Pharmacotechnical and biological characterization of a cream formulation based on aqueous extract of the trunk bark of *Parkia biglobosa* Jacq. (Fabaceae-Mimosoideae) intended for the treatment of inflammation

ATCHADE Boladé Constantin[1,2,*], OUEDRAOGO Salfo[1,2], TRAORE Tata Kadiatou[2], BONOU-SELEGBE Isanorelle[1], SOMBIE Bavouma Charles[1], ZIME-DIAWARA Hermine[1], YAMEOGO Josias B.G[1], OUEDRAOGO Noufou[2], SEMDE Rasmané[1].

[1] Laboratoire de Développement du Médicament (LADME), Centre de Formation, de Recherche et d'Expertises en Sciences du Médicament (CEA-CFOREM), École Doctorale Sciences de la Santé (ED2S), Université Joseph KI-ZERBO, BP 7021, Ouagadougou (Burkina Faso).

[2] Laboratoire de Recherche-Développement de Phytomédicaments et Médicaments (LR-D/PM), Institut de Recherche en Sciences de la Santé (IRSS), Centre National de la Recherche Scientifique et Technologique (CNRST) BP 7047 Ouagadougou (Burkina Faso).

Date de réception : 30 Avril 2025 ; Date de révision : 27 Juin 2025 ; Date d'acceptation : 15 Juillet 2025.

Abstract:
Parkia biglobosa is a plant widely used in traditional medicine to treat pathologies with an inflammatory component. This study aimed to formulate, characterize, and determine the efficacy of a cream based on an aqueous extract of *Parkia biglobosa* trunk bark. Different proportions of extract were used in the formulations to identify the most effective formulation and also the impact of the extract on the preparations. Shea butter was used in the fat phase and Tween 60 / Span 60 was used as a surfactant. Direct emulsification is the technique used to prepare O/W emulsions. The creams obtained were subjected to quality control tests (macroscopic characteristics, pH, viscosity, microscopy) and efficacy tests. The tracer was detected by thin-layer chromatography. The creams were homogeneous and brown. The pH of the preparations containing the extract varied between 7.02 and 7.2. Viscosity was a function of the proportion of extract in the preparations. The 3% cream therefore had the highest viscosity at 29.414 mPas. Microscopy revealed the particle size of the preparation. Research into the tracer revealed the presence of flavonoids. The antioxidant activity by inhibiting the ABTS radical and lipid peroxidation enabled the anti-inflammatory mechanism of action of the cream based on *Parkia biglobosa* trunk bark to be identified. Cream made from *Parkia biglobosa* trunk bark powder could be an alternative to the suppository form.

Keywords: Pharmacotechnical, Antioxidant activity, Cream, *Parkia biglobosa*, Inflammations.

Caractérisation pharmacotechnique et biologique d'une formulation de crème à base d'extrait aqueux d'écorce de tronc de *Parkia biglobosa* Jacq. (Fabaceae-Mimosoideae) destinée au traitement de l'inflammation

Résumé :
Parkia biglobosa est une plante largement utilisée en médecine traditionnelle pour traiter les pathologies à composante inflammatoire. Cette étude visait à formuler, caractériser et déterminer l'efficacité d'une crème à base d'un extrait aqueux d'écorce de tronc de *Parkia biglobosa*. Différentes proportions d'extrait ont été utilisées dans les formulations afin d'identifier la formule la plus efficace et d'évaluer l'impact de l'extrait sur les préparations. Le beurre de karité a été utilisé en phase grasse et le Tween 60 / Span 60 comme tensioactif. L'émulsification directe est la technique utilisée pour préparer les émulsions H/E. Les crèmes obtenues ont été soumises à des tests de contrôle qualité (caractéristiques macroscopiques, pH, viscosité, microscopie) et à des tests d'efficacité. Le traceur a été détecté par chromatographie sur couche mince. Les crèmes étaient homogènes et brunes. Le pH des préparations contenant l'extrait variait entre 7,02 et 7,2. La viscosité était fonction de la proportion d'extrait dans les préparations. La crème à 3 % présentait donc la viscosité la plus élevée, soit 29,414 mPas. La microscopie a révélé la granulométrie de la préparation. L'analyse du traceur a révélé la présence de flavonoïdes. L'activité antioxydante par inhibition du radical ABTS et de la peroxydation lipidique a permis d'identifier le mécanisme d'action anti-inflammatoire de la crème à base d'écorce de tronc de *Parkia biglobosa*. La crème à base de poudre d'écorce de tronc de *Parkia biglobosa* pourrait constituer une alternative à la forme suppositoire.

