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PHARMACOGNOSTIC STUDY OF *MORINGA OLEIFERA* LAM. (*MORINGACEAE*), A PLANT USED IN THE TREATMENT OF DIABETES IN MALI

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ABSTRACT: *Moringa oleifera* is the plant most frequently used by diabetic patients in Bamako (Mali) for the management of their diabetes. The present study aimed to determine the pharmacognostic parameters of the leaves of *Moringa oleifera* harvested in Mali. The pharmacognostic study consisted of determining the botanical characteristics (organoleptic features and microscopic elements), physicochemical parameters (water and ash contents), and chemical constituents according to methods described in the European Pharmacopoeia. The powder of leaves of *M. oleifera* was green in color, with a semi-coarse texture, an uncharacteristic odor, and an insipid flavor. Micrograph revealed the presence of anomocytic stomata, calcium crystals, single-celled covering hairs and spiral vessels. The water content is greater than 10%. The contents of insoluble ashes in 10% diluted HCl were less than 1%. Phytochemical screening revealed the presence of polyphenols (flavonoids and tannins), saponins, sterols and triterpenes. Pharmacognostic parameter determined on this study can help in the efficient utilization of this medicinal plant.

INTRODUCTION: Diabetes is a public health problem in West Africa. Medicinal plants are a therapeutic remedy frequently used by diabetic patients for the management of their diabetes [1, 2]. The most frequently used plant by diabetic patients in Bamako (Mali) is *Moringa oleifera* Lam. [3]. *Moringa oleifera* can grow up to 12 m in tropical and subtropical environments [4]. It produces composite leaves that are alternate, bipinnate or partly tripinnate (which measures 30–70 cm long) with two to six pairs of opposite pinnate bearing leaflets in three to five pairs. Leaflet at the terminal end is larger than the other leaves, may or may not be glaborous with ovate to elliptic size. The leaves are one to two cm long and 0.5–1.5 cm in width with a rounded apex and base [5]. Although it is native to South Asia, the cultivation itself has already spread to the Middle East, Africa, Asia, and other areas [4].

The leaves of *M. oleifera* mainly contain bioactive compounds such as phenolic compound, terpenoids and sterols [6] which are thought to be partly responsible for the numerous pharmacological activities observed *in-vitro* and *in-vivo* such as hypoglycemic, antioxidant, anti-inflammatory, antimicrobial activities [7–9]. Clinical studies conducted in type 2 diabetic patients have shown that the leaves of *M. oleifera* are beneficial in the management of type 2 diabetes and in the prevention of its complications [10]. In Mali, the work of the National Institute for Research on

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Traditional Medicine and Pharmacopoeia (NIRTMP) has made it possible to develop an MTA based on the leaves of *M. oleifera* called "MODIA" used in the treatment of type 2 diabetes [11–13]. However, it is necessary to conduct pharmacognostic studies in order to establish quality standards for *Moringa oleifera* leaves harvested in Mali. It is in this context that the present study was initiated and aimed to determine the pharmacognostic parameters of *Moringa oleifera* leaves harvested in Mali, more specifically to determine the botanical characteristics, physicochemical parameters and phytochemical constituents.

MATERIALS AND METHODS:

Plant Material: The plant material consisted of *Moringa oleifera* leaves harvested from the botanical garden of the National Institute for Research on Traditional Medicine and Pharmacopoeia (NIRTMP). The botanical identity of the plant was confirmed by Seydou Mamadou DEMBELE, Water and Forestry Engineer, head of the Ethnobotany and Raw Materials Department of NIRTMP.

The leaf samples were dried in the shade in the drying room of the INRMPT for 2 weeks. After drying, the dried leaf samples were pulverized with a Resch type SM2000 OSI /1430 upm grinder. An herbarium specimen of the leaves is deposited in the NIRTMP Herbarium under the number 1391/DMT.

Determination of Botanical Characteristics: The botanical characteristics of *M. oleifera* leaf powder were determined according to methods described by Fofie *et al.* [14]. The botanical characteristics determined concerned the organoleptic characters and the microscopic elements.

