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Original Article

COMPARATIVE ASSESSMENT OF THE QUALITY OF PARKIA BIGLOBOSA TRUNK BARK POWDERS JACQ. BENTH (FABACEAE-MIMOSOIDEAE) INTENDED FOR THE PHARMACEUTICAL PRODUCTION OF PHYTO-DRUGS

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ABSTRACT

Objective: This study was conducted to determine the physicochemical characteristics and organic and inorganic contaminants of *Parkia biglobosa* trunk bark powders collected in four localities (Gonse, Yako, Bobo and Nobere) of Burkina Faso.

Methods: The parameters studied were the physicochemical characters, the contents of heavy metals, pesticides and the microbial quality according to the methods of the European Pharmacopoeia.

Results: The study of these parameters revealed a residual moisture content of less than 10% and a uniform pH, macroscopical character and particle sizes for all raw materials. Total ash ranged from 0.09 to 0.96 for powders from Yako and Bobo, respectively. Contaminant assessment revealed that *Parkia biglobosa* trunk bark contains high levels of manganese (Mn) and lead (Pb). The microbial analysis shows that the trunk bark powders from Gonse, Yako and Bobo complied with the specifications of the European Pharmacopoeia.

Conclusion: These quality control studies allowed the correct identification, characterization and determination of the appropriate harvesting sites for pharmaceutical production of phytomedicine.

Keywords: Quality control, *Parkia biglobosa*, Trunk bark powders, Pharmaceutical production

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INTRODUCTION

Several medicinal plants have an essential role in treating of animal and human pathologies. However, the lack of information on specific parameters of medicinal plants is a significant problem for their use in medicine [1]. Current trends in care depend almost entirely on traditional medicine systems for good health [2]. *Parkia biglobosa* (Jacq.) is a robust tree of the Fabaceae-Mimosoideae family. This plant originated from Africa and is used in traditional medicine for its diversified medicinal properties [3]. These seeds are used for their anti-hypertensive properties [3]. These leaves are used as antiparasitic and barks for their antibacterial, anti-hemorrhoidal, anti-inflammatory and antioxidant properties [3, 4].

These properties are justified by the presence of metabolites contained in the plant. Indeed, several studies have highlighted the presence of tannins, flavonoids, coumarins, saponosides,., in the raw materials from the plant [4]. A galenic formulation study developed two types of syrups based on lyophilized hydroalcoholic extracts of *Parkia biglobosa* trunk bark to manage digestive parasitosis [5]. Another study aims to create a topical form containing aqueous extracts of the plant. Because of the popularity of medicinal plants, they are confronted with the problems of adulteration and substitution [6].

Given these facts, the WHO encourages the preparation of monographs intended mainly to promote the harmonization of medicinal plant use concerning safety, efficacy and quality control [7, 8].

Indeed, the controls of plant drugs are necessary because of the significant variability of the secondary plant metabolism (inter-and intraspecific variability and variability according to the geographical origin and the conditions of drying and conservation of the drug). These controls include botanical controls (examination of organoleptic characteristics; macroscopic and microscopic descriptions), chemical controls (color identification reactions, thin layer chromatography.) and searches for potential impurities (microbiological analyses, search for residues of pesticides and heavy metals, radioactivity, mycotoxins: aflatoxins, ochratoxins.) [9]. This study investigated physicochemical and microbiological quality control parameters of *Parkia biglobosa* trunk bark powders from four localities (Gonse, Yako, Bobo and Nobere) in Burkina Faso.

MATERIALS AND METHODS

Material (Plant materiel)

The plant material consisted of trunk bark of *Parkia biglobosa* (jacq) Benth, collected in May 2020 in four localities of Burkina Faso, namely Gonse, Yako, Bobo and Nobere. A botanist Dr GANABA Souleymane in the Department of Environment and Forests, Institute of Environment and Agricultural Research, Ouagadougou, Burkina Faso (INERA/CNRST) identified the samples under the number 8757 in the National Herbarium of BURKINA FASO of the National Center for Scientific Research and Technology. The harvested trunk barks were dried in a ventilated room at room temperature (20-25 °C) without light and dust. They were then ground and stored in food bags.