Mots-clés : Pharmacotechnique, Activité antioxydante, Crème, *Parkia biglobosa*, Inflammations.

Introduction

Parkia biglobosa is a plant widely used in Africa for its many nutritional (Termote et *al*., 2022) and therapeutic (Houndonougbo et *al*., 2020; Airaodion et *al*., 2020) properties. From the Fabaceae-Misosoideae family, commonly known as Néré, *P. biglobosa* is a species from the Sudanian and Sudano-Guinean savannas, widespread in fields and fallow land, and found in around twenty countries (Fafunké et *al*., 2016). The pulp of *P. biglobosa* is a source of food (Burlando, et *al*., 2019) for local populations, especially during the lean season, and the seeds of néré are generally fermented to produce a condiment commonly known as soumbala (Cisse et *al*., 2023). In addition to its nutritional properties, *P.biglobosa* is used in traditional medicine to treat several illnesses (Saleh et *al*., 2021 ; Kandeda et *al*., 2022 ; Adewale et *al*., 2011).

(*) Correspondance : ATCHADE B.C. ; e-mail : constantinatchade@yahoo.fr ; tél. : (+226) 63590115.

These include diseases with an inflammatory component. Inflammation is associated with the production of free radicals. Free radicals can maintain the inflammatory state, leading to chronicity. In this sense, medicinal plants benefit human health by preventing chronic inflammation. This effect is possible because of their content of secondary metabolites (Kagambega et *al*., 2022). Polyphenols are thought to have anti-inflammatory, antioxidant, immunomodulatory, and analgesic properties (Lipiński et *al*., 2017).

Among the plants most commonly used in traditional medicine to treat diseases with an inflammatory component, *Parkia biglobosa Jacq*, in the form of trunk bark, was cited (Kagambega et *al*., 2022). Previous studies have demonstrated the general and local anti-inflammatory, analgesic, and antioxidant activity of the aqueous extract of *Parkia biglobosa* trunk bark (Ouedraogo et *al*., 2020). A suppository formulation has been developed (Atchadé et *al*., 2024) to to treat hemorrhoidal crisis. To propose an alternative galenic form to the suppository form, we set ourselves the target of producing pharmaceutical-quality emulsions that would be effective in the treatment of diseases with an inflammation component.

1. *Material et methods*

1.1. Material

The plant material, consisting of trunk bark of *Parkia biglobosa* (Jacq) Benth, was collected in May 2020 in Bobo-Dioulasso, Burkina Faso. One specimen was identified as number 8757 in the National Herbarium of Burkina Faso (HNBU) of the National Center for Scientific Research and Technology (CNRST). The bark was ground and the powder stored in a sealed plastic bag.

The aqueous extract of *Parkia biglobosa*, which constitutes the active ingredient of the formulation, was obtained after reflux decoction for 20 minutes of 20 g of powder dispersed in 500 mL of distilled water.

The resulting decoction was freeze-dried using an Alpha1-4 LSC basic freeze-dryer. The characterization of the extract was carried out in a previous study (Atchadé et *al*., 2024).

1.2. Methodology

- ***Cream formulation and preparation***

A formulation was developed with a variation in the extract proportion from 0.25 to 3 %. A blank formulation without extract was developed as a control. The formulation is composed of two phases, one hydrophilic and the other lipophilic. To facilitate mixing of the phases, a pair of surfactants was used (Le Hir et *al*., 2009). The composition of the creams is presented in Table I.

Table I: Formulation of cream based on *Parkia biglobosa* extract

Denomination	F1	F2	F3	F4
P.biglobosa aqueous extract (%)	0.25	0.5	1	3
Shea butter (%)	25	25	25	25
Cetyl Alcohol (%)	4	4	4	4
Span®60 (%)	2.38	2.38	2.38	2.38
Tween®60 (%)	3.12	3.12	3.12	3.12
Aqua conservans ad (g)	100	100	100	100

F: *Formulation*

The direct hot emulsification method was used to prepare the cream (Le Hir et *al*., 2009).

Two methods of incorporating the extract were used. The first involved mixing the extract with the aqueous phase (Process 1) and the second involved adding the extract at the end of emulsification (Process 2).

The aqueous phase consisted of Aqua Conservans and Tween®60, and the oily phase of Shea Butter consisted of Span®60. Both phases were heated in a water bath to 75 °C. When both phases reached a temperature of approximately 70°C, emulsification was performed using an IKA propeller stirrer.

The oily phase was added dropwise while stirring vigorously. After adding the internal phase, the preparation was removed from the water bath to cool while stirring continuously.

The creams were packaged in 100 g aluminium tubes at a temperature of 25 °C.

- ***Pharmacotechnical quality of preparations***

A pharmaceutical control was carried out on the preparations obtained according to the requirements of the European Pharmacopoeia 10th Ed (EDQM, 2019). The tests carried out were:

- ***Macroscopic and sensory analysis***

The characteristics assessed were: appearance, colour, odour, consistency, ease of spreading and

the presence or absence of a sticky effect after application.

- ***pH measurement***

The pH was determined using the ebro* PHT 810 pH meter at Day 0. The pH meter electrode was immersed directly into the homogenised preparation. The test was carried out in triplicate. The mean (m) and standard deviation (σ) were calculated (m ±σ, n=3).

- ***Viscosity measurement***

Viscosity was measured at 25°C using a Brookfield LVDV rotary viscometer with coaxial cylinders and its R3 mobile arm, to which a small-volume adapter (external cylinder) was fitted. The viscosity of the cream was measured at moving arm rotation speeds ranging from 0.3 to 100 rotations per minute (rpm). Shear rates D (s-1) were obtained by multiplying the rotational speed read of the instrument (in rpm) by 1.32.

- ***Microscopic appearance***

The purpose of the microscopic examination of the creams was to check the homogeneity of the dispersed droplets. A Karl Zeiss microscope with a 10x magnification eyepiece was used. The eyepiece was fitted with a graduated micrometer scale. The observation was carried out on samples of cream (previously diluted 1:10 with distilled water) spread out in a thin layer between the slide and coverslip. During reading, the size range was divided into 4 particle classes: 0-5 µm; 5-10 µm; 10-15 µm; 15-25µm.

- ***Phytochemical characterization and antioxidant activity***

  - ***Identification of flavonoids by Thin Layer Chromatography (TLC)***

The method described by (Wagner et *al.*, 1996) was used, and a volume of 5 µL of the methanolic solution and the extract at a concentration of 4 mg/mL was deposited on a thin-layer silica gel stationary phase (Silica G-60; $_{F254}$; 10 cm × 5 cm; rigid aluminium support). The chromatography plates were eluted over a path of 8 cm in a glass tank containing the ethyl acetate-methanol-water (9-1-1) solvent system (Mamyrbekova-bekro et *al.*, 2013).

After elution, the chromatoplates were removed and dried at room temperature (25 °C) and then in a ventilated oven (40 °C) for 5 min. The dried chromatoplates were developed with Neu's reagent and then observed under UV light at 365 nm.

  - ***Dosage of flavonoids***

Flavonoids were determined using the method of (Kumaran et *al.*, 2007), adapted by (Abdel-Hameed, 2009). Two (2) mL of samples (extract and cream) with a concentration of 1 mg/mL in methanol were mixed with 2 mL of aluminium trichloride ($AlCl_3$ 2%) in methanol. After 40 min incubation, absorbance was measured at 415 nm. The white control tube consisted of 2 mL of methanol. The quantity of flavonoids, expressed as quercetin equivalent (QE).

- ***Antioxidant activity of formulations***

Antioxidant activity by inhibition of the 2,2'-azino-bis(3-ethylbenzthiazoline-6-sulfonic acid (ABTS) radical and lipid peroxidation (LPO) were used to assess the biological activity of the extract and cream.

  - ***Antioxidant activity by reduction of the 2,2'-azino-bis(3-ethylbenzthiazoline-6-sulfonic acid***

The method used is that described by (Arts et *al.*, 2004)**.** The concentration of the extracts used was 1mg/mL and that of the creams 10 mg/mL. This test is based on the oxidation-reduction mechanism of ABTS (ammonium salt of 2,2'-azino-bis(3-ethylbenzthiazoline-6-sulfonic acid). The ABTS salt loses an electron to form a radical cation ($ABTS^+$) in the presence of a free-radical scavenger. This reduction of $ABTS^{\bullet+}$ results in a green discoloration of the solution.

96-well microplates were used. Trolox was used as the reference substance. Each well for each concentration was filled and placed on a 96-well microplate with 200 µL of ABTS solution mixed with 20 µL of samples or reference. The whole was incubated for 30 minutes at 25°C and the absorbances were read at 415 nm and the 50% inhibitory concentration was determined.

  - ***Antioxidant activity by inhibition of lipid peroxidation***

The principle consists of inducing lipid peroxidation of rat liver homogenate *in vitro* with a mixture of ferric bichloride ($FeCl_2$) and hydrogen peroxide (H_2O_2). Peroxidation is inhibited in the presence of a substance with inhibitory activity. The method of (Ohkawa et *al.*, 1979) modified by (Sombie et *al*., 2011) with a few modifications was used. 0.2 mL of the samples (concentration 1.5 mg/mL for the extract and 10mg/mL for the cream) was mixed with 1 mL of 1% Wistar rat liver homogenate, then 50 µL of $FeCl_2$ (0.5 mM) and 50 µL of H_2O_2 (0.5 mM) were added. The mixture was incubated at 37°C for 60 minutes, then 1 mL of trichloroacetic acid (15 %) and 1 mL of 2-thiobarbituric acid (0.67%) was added and the mixture was heated in boiling water for 15 minutes. The absorbance was read at 532 nm and Trolox was used as the reference product. The percentage inhibition was determined.

- ***Statistical analysis***

Data analysis of the tablet test results was performed with GraphPad Prism software

version 10.3.1 using a One-way ANOVA test at a 95 % confidence level. The physicochemical and pharmacotechnical characteristics were interpreted according to the European Pharmacopoeia 10th Ed requirements.

2. *Result*

- ***Quality control of Parkia biglobosa extract***

The characteristics of Parkia biglobosa extract are given in the table II below.

The extract powder was brown in colour, odourless, with a fine texture and an astringent taste. It had a moisture content of 4.67 %, a pH of 7.17 and a particle size that reflected its texture, with very fine particles.

- ***Assessing the quality of creams***

To reassure ourselves of the quality of the creams prepared and therefore check compliance with the European pharmacopoeia, pharmacotechnical tests were carried out. The table III below summarises the various results obtained.

Table II: Macroscopic and organoleptic characteristics of the extract

	Organoleptic characteristics		RMC (%)	pH	Particle size
Extract	Colour	Brown	4.67	7.17	100 µm
	Odour	Characteristic of shea butter			
	Taste	Astringent			
	Texture	Fine			

Table III: Physico-chemical characteristics of creams

Physico-chemical parameters		Preparation			
		CPB 0.25%	CPB 0.5%	CPB 1%	CPB 3%
Macroscopic characteristics	Appearance	Homogenous	Homogenous	Homogenous	Homogenous
	Consistency	Semi-solid	Semi-solid	Semi-solid	Semi-solid
	Colour	Brown	Brown	Brown	Brown
	Odour	Shea butter	Shea butter	Shea butter	Shea butter
	Physical stability	No phase separation			
pH (J0) ($\bar{m} \pm \sigma$, n=3)		7.03 ± 0.3**	7.01 ± 0.04**	7.18 ± 0.58**	7.2 ± 0.2**
Viscosity ($\bar{m} \pm \sigma$, n=3) aisle in mPas at 0.3rpm(J2)		21227 ± 2162***	24221 ± 1157***	29390 ± 4287***	29414 ± 2041***
Average diameter (µm) of droplets in creams (n=3)		3.63 ± 0,7***	4.89 ± 0,48***	4.26 ± 0,7***	5.01 ± 0.24ns

ns: not significant ; *n = 3; ***P < 0.05 Vs Blank: (ANOVA analysis)

Figure 1: Creams from aqueous extracts of the trunk bark of *Parkia biglobosa*

The pharmacotechnical tests carried out to control the quality of the creams focus mainly on macroscopic characteristics, pH, physical stability, viscosity and microscopy. The neutral cream containing no extract was used as a control to determine the impact of the extract on the quality parameters of the creams. The results showed that the creams were brown with an odour characteristic of shea butter. The creams had a semi-solid consistency with a homogeneous appearance for creams made using process 1 and a heterogeneous appearance for creams made using process 2. No phase separation was observed.

The pH of the extract-based creams varied between 7.01 and 7.2, with a significant

difference between the neutral cream and the creams containing the extracts.

Viscosity varied between 18250 and 29414 mPas. The viscosity of the creams increased with the proportion of extract in the preparation. Viscosity was measured at 25°C using a rotary cylinder viscometer and its R3 mobile arm (internal cylinder). The viscosities of the creams were measured at mobile arm rotation speeds ranging from 0.3 to 100 rotations per minute (rpm). The rheogram (a graphical representation of the viscosity as a function of the shear rate of the creams) was established and the rheological profile was determined.

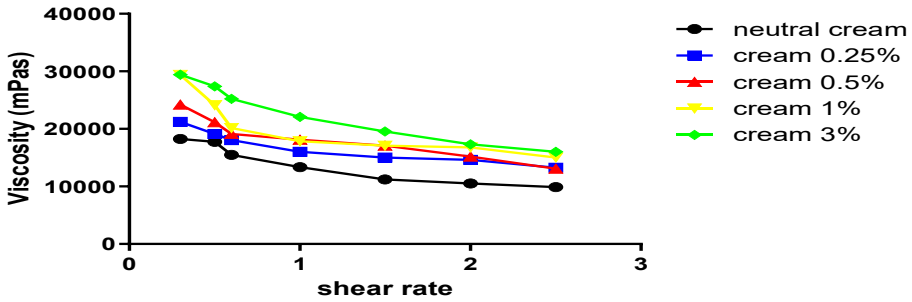


Figure 2: Flow rheograms of creams at D2 at 25 °C with the R3 mobile arm

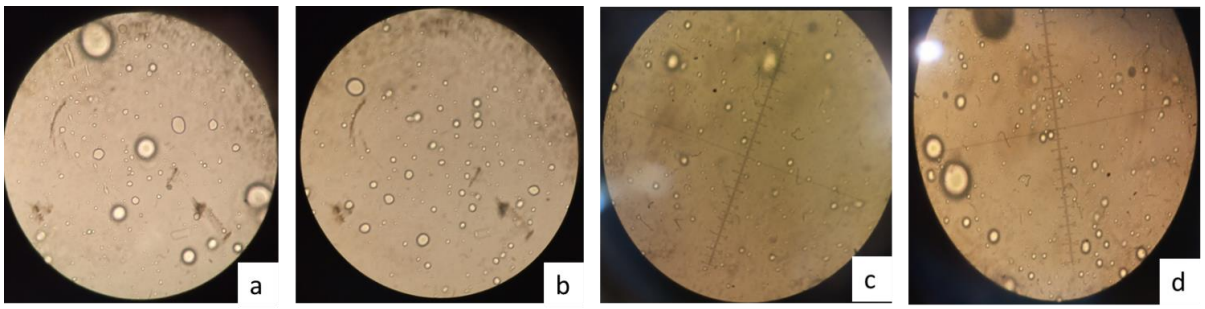
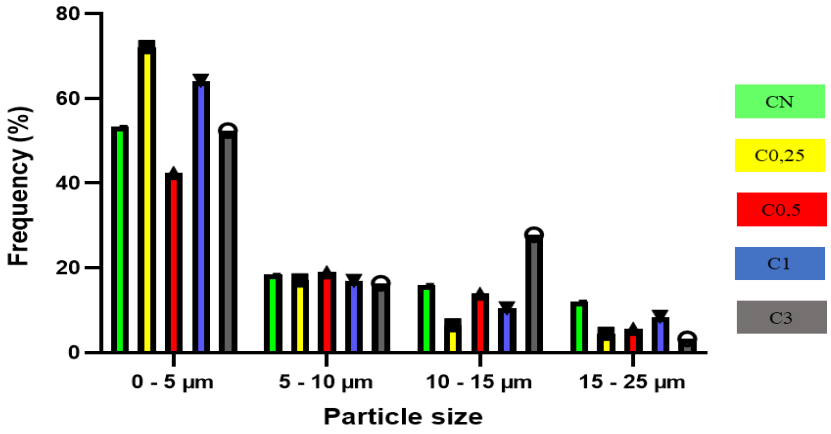


Figure 3: Light microscopy images of the creams

a. Shea butter-based cream containing *Parkia biglobosa* extract *0.25% ;* **b.** Shea butter-based cream containing *Parkia biglobosa* extract *0.5 ;* **c.** Shea butter-based cream containing *Parkia biglobosa* extract *1% ;* **d.** Shea butter-based cream containing *Parkia biglobosa extract 3%*.

The various images in the figure show that the oil droplets are spherical. Furthermore, the incorporation of *Parkia biglobosa* extract does not lead to any variation in the morphological distribution of the oil droplets. The particles in the creams are homogeneous, with a predominance of 0-5µm particles.



CN: Neutral cream**; C0.25:** Cream 0.25 %**; C0.5:** Cream 0.5 %**; C1:** Cream 1 %; **C3:** Cream 3 %.

Figure 4: Particle size distribution of the different batches of cream

- ***Tracer identification and assay***

Identification by Identification by the layer thin-layer chromatography method revealed the presence of flavonoids in the cream and extract. The table shows the results of the layer thin-layer chromatography of the *Parkia biglobosa* extract and the preparations revealed by the NEU reagent (Table V).

Phytochemical screening revealed traces of flavonoids in the cream and a clear presence in the extract. A quantitative study was carried out to determine the content in the creams and extracts (Table VI).

The dosage of the creams shows that the flavonoid content is proportional to the extracted content. The 3% cream therefore has a significantly higher flavonoid content of 0.868 µg/mg EQ. The extract has a significantly higher flavonoid content than the creams.

- ***Biological activity of the formulations***

The results of the antioxidant activity of the extracts are shown in the table VII below:

Table V: Phytochemical screening by TLC of the preparations produced

	Extract	Cream (Emulsion)
Flavonoids	+	+
Solvent system	Ethyl acetate - Methanol - Water(9 - 1 -1)	

+ : *Presence*

Table VI : Flavonoid assays *n = 3; ***P < 0.05 Vs Extract (ANOVA analysis)

Extract concentration / Formulation	Extract concentration / Formulation (µg/mg EQ)
0.25 % cream	0.0724 ± 0.0017***
0.5 % cream	0.144 ± 0.02***
1 % cream	0.289 ± 0.01***
3 % Cream	0.868 ± 0.012***
Extract	28.96 ± 0.50

Table VII : Antioxidant activity of the preparations ***n = 3 ; ***P < 0.05 Vs Trolox ; ### P < 0.05 Vs zileuton: (ANOVA analysis)**

Extract / Cream	ABTS	LPO
	IC_{50} (µg/mL)	% inhibition
Extract	2.33 ± 0.0018 ns	42.41±0.19***
0.25% cream	Id	23.10±4.70***
0.5% cream	Id	25.05±2.37***
1% Cream	25.9 6± 0.005***	54.29±0.11***
3% Cream	9.57±0.17*	44.68±4.43
Trolox	4.37±0.005	75.82±0.9

Id: undetectable; ns: not significant

3. *Discussion*

The use of refined shea butter is explained by the absence of free fatty acids and oxidation products (hydroperoxides, peroxides, aldehydes, etc.), unpleasant aromas, colourings, toxic products (pesticides, glycosides) and phospholipids (Abdel-Razek et *al*., 2010).

- ***Incorporation of the extract***

The preparation process that enabled homogeneous preparations to be obtained was the process consisting of incorporating the extract into the aqueous phase before emulsification. Adding the extract after emulsification (Process 2) does not encourage total dissolution of the extract, giving the preparation a heterogeneous appearance. As the emulsion is biphasic, with an aqueous phase and a lipophilic phase, the particles of the internal phase (lipophilic) do not favour the total dissolution of the aqueous extract.

Dispersