutilized wild food plants leaves consumed in Northern Angola:**

#### ***Mondia whitei* and *Pyrenacantha klaineana***

#### **ABSTRACT**

**Background/Aims:** Traditional ~~edible food~~ plants are good sources of minerals, fibers, proteins and others useful phytochemicals for human nutrition and health. *Mondia whitei* and *Pyrenacantha klaineana* leaves are underutilized, wild edible plants considered as food and spice in habitants in some part of Northern Angola. The aim of this study was to investigate the nutritional value and mineral contents of *M. whitei* and *P. klaineana* leaves.

**Materials and Methods:** The leaves were harvested from a forest. The samples were analyzed for proximate and mineral contents using the standard methods. The results were analyzed statistically using mean and standard deviation.

**Results :** The proximate composition of *M. whitei* raw and cooked leaves showed that the samples had ranged of ash, 9.53 - 12.93%, fiber 13.16 - 15.11%, protein 16.48 - 19.24%, fat 2.95 - 4.94%, carbohydrates 51.59 - 54.48% and energy (kcal) 310.39 - 326.10 in 100 g respectively. The proximate composition of *P. klaineana* raw and cooked leaves showed that the samples had range of ash, 4.13 - 6.74%, fiber 40.45 - 43.56%, protein 14.93 - 18.80%, fat 1.13 - 3.78%, carbohydrates 29.74 - 36.58% and energy (kcal) 217.77 - 227.88 in 100 g respectively. The mineral contents of the *P. klaineana* raw leaves, K 2459.20 mg, Ca 2126.33 mg, P 239.90 mg, Se 77.86 mg are richer than *M. whitei* raw leaves, K 1149.83 mg, Ca 844.87 mg, P 175.89 mg, etc. Conversely, the leaves of *M. whitei* are richer in Se 87.80 mg and Cu 3.14 mg/ 100 g than the *P. klaineana* (Se 77.86 and Cu 2.84 mg/100 g).

**Conclusion :** The wild edible leaves are rich in nutritional value and mineral composition such as fiber, protein, Ca, Fe, K, Mn, Mg, P, Se etc. The consumption of *M. whitei* and *P. klaineana* leaves should be vulgarized to nutrition, diversity diet and food security.

**Keywords :** *Mondia whitei*, *Pyrenacantha klaineana*, Northern Angola, Nutritional value, wild plants

#### **1. Introduction**

The increase in world demography, the depletion of natural resources and the necessity to feed the population call for more food supplies, ~~and it~~ is imperious that local ~~deciders-leader~~ and scientists engage in exploring new food resources within their ecosystems. The humankind has evolved using plants abundantly, as natural and organic resources for several purposes, and animals do so, equally. Henceforth, research on new plants that have such potential for the purposes, such as food, fodder crops, as well as medicinal, energy and industrial uses should be undertaken. It is a matter of survival, amid the progress in processed food, pharmaceutical products and genetically modified crops and plants. Wild food plants used such as traditional foods have maintained- their importance in human history [1].

According to Turner *et al.* [2], many people around the world rely on wild plants – which include roots, shoots, leafy greens, etc. - to meet their daily minimum necessary nutritional requirements. Wild food plants and locally produced foods are valuable and important nutrient contributors in the diet for humans, both in rural and urban areas. However, it should be stressed that they are most important in the rural areas where nutrition is likely based on natural organic food [3]. Nowadays, vegetables are essential foods as far as nutrition and health are concerned [4]. Compared to the other plants, which are mainly grown for food, wild plants possess superior nutritional values. Previous researches have reported on the richness of these referred species in proteins, vitamins, minerals, carbohydrates, fibers, and secondary metabolites such as phenolic compounds [5]. ~~And,~~ ~~More~~ More wild vegetables and edible plants are good sources for minerals and other useful phytochemicals for human health, thus they play a great role in supplying the mineral requirements of local rural populations [1], Ertan *et al.* [6] emphasized that, minerals with critical significance in human nutrition and health are essential nutrients for normal physiological functions of the body. As for dietary fibers, they play an important role in decreasing the risks of many disorders such as constipation, diabetes, cardiovascular diseases, diverticulosis and obesity [7].

The consumption of wild food plants contributes in health protective functions. For instance, vegetables provide vital nutrients for healthiness and maintenance of the human body [8], and the dietary intake of fruits and other edible plant parts rich in health protective and diseases preventive phytochemical, contributes to same kind of disease prevention and good health. In general, they have been shown to provide protection against a wide variety of cancer and a number of chronic and degenerative diseases such as neoplasm, cardiovascular diseases, cataracts, diabetes, aging process, etc. [9]. Beside the dietary and nutritional benefits, wild-growing plants also constitute a source of income through sales as food or medicinal plants, i.e. phytotherapy [10]. In sum, wild edible plants and herbs play an essential role in food security, human nutrition and health and economic welfare of rural communities; thus, a huge contribution to world's development [11].

In Northern Angola-Africa, a great number of wild edible plants species are consumed by local communities as vegetables, shoots, fruits, seeds, barks, spices, roots, tubers, wine palms, etc. [12, 13, 14, 15]; but, some of the wild edible plants are underutilized with among them the green edible leaves of *Mondia whitei* and *Pyrenacantha klaineana*.

The neglect or underutilization of wild edible plants as food by consumers would have arisen as consequence of the introduction of exotic vegetables into the markets [16], and also a lack of vulgarisation and non-provision of objective information about their nutrients contents and therapeutic properties [17]. Industrial revolution, changes in lifestyle, less contact with nature (e.g. society urbanization), large-scale cultivation of a limited number of crops (such as wheat, maize and rice), are also among other reasons to consider for such a decline in wild edible products consumption [18].

*Mondia whitei* (Hook.f.) Skeels is an African plant which belongs to the Apocynaceae family [19]. The plant is a perennial climber, characterized by latex and woody roots, which are aromatic when old. It grows in the savannah and forest, and encountered in the Angolan Uíge province savannah land. *M. whitei* is endemic to South, Central, East and West Africa [21]. It is one of the few wild green leafy vegetables used by Bakongos' ethnic groups in Northern Angolan region. This plant ~~has-got~~ has many local names in *Kikongo language* such as *Kimbiolongwa*, *Nlondo* or *Nlondo nlondo*. The *M. whitei* leaves are eaten cooked as a soup mixed with palm oil,

onion, tomatoes, peanut butter, [20] “*mwamba nguba in kikongo language*”, fish, meats, caterpillars, etc.

Furthermore, *M. whitei* is endemic to South, Central, East and West Africa [21].

*Pyrenacantha klaineana* Pierre ex Excell & Mendonça belongs to the Icacinaceae family. This plant is a forest liana, reaching the treetops, with an unpleasant smell; it grows wild in the savannah and forest [22]. This plant has many local names in *Kikongo language* such as *Ndulu nsi*, *Mbizi a nsaki* or *Mbizi ya nsaki*. Juice of *P. klaineana* leaves ~~are~~ used as a spice and a sodium bicarbonate substitute. Said, this juice is added before or during the cooking of the cassava leaves in order to tenderize them and enhance the taste or flavour.

The study of wild food plants is important ~~to~~ identify the potential nutrients sources which could be utilized as alternative food [23]. It has been observed that no nutritional composition of either *M. whitei* leaves nor *P. klaineana* – two specific wild edible plants species growing in Northern Angola region – are available in the literature. Thus, there is a need for a research aimed at assessing and providing their respective nutritional information and some other properties such as medicinal or nutraceutical, as well.

This study has investigated the nutritional and mineral contents of *M. whitei* and *P. klaineana* leaves, two of the underutilized wild food leaves of Northern Angola. Besides, we have evaluated the functional properties of these plants to better understand their importance in human’s nutrition. The results and parameters could then provide fundamental bases for the nutritive exploitation, reducing food insecurity, and malnutrition problems and also increasing dietary diversity within local communities and beyond. ~~Besides, we have evaluated the functional properties of these plants to better understand their importance in human’s nutrition.~~

## 2. MATERIAL AND METHODS

### 2.1 Plant material

The plant material consist of the wild edible leaves of *M. whitei* (Figure 1a) and *P. klaineana* (Figure 1b) that were collected in the Northern region of Angola, respectively at Ambuila municipality (S 07°29.778’ ; E 014°38.440’) and Mbanza Kongo municipality (S 05°52.122’ ; E 014°04.998’). The collection was completed in beginning of May 2018 and plant material samples systematic identification was done at the Biological Department, Faculty of Sciences, University of Kinshasa where the specimens were deposited in Herbarium.



Figures 1a and 1b show the plant material respectively, *Mondia whitei* and *Pyrenacantha klaineana*.

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## 2.2 Proximate composition analysis

The ash, crude protein, fat, fiber, estimation of available carbohydrate and calorie contents were determined in accordance with AOAC [ 24].

## 2.3 Mineral Determination

The mineral contents were determined by Inductively Coupled Argon Plasma Optical Emission Spectrometry (ICP-OES) [Optima 8300 Perkin Elmer, USA], Ngbolua *et al.* [25].

## 2.4 Statistical analysis

All assays were carried out in triplicate and the values were obtained by calculating the average of three experiments and data are presented as Mean  $\pm$  SD (Standard Deviation). Data were subjected to analysis of variance (ANOVA) and significant differences were determined by the Tukey test at  $p \leq 0.05$  probability level, using Sisvar 5.7 software.

## 3. RESULTS AND DISCUSSION

Wild food plants contain fascinating dietary components for human population. In this study, chemical composition of selected wild underutilized edible plants grown in Northern Angola were analyzed. These are two plants species, namely *M. whitei* and *P. klaineana*, mostly used for food purposes such as vegetables in the region.

### 3.1 Proximate composition

Ash, fiber, protein, fat, carbohydrates and energy content were presented in the table 1. Statistical analysis showed a significant difference ( $P < 0.05$ ) in the ash, fibre, protein, fat, carbohydrates and energy of *M. whitei* and *P. klaineana* leaves. The proximate composition comprising the major nutritional value indicators and the energetic value of *M. whitei* and *P. klaineana* leaves are presented in Table 1.

Table 1: The proximate composition (%) and energy value (kcal) of *M. whitei* and *P. klaineana* leaves.

Parameters	<i>M. whitei</i>		<i>P. klaineana</i>	
	Raw	Boiled	Raw	Boiled
Ash (%)	12.93 $\pm$ 0.20 <sup>a4</sup>	9.53 $\pm$ 0.07 <sup>a3</sup>	6.74 $\pm$ 0.09 <sup>a2</sup>	4.13 $\pm$ 0.13 <sup>a1</sup>
Crude Fiber (%)	13.16 $\pm$ 0.31 <sup>a1</sup>	15.11 $\pm$ 0.12 <sup>a2</sup>	40.45 $\pm$ 0.36 <sup>a3</sup>	43.56 $\pm$ 0.49 <sup>a4</sup>
Crude protein (%)	16.48 $\pm$ 0.23 <sup>a2</sup>	19.24 $\pm$ 0.96 <sup>a4</sup>	14.93 $\pm$ 0.36 <sup>a1</sup>	18.80 $\pm$ 0.49 <sup>a3</sup>
Fat (%)	2.95 $\pm$ 0.06 <sup>a2</sup>	4.94 $\pm$ 0.93 <sup>a3</sup>	1.13 $\pm$ 0.11 <sup>a1</sup>	3.78 $\pm$ 0.21 <sup>a2a3</sup>
Carbohydrates (%)	54.48 $\pm$ 0.16 <sup>a4</sup>	51.59 $\pm$ 1.74 <sup>a3</sup>	36.58 $\pm$ 0.69 <sup>a2</sup>	29.74 $\pm$ 0.75 <sup>a1</sup>
Energy (kcal/100 g)	310.39 <sup>a1</sup>	326.10 <sup>a2</sup>	217.77 <sup>a2</sup>	227.88 <sup>a3</sup>

Values are mean  $\pm$  standard deviation. Values with different superscripts in the same row are significantly and statistically different ( $P < 0.05$ ).

The ash content that reflects the total mineral content reveals a greater richness of *M. whitei* leaves than *P. klaineana*. *Mondia whitei* leaves is richer in ash than *P. klaineana* both in raw and boiled leaves (12.93  $\pm$  0.20% and 9.53  $\pm$  0.07%) and (6.74  $\pm$  0.09 and 4.13  $\pm$  0.13%), respectively (Table 1). Ash is an indication of minerals

concentration in food. Food with high ash is said to possess high mineral constituents. The results of the study show that boiling resulted in higher ash losses, -26.30 and -38.72% in the *M. whitei* and *P. klaineana* leaves, respectively. This corroborates those of Nafir-Zenati *et al.* [26] obtained on the cooking of spinach. ~~The finding shows that the ash content depends on the plant species, geographical and genetic variability, soil type, etc.~~ Finally, the significant decrease in ash content during boiling would result from diffusion of minerals into the boiling water. Similar results have been reported for others foods such as, *Solanum macrocarpum*, *Amaranthus hybridus*, and *Ocimum gratissimum* [27].

The amount of **fiber** could be of immense importance in the human digestive process in controlling for example constipation and accelerating the feces. *P. klaineana* is richer in dietary fiber than *M. whitei* in both raw and boiled leaves, ( $40.45 \pm 0.36$  et  $43.56 \pm 0.49$  %) and ( $13.16 \pm 0.31$  et  $15.11 \pm 0.12$ %), respectively. In addition, the results of this study show that cooking in water results in an increase on dietary fiber, +7.69 and +14.82%, respectively, on the leaves of *P. klaineana* and *M. whitei*. The increase of dietary fibers content may be attributed to their solubility after cooking. Furthermore, this amount of fibers could ~~have be of~~ immense importance in the digestive process of humans in controlling constipation [28].

**Protein** is an important source of amino acids ~~that and~~ is required for body development and maintenance [29]. The chemical composition of these two species shows a good level of proteins (Table 1). *M. whitei* is richer in proteins than *P. klaineana* in both raw and boiled leaves, ( $16.48 \pm 0.23$ ;  $19.24 \pm 0.96$ %) and ( $14.93 \pm 0.36$ ;  $18.80 \pm 0.49$ %), respectively. In addition, it is that cooking in water results in a significant increase in protein, +16.75 and +25.92%, respectively, in the *M. whitei* and *P. klaineana* leaves. It is worth to indicate that the protein content which increases in cooked *M. whitei* leaves could be attributed to solubilisation of components in agreement with Pujola *et al.* [30] whose report for peas, lentils, beans and chickpeas showed that, the increase in protein content in cooked beans and lentils were attributed to solubilisation of components and, consequently, as a concentration effect. The results of this study are encouraging, as these plants could be used by adults, children, pregnant women and lactating mothers to make up for the deficit of proteins population in rural area.

*M. whitei* is richer in **fat** than *P. klaineana* in both raw and boiled leaves, ( $2.95 \pm 0.06$ ;  $4.94 \pm 0.93$ %) and ( $1.13 \pm 0.11$ ;  $3.78 \pm 0.21$ ), respectively. In addition, the results show that cooking in water results in a significant increase ( $P < 0.05$ ) in lipid, +67.46% in *M. whitei* and +234.51% in the *P. klaineana* leaves. This increase would be attributed to the concentration of dry matter in the food after cooking. Results of crude fat corroborate those of previous studies such as Vodouhe *et al.* [27], whose research work found that cooking in water increase contents on lipids leaves.

**Carbohydrates** are important sources of quick fuel for the brain, which solely depends on it for good function alongside with many other organs of the body. *Pyrenacantha klaineana* is richer in carbohydrates than *M. whitei* in both raw and boiled leaves, ( $54.47 \pm 0.16$ ;  $51.59 \pm 1.74$ %) and ( $36.58 \pm 0.69$ ;  $29.74 \pm 0.75$ %), respectively. The high carbohydrate content indicates a high energy content in foods. According to Yisa *et al.* [31], the main function of carbohydrates in the body is to provide energy ~~and it is responsible for doing daily~~ activities in our ~~daily~~ lives.

*M. whitei* is richer in **energy** (kcal) than *P. klaineana* in both raw and boiled leaves, (326.10; 310.37 kcal) and (217.77; 227.88 kcal), respectively. The energy content (kcal) of the two edible wild leaves was observed to increase with the cooking ~~and their protein and carbohydrates contents~~. In addition, cooking the *M. whitei* and *P. klaineana* leaves resulted in an increase in protein, carbohydrates and fat, resulting in an increase in energy. The

amount of energy in the leaves of these two wild edible plants can be an adequate source of energy for rural populations in Northern Angola.

### 3.2 Mineral compositions of *M. whitei* and *P. klaineana* raw leaves

The mineral contents (macro and micronutrients) of the two selected wild food underutilized in Northern Angola were statistically significant ( $P < 0.05$ ), and were found to be the rich sources of minerals (Tables 2 and 3).

Table 2: Macro elements present in the *M. whitei* and *P. klaineana* raw leaves (mg/100 g dry weight or DW)

Parameters	<i>P. klaineana</i>	<i>M. whitei</i>
Sodium (Na)	126.77 ± 0.24 <sup>a2</sup>	101.57 ± 0.15 <sup>a1</sup>
Potassium (K)	2459.20 ± 0.31 <sup>a2</sup>	1149.83 ± 0.09 <sup>a1</sup>
Calcium (Ca)	2126.33 ± 0.09 <sup>a2</sup>	844.87 ± 0.09 <sup>a1</sup>
Magnesium (Mg)	241.93 ± 0.18 <sup>a2</sup>	219.90 ± 0.09 <sup>a1</sup>
Phosphorus (P)	239.90 ± 0.06 <sup>a2</sup>	175.89 ± 0.17 <sup>a1</sup>

Values are means of three (3) individual measurements ± standard deviation. Means in each column followed by different superscript letters are significantly different ( $P < 0.05$ ).

Table 3: Oligo-elements contents in the *M. whitei* and *P. klaineana* raw leaves ( mg/100 g DW)

Parameters	<i>P. klaineana</i>	<i>M.whitei</i>
Copper (Cu)	2.84 ± 0.04 <sup>a1</sup>	3.14 ± 0.04 <sup>a2</sup>
Zinc (Zn)	3.47 ± 0.02 <sup>a1</sup>	1.42 ± 0.05 <sup>a2</sup>
Manganese (Mn)	6.14 ± 0.06 <sup>a2</sup>	5.11 ± 0.03 <sup>a1</sup>
Selenium (Se)	77.86 ± 0.11 <sup>a1</sup>	87.80 ± 0.12 <sup>a2</sup>
Cobalt (Co)	2.84 ± 0.12 <sup>a2</sup>	2.73 ± 0.05 <sup>a1</sup>
Aluminium (Al)	96.81 ± 0.17 <sup>a2</sup>	38.75 ± 0.09 <sup>a1</sup>
Iron (Fe)	21.69 ± 0.07 <sup>a2</sup>	14.21 ± 0.17 <sup>a1</sup>
Nickel (Ni)	7.76 ± 0.03 <sup>a2</sup>	6.32 ± 0.06 <sup>a1</sup>

Values are means of three (3) individual measurements ± standard deviation. Means in each column followed by different superscript letters are significantly different ( $P < 0.05$ ).

The mineral elements are necessary for human biological processes, which regulate the osmotic pressure and protects against many disorders, such as cancer and cardiovascular diseases. In addition, they are ingredients of the skeleton and the enzyme systems [32].

**Phosphorus** concentration averagely ranged from  $175.89 \pm 0.17$  mg/100 g in *M. whitei* to  $239.90 \pm 0.06$  mg/100 g in *P. klaineana*. Phosphorus is the most abundant mineral in the body after calcium. Phosphorus regulates various endophysiological functions including skeletal development, metabolization of mineral, transfer of energy through mitochondrial metabolism, cell signaling and aggregation of blood platelets [33]. It is a building material of bones and teeth together with calcium [34].

In this study, the means value of phosphorus is 174.99 mg/100 g. The phosphorus levels of some wild plants were found in the ranges of 27.6 to 431.0 mg/100 g [35]. According to Achaglinkame *et al.* [28], the role of phosphorus in the formation of strong bones and teeth, the maintenance of a regular heartbeat, muscle contraction, regulation of the storage and use of body energy, among other roles, cannot be undervalued. This is backed up by the fact that RDA requirement for phosphorus in both adult males and non-pregnant females is 700 mg/day [36].

**Potassium** concentration averagely ranged from  $1149.83 \pm 0.09$  mg/100 g DW in *M. whitei* to  $2459.20 \pm 0.31$  mg/100 g DW in *P. klaineana*. Potassium is the mineral element, which presents the highest concentration in the leaves of *P. klaineana* than in those of *M. whitei*. Similar results were reported for K contents and that were obtained in the related studies for 542.88 to 1544.38 mg/100 g [37]. The highest macro element in many wild edible plants studied by Özer and Aksoy [4] was determined as potassium. The highest macro element was also identified as K in this study. Potassium plays a very crucial role in the body by helping maintain body fluid and osmotic balance, as well as aiding in the regulation of nerve signals and muscle contractions [38]. According to Institute of Medicine cited by Umerah *et al.* [39], the Recommended Daily Allowance (RDA) for potassium for both normal healthy males and non-pregnant females between the ages of 19 and 50 years is 4700 mg/day. The range of potassium content reported in this study shows that the vegetables may be capable of providing about 24.46% (*M. whitei*) and 52.32% (*P. klaineana*) of RDA for healthy living.

Magnesium concentration averagely ranged from  $219.90 \pm 0.09$  mg/100 g in *M. whitei* to  $241.93 \pm 0.18$  mg/100 g in *P. klaineana*. Magnesium contents of various wild edible plants varied from 15.2 to 468.0 mg/100 g [35]. It established that magnesium helps relax muscles along the respiratory pathway, enabling asthmatics to breathe with ease [40]. However, the consumption of the *M. whitei* and *P. klaineana* leaves may help prevent these health issues, following their high values. According to [41], Magnesium is a major constituent of bones and teeth alongside calcium and phosphorus; also, it is necessary for tissue respiration, the release of parathyroid hormone and for its action in the backbone, intestine, and kidney.

The concentration of **calcium** ranged from  $844.87 \pm 0.09$  mg/100 g in *M. whitei* to  $2126.33 \pm 0.09$  mg/100 g in *P. klaineana*. According to Theobald, [42], Calcium plays an important role in strong bone and teeth formation, the regulation of muscle contractions, and the transmission of nerve impulses in the body; thus, its presence in human diets is a necessity. Calcium also plays a crucial role in nerveimpulse transmission and in the mechanism of neuromuscular system [33]. It plays an important role in blood clotting, muscles contraction, and neurological function and also helps in enzymatic metabolic processes [43]. Deficiency can cause rickets, bone pain and muscle weakness [44]. These wild underutilized food leaves can supplement the daily requirements of Ca which have been put by [45] at 260 mg/day.

A range of  $101.57 \pm 0.15$  mg/100 g in *M. whitei* to  $126.77 \pm 0.24$  mg/100 g in *P. klaineana* of **sodium** was observed among the leaves, and this was significant difference ( $P < 0.05$ ) between two plant species. Sodium which plays a vital role in the conduction of nerve impulses alongside potassium [46]. Compared with other



major elements (K, P, Ca and Mg) examined in this study, the sodium content of the plant was found to be relatively low (Table 2). However, the sodium levels determined in the current study are compatible with findings of Roe *et al.* [47] on some common vegetables (0.5 to 30 mg/100 g) and findings of Kibar and Temel [48] on different wild plants (26.24 to 36.10 mg/100 g). Excess intake of sodium has been implicated in inducing hypertension. Adequate intake for sodium is 1.2 to 1.5 grams per day [49]. The RDA requirement for sodium is 1500 mg and 2300 mg/day for normal healthy male adults and female non-pregnant adults aged 19-50 years respectively [50].

The content of **selenium** present in the *M. whitei* leaves is higher than that of *P. klaineana*,  $87.80 \pm 0.12$ ;  $77.86 \pm 0.11$  mg/100 g DW respectively. According to Kieliszek and Błazejak, [51], selenium is an element whose traces are essential for life. It participates in the protection of cells against excess  $H_2O_2$ , in the detoxification of heavy metals and in the regulation of the immune and reproductive system. It also ensures the proper functioning of the thyroid gland. Selenium induces the synthesis process of selenoproteins involved in the body's antioxidant defense mechanism.

**Aluminum** is highly concentrated in *P. klaineana* leaves than in *M. whitei* leaves,  $96.81 \pm 0.17$  and  $38.75 \pm 0.09$  mg/100 g DW respectively. The **cobalt** present in the leaves of *P. klaineana* is higher than that of *M. whitei*, ( $2.84 \pm 0.12$  mg/100 g DW) and ( $2.73 \pm 0.05$  mg/100 g DW), respectively. *P. klaineana* leaves are richer in iron than *M. whitei*,  $21.69 \pm 0.07$  and  $14.21 \pm 0.17$  mg/100g DW, respectively. Animals also require Fe to maintain the activities of many important enzymes and for vital haem proteins such as haemoglobin, myoglobin and cytochromes that are involved in oxygen transport and energy metabolism respectively. Like Cu, Fe is subject to strict homeostatic control, although unlike Cu, Fe deficiency is common in both industrialized and developing countries [52]. According to Elinge *et al.* [41], Iron performs several important functions in the body, such as the formation of blood and the transport of oxygen and carbon dioxide to tissues. In addition, iron is very important for the transport of oxygen in the blood and the control of anemia and its side effects [40]. The iron content of the *M. whitei* leaves and *P. klaineana* was higher than the FAO/WHO [45] Recommended Dietary Allowance for men (1.37 mg/day) and women (2.94 mg/day). The high level of iron in these wild food plants could be a major reason for recommending consumption as an alicament as food or health for the control of diseases associated with iron deficiency (anaemia). In addition, the studied wild underutilized food plants could be recommended in diets for reducing anemia, which affects over one million people worldwide [53].

The highest and lowest **copper** contents were observed: *M. whitei* ( $3.14 \pm 0.04$  mg/100 g DW) and *P. klaineana* ( $2.84 \pm 0.04$  mg/100 g DW), respectively (Table 3). For adults, 0.9 mg of daily Cu intake can meet their daily requirement [54]. Cu content in general, varies from 3 to 8 mg/kg for leafy vegetables [55]. The safe and adequate dietary intake of Cu is estimated to be between 1.2 and 3.0 mg per day [56]. Copper is an important trace element required for the activity of several key enzymes, such as cytochrome c oxidase, amino acid oxidase, superoxide dismutase and monoamine oxidase, and copper has been implicated in host cell defense mechanisms, red and white blood cell maturation, Fe transport, cholesterol and glucose transport, metabolism, myocardial contractility, bone strength and brain development [56].

The highest value of **zinc** was determined in the *P. klaineana* ( $3.47 \pm 0.02$  % DW) and the lowest value was determined in *M. whitei* ( $1.42 \pm 0.05$  mg/100 g DW) (Table 3). In previous studies, the levels of zinc in two different wild food plants were in the ranges of 2.28 to 12.1 mg/100 g DW. According to Bello *et al.* [40], zinc is substantially linked to protein synthesis, catalytic activity of several enzymes, and rapid growth and development



during early childhood, adolescence and wound healing. In addition, zinc is a membrane stabilizer and stimulator of the immune response. Zinc deficiency leads to stunted growth and poor development of gonadal function [57].

Nickel is slightly higher in the leaves of *P. klaineana* than in those of *M. whitei*,  $7.76 \pm 0.03$  and  $6.32 \pm 0.06$  mg/100 g DM, respectively. According to Williams, [57], Nickel is a cofactor for an enzyme functioning in nitrogen metabolism.

Manganese content of *M. whitei* leaves was  $5.11 \pm 0.03$  mg/100 g DW and was  $6.14 \pm 0.06$  mg/100 g on *P. klaineana* leaves. The RDA for manganese (1.8 mg/day) shows that *M. whitei* and *P. klaineana* are rich sources of manganese, which is a component of several metalloenzymes e.g., superoxidase dismutase [40].

~~The difference observed between the results of this study and those found on other wild edible plants would be attributed to several factors, including the season, the presence of soil microfauna, topography, geography, soil diversity and climatic conditions, the physiological state and maturity of the plant, the plant organ, the genetics and the analytical methods used. According to Ozcan, [58], and Özer and Aksoy, [4], the presence of minerals in plants may be due to ecological factors and collection time, soil characteristics, water availability in the soil, growth stage of the plant during collection, the growing area of plants, climate and weather conditions [4] and topography.~~

#### 4. Conclusions

Wild edible plants are good sources for minerals, fiber and others useful chemical for human health. In this study, two wild edible leaves species underutilized and consumed in northern Angola were screened for their nutritional and mineral values. The result showed that *M. whitei* and *P. klaineana* leaves are poor sources of fat that make them good for obese people; they are good sources of fiber and can decrease the concentration of high cholesterol level in body. The mineral content showed that the wild edible leaves of *M. whitei* and *P. klaineana* are good sources of various minerals such as sodium, calcium, iron, calcium, magnesium, phosphorus, potassium, and selenium. According to their physiological importance, these macro and micronutrients will be of nutritional and health interests for rural populations that consume those leaves. The knowledge of the composition of these leaves seems to be a major nutritional argument to promote their consumption. However, variations in chemical nutrients may be attributed to species, plant genetic structure, topography and different agroclimatic conditions, maturity organ and stage of plant development. There are many wild edible plants available in this part of the country, whose nutritional profile is yet to be documented. In addition, the wild edible leaves, which are mostly neglected, have a good potential in terms of food value and can serve as an easily accessible food resources. Finally, the phytochemical studies should be carried out to discover the toxic and medicinal properties of these plants.

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