Determination of Organoleptic Characteristics: The organoleptic characteristics of *M. oleifera* leaf powder were determined using the method described by Fofie *et al.* [15]. The organoleptic characteristics determined concerned the color, taste, smell and texture of the powder.

Microscopic Examination: Micrographs of *M. oleifera* leaf powder were carried out according to the method described by Fofie *et al.* [14]. The *M. oleifera* leaf powder was mounted between slide and coverslip in a 5% diluted aqueous solution of potassium hydroxide (KOH).

The microscopic elements were observed with the objective 40 of an OPTIKA ITALY microscope and then photographed using an iPad device that was directly connected to the microscope.

Physicochemical Analyses: Physicochemical parameters such as water content, ash content (total ash and ash insoluble in 10% dilute hydrochloric acid), and content of substances extractable by water and 70% ethanol were determined according to methods described in the European Pharmacopoeia [16].

Phytochemical Screening: Phytochemical analysis was conducted to determine the presence of alkaloids (Dragendorff reagent), anthocyanins (acid and base reaction), anthraquinones (Bornträger reaction), flavonoids (Cyanidine reaction), saponins (foaming power determination), sterols and triterpenes (Lieberman reaction) and tannins (trichloride reaction) [17]. The results were categorized as follows:

- Strongly positive reaction: +++
- Moderately positive reaction: ++
- Weakly positive reaction: +
- Negative reaction: -

RESULTS AND DISCUSSION:

Botanical Characteristics: The powder of *M. oleifera* leaves collected from the NIRTMP garden in Bamako, Mali was green in color, with a semi-coarse texture, an uncharacteristic odor, and an insipid flavor.

Micrograph of *M. oleifera* leaves powder revealed the presence of anomocytic stomata (a), calcium crystals (b and b'), single-celled covering hairs (c) and spiral vessels (d) (see **Fig. 1**). These botanical characteristics of *M. oleifera* leaf powder will contribute to their identification and the determination of falsifications.

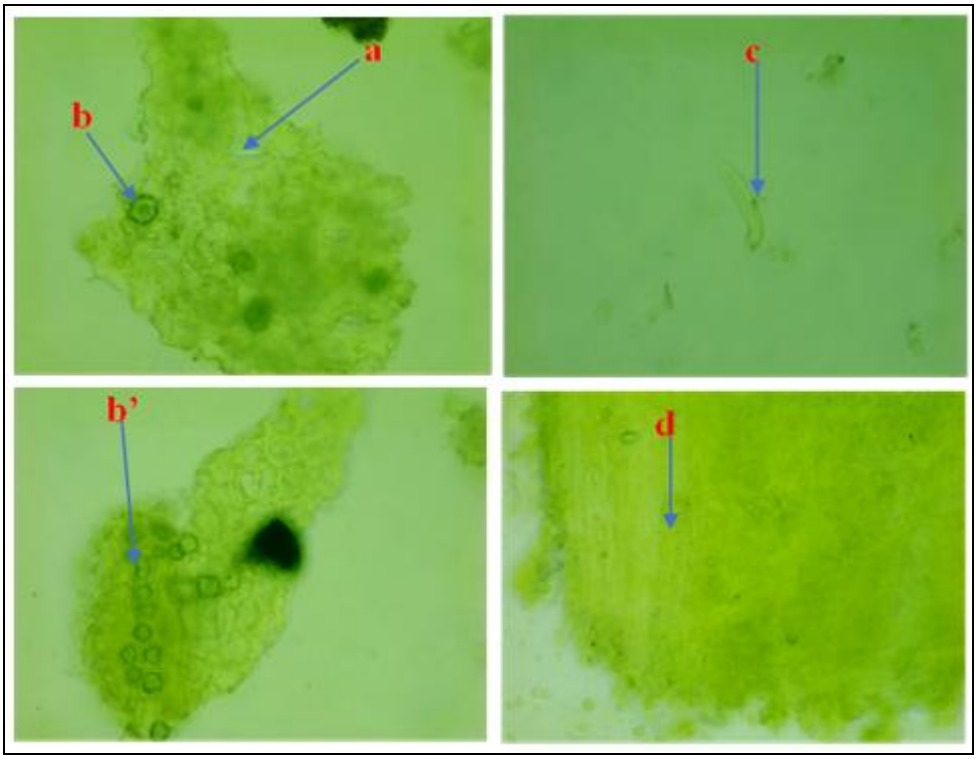

FIG. 1: MICROGRAPH OF *M. OLEIFERA LEAF* POWDER (40X40). a: anomocytic stomata; b and b: calcium crystals; c: single-celled covering hairs; d:spiral vessels.

Physicochemical Parameters: Physicochemical analysis is an essential element of quality control of plant material. The results of the physicochemical parameters studied are presented in **Table 1**. The water content in *M. oleifera* leaf powder is greater than 10% (see **Table 1**). This value is higher than the limit recommended by Pharmacopoeias, which generally require a water content of less than 10% [16, 18]. A high-water content promotes oxidation and fermentation reactions and the development of mold, which are phenomena that can alter the active ingredients during storage [19].

Physicochemical analysis conducted on samples of *M. oleifera* leaf powder collected in Nigeria showed that the water content in *M. oleifera* leaf powder varies from 4 - 14.2% [20–23]. This variability could be due to drying conditions (humidity in the air in August in Mali). The total ash content was 8.07 ± 0, 36%. Total ash content values in *M. oleifera* leaf samples collected in Nigeria ranged from 7-16% [20–23]. The insoluble ash content in 10% HCl were less than 0.5% (see **Table 1**). This result suggests that the powder of *M. oleifera* leaves contains a low proportion of siliceous elements such as sand and dust [19]. The high total ash content coupled with a low content of hydrochloric acid insoluble ash suggests that the powder of the leaves of *M. oleifera* are good sources of minerals when compared to the cereals, dairy products, some fruits and vegetables [24]. The content of water-extractable substances was higher than those extractable by 70% ethanol. This result suggests that the chemical constituents of *M. oleifera* leaves are more soluble in water than in hydroethanolic solution, which is in favor of the traditional form of use (decoction, infusion).

TABLE 1: PHYSICOCHEMICAL PARAMETERS OF *MORINGA OLEIFERA* LEAVES

Physicochemical parameters	Value (%)
Water content	11.99 ± 0.29
Total ash	8.07 ± 0,36
Ashes insoluble in hydrochloric acid	0,33 ± 0,06
Water-extractable substances	14.7 ± 1.69
70% ethanol extractable substances	7.82 ± 1.7

Phytochemical Constituents: Phytochemical screening revealed the presence of anthraquinones, flavonoids, saponins, sterols, triterpenes, and tannins in the powder of leaves of *M. oleifera* (see **Table 2**). These compounds have been identified in *M. oleifera* leaves harvested in other localities in Mali [25, 26] and Africa [27, 28]. In addition to these compounds, the presence of alkaloids has been reported in *M. oleifera* leaf samples collected in Nigeria [20] and India [29].

The presence of some of these compounds could justify the use of *M. oleifera* leaves in the management of diabetes and its complications. Growing evidence indicates that polyphenols (flavonoids, tannins) may influence blood glucose at different levels and may also help control and prevent diabetes complication [30, 31]. Triterpenes are also promising agents in the prevention of diabetic complications. They have strong antioxidant activity and inhibit the formation of advanced glycation end products, implicated in the pathogenesis of diabetic nephropathy, embryopathy, neuropathy or impaired wound healing [32].

TABLE 2: PHYTOCHEMICAL CONSTITUENTS OF *M. OLEIFERA* LEAVES

Phytochemical constituents	Powder
Alkaloids	-
Anthocyanins	-
Anthraquinones	+
Flavonoids	++
Leucoanthocyanins	-
Sapononins	+
Sterols and triterpenes	+++
Tannins	+++

CONCLUSION: This study made it possible to determine, on the one hand, the botanical characteristics of the powder of *M. oleifera* leaves harvested in Mali and, on the other hand, the physicochemical and phytochemical parameters. These data will thus contribute to the identification of *M. oleifera* leaves, to the detection of falsifications and contamination by foreign bodies.

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CONFLICT OF INTEREST: Nil

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