Table 1: Geographical coordination

Localities	XY	Gonse	Yako	Bobo	Nobere
Geographic Coordinates	X	0683032	0564356	0378375	0687209
	Y	1376808	1430667	1223767	1295737

Macroscopic and organoleptic characteristics

Macroscopical and organoleptic studies of trunks barks powders were done by the naked eye and shape, colour, taste and odour were determined and reported.

Particle size distribution

The particle size was determined by the sieving method of the European Pharmacopoeia. A column of ten (10) sieves with a mesh size of 1.6; 1.25; 1; 0.9; 0.71; 0.63; 0.5; 0.4; 0.32 and 0.1 mm was used. The vibration duration was 30 min, and the amplitude was 80 vibrations per minute. The rejects from the different sieves were weighed using a precision balance. Histograms of the simple and cumulative particle size frequencies were made to graphically determine the median size (d50) corresponding to the 50% particle size [10].

Residual moisture content

The residual moisture content of the trunk barks powders was determined according to the thermogravimetric method of the European Pharmacopoeia 6th edition in an oven (Memmert, Germany). The assay was performed in triplicate on one (01) g of trunks barks powders. The mean and standard deviation were calculated (n = 3, mean, standard deviation).

Total ash rate

The total ash was determined by calcining the powders in a kiln at 600±25 °C to constant mass. The total ash content (% Ct) was expressed as a percentage [11].

Heavy metal content

Samples were prepared according to the method of Demirel *et al.*, with slight modifications [12]. After calcining the powder according to the ash determination method described above, the ash obtained was dissolved in 100 ml of 2% HNO_3/HCl nitric solution to ionize the mineral elements present in the sample. The heavy metals sought were chromium (Cr), copper (Cu), cobalt (Co), cadmium (Cd), manganese (Mn) and lead (Pb). They were determined by flame atomic absorption spectrometry (FAAS) using a VARIAN 240FS atomic absorption spectrometer (Mulgrave, Australia), equipped with single or multi-element hollow cathode lamps.

Pesticide content

The QuECHERS method has been used with some modifications [13]. The analysis was performed using a gas chromatograph (GC) with a micro-detector that captures electrons (GC-μECD/GC-FPD, Hewlett Packard). A GCMS-type capillary chromatographic column of high purity Helium N60 was used as carrier gas. The injection was carried out using the Split/Splitless injection technique with an injection volume of 1 μL. The temperatures of the device were as follows: injector room programmed at 270 °C with a pressure of 14.77 psi; - Column (70 °C for 5 min, 70 °C-120 °C with a flow rate of 20 °C, 120-200 °C with a flow rate of 10 °C/min and 5 °C/min up to 310 °C for 5 min); Detector (280 °C).

Microbial quality

The microbiological quality was determined according to the indications of the European Directorate for the Quality of Medicines [10]. The germs sought were total flora, yeasts and moulds, gram-negative bacteria, *Escherichia coli*, Salmonella and *Staphylococcus aureus*. This control required the use of appropriate culture media, and the results obtained were interpreted according to the special provision for herbal medicines exclusively composed of one or more herbal drugs (whole, divided or powdered).

Determination of pH

The pH was determined by a pH meter by immersing the electrode in 1% (m/v) aqueous solutions of each powder. For each test, the measurement was performed three (03) times. The mean value and the standard deviation were calculated (m±standard deviation, n = 3) [14].

RESULTS AND DISCUSSION

The macroscopic and organoleptic characteristics, residual moisture content, pH, mean diameter and total ash of *Parkia biglobosa* trunk bark powders from the four localities are recorded in table 2.

Table 2: **Physicochemical characteristics of *Parkia biglobosa* powders**

Powder location	Macroscopical	RMC	pH	Particle size (Average powder diameter)	Total ash
Gonse	Brown, Pungent, Bitter, Astringent, Sandy	6.9909±0.0507	5.48±0.03	281.12	0.25
Yako	Brown, Pungent, Bitter, astringent, Sandy	7.8760±0.0048	5.42±0.00	289.39	0.09
Bobo	Brown, Pungent, Bitter, Astringent, Sandy	7.9778±0.0143	5.46±0.01	267.02	0.96
Nobere	Brown, Pungent, Bitter, Astringent, Sandy	7.9499±0.0266	5.46±0.01	257.8719	0.88

RMC*: Residual moisture content, All values of RMC and pH are expressed in terms of mean±SEM n=3

These results show that the powders from the 4 locatities have the same colour (brown), the same bitter taste, the same smell and the same texture. These characteristics can be used as recognition parameters for plant powders. These results could also be used to verify the purity level based on the presence or absence of foreign elements and to detect any falsification [15]. Indeed, to ensure the reproducible quality of the herbal drugs, the exact identification and the quality assurance of the raw material are essential because they eventually ultimately contribute to the drug's safety and efficacy [16].

The residual moisture content of the different powders was below 10%, with a significant difference between the THR of the Gonse powder (6.99%) and that of the other cities. The pH of the four powders was about 5.7, and there was no significant difference between the four pH powders ($P<0.05$).

The moisture contents of the powders ranged from 5.3567% to 6.833%, thus less than 10% (table 1), and according to the European Pharmacopoeia, the powders can be stored for a long time without mould or yeast growth [17].

Analysis of the particle size distribution shows that the average diameters ranged from 257.8719 to 281.115 μm. The average diameter of the powder in Gonse was 281.1155 μm, that of Yako 289.3851 μm. The Bobo and Nobere powders had the lowest mean diameters of 267.0196 μm and 257.8719 μm, respectively. Indeed, these results show that the powders were all homogeneous. According to the terminologies of the European pharmacopoeia, they were almost uniform in terms and are classified as moderately satisfactory. This particle size is involved in the physical and functional properties of a powder and could be used during extraction, as it influences solubility and wettability [18].

The ash contents are less than 5% m/m, and that of the Yako trunk bark powder was the lowest. These contents are related to the physicochemical characteristics of the soils and the climate of the different harvesting sites. Indeed, the ash content of plant material is helps detect contamination or adulteration with inorganic material, e. g. siliceous material (insoluble in ash acid), resulting from contamination of plant powders with sand or dust, also with mineral elements [19].

The results of the heavy metal contents of the powders are reported in microgram/gram (μg/g) of powder in table 3.

Table 3: Heavy metal content of *Parkia biglobosa* trunk bark powders

	Gonse (µg/g)	Yako (µg/g)	Bobo (µg/g)	Nobere (µg/g)
As	4.114±0.001	3.2560±0.001	3.2340±0.001	3.9340±0.002
Cu	2.6700±0.001	2.6900±0.003	2.9900±0.000	2.3100±0.000
Mn	44.3100±0.0009	46.4100±0.0004	35.4900±0.0010	74.5100±0.0011
Co	4.1800±0.0002	3.0200±0.0006	4.2800±0.0001	3.7800±0.0007
Cd	0.6800±0.0001	0.4800±0.0001	0.6800±0.0002	0.6000±0.0002
Pd	11.8700±0.0004	8.8300±0.0002	10.4700±0.0005	10.4100±0.0001

All values are expressed in terms of mean±SEM (n=3)

Table 3 shows that *Parkia biglobosa* trunk bark powders from Nobere contain the highest levels of manganese (Mn), with lead (Pb) being higher for Gonse. Other heavy metals did not vary significantly by locatities. These heavy metals included not only those on the lists of priority contaminants of international conventions and regulations (arsenic, lead, mercury, cadmium) because of their frequency and toxicity but also other heavy metals that can cause damage to the body [20, 21]. These heavy metals in *Parkia biglobosa* powders fell within the tolerated limits of average daily consumption in humans [22]. This constitutes a quality control reference and can be explained by the raw materials being collected according to good practices [23].

Residual pesticide levels in the trunk bark powders are recorded in table 4. The table shows that the powders from Yako and Gonse were above the limit.

Table 4: Concentration of pesticides in bark powders of *Parkia biglobosa* trunks barks

		Gonse	Yako	Bobo	Nobere	Limites
Organochlorines (mg. kg-1)	Aldrin	0.02	0	0	0.02	0.05
	Alachlor	0	0	0.02	0	0.05
	Dieldrin	0.22	0.02	0.02	0.06	0.05
	2,4-ddt	0.02	0.02	0.04	<DL*	1
	Op' ddt	0.02	<DL*	<DL*	<DL*	1
	Hcb	0.04	0	0.06	0	0.1
	Heptachlor	0.02	0.02	0	0	0.01
	Lindane	0.08	0.34	0	<DL*	0.06
Organophosphorus and	Azinfos ethyl	0.02	0.02	0	<DL*	0.01
nitrogen (mg. kg-1)	Diazinon	0.02	0.06	0	0.04	0.05
	Ethoprophos	0.2	0.1	0.02	0.08	0.2
	Heptenophos	0.06	0	0	0.04	0.1
	Monocrotophos	0.28	0.08	0.08	0.14	0.1
Pyrethroids (mg. kg-1)	Bifenthrin	0	0.02	0	0	0.2
	Cypermethrin	0.5	0.04	0.02	0.18	0.05
	Alfa-cypermethrin	0.22	0.06	0.06	0.3	0.05
	Deltamethrin	0	<DL*	0	<DL*	0.05
	Cyfluthrin	0.06	0.1	3	0.18	0.01
Carbamates (mg. kg-1)	Carbofuran	0	0.1	0.02	0.02	0.2
	Methomyl	0.08	0.06	0.04	0.12	1
Others (mg. kg-1)	Imazalil (fungicide)	0.08	0	0.02	0.1	5
	Betha-endosulfan (organochlorine)	0	0.02	0.02	0.02	3
	Propargite	0.04	0	0	0.02	5
	Alfa-endosulfan	0.6	0.1	<DL*	<DL*	3
	Simazine	0.02	0.32	0.24	0.4	2.5

DL*: Detectable Limit

These residual pesticide levels in the trunk bark powders are acceptable, except for the lindane levels detected in the powder from Yako and Gonse, which were 0.34 mg/kg and 0.08 mg/kg, respectively, above the limit. This may be due to the misuse of pesticides and the lack of environmental education of farmers; these powders cannot be directly used. Any use of raw material with pesticide contents above the limit requires prior treatment (bark washing, powder decoction), as heat and washing reduce the concentration of pesticides [24].

The microbial quality control of the powders from the four (04) harvesting sites gave the results listed in table 5.

Table 5: Microbial quality of *Parkia biglobosa* trunk bark powders

	Gonse	Yako	Bobo	Nobere	Specification
TAMC* CFU*/g	0	190	130	1998000	$\leq 10^3$
TYMC CFU/g	30	20	10	20	$\leq 10^2$
Gram-bacteria resistant to bile salts CFU/g	0	0	0	$\geq 10^3$	$\leq 10^3$
E. coli/1g	Absent	Absent	Absent	Absent	Absent
Salmonella/10g	Absent	Absent	Absent	Absent	Absent
Staphylococcus aureus/10g	Absent	Absent	Absent	Absent	Absent
Pseudomonas aeruginosa/10g	Absent	Absent	Absent	Absent	Absent

TAMC*: Total Aerobic Microbial Count, CFU*: Colony Forming Unit, TYMC*: Total yeast and mold count, Assay was performed in triplicate (n=3) and the results are expressed the mean of three values±standard deviation

It emerges a total absence of E coli, salmonella, staphylococcus and pseudomonas in the powders resulting from the four sites of harvests. However, the presence of total aerobic germs is higher than the specification in the powder from Nobere.

The microbial quality of the powders complies with the recommendations of the European Pharmacopoeia for natural raw materials administered by the oral route [10]. The absence of specific pathogens such as *Salmonella*, *E coli*, *Pseudomonas*, *staphylococci* and the low presence of total flora and yeast on Gonse, Bobo and Yako proves the good microbial quality of the plant powders. However, the bark powders from the Nobere harvesting site had total aerobic germ (DGAT) values above the European Pharmacopoeia specifications. This indicates contamination possibly related to the environment, harvesting, packaging, transport, drying or grinding methods [25].

CONCLUSION

Preliminary physicochemical and contaminant studies were conducted on *Parkia biglobosa* trunk bark powders from different climatic zones in Burkina Faso. The characteristics of the powders from the four localities showed that the *Parkia biglobosa* powders from Gonse, Bobo and Yako complied with the European Pharmacopoeia standards for medicinal plant substances. Thus, the Physico-chemical characteristics and the contamination by the studied organic, inorganic materials constitute elements of monitoring for the guarantee of the quality of the raw materials. These investigations should help in the correct identification, characterization and determination of the appropriate harvesting site for the formulation work.

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AUTHORS CONTRIBUTIONS

All authors had similar contributions to manuscript writing, literature research, review design, literature analysis and final text approval.

CONFLICT OF INTERESTS

The authors declared that the no conflict of interest for the given article.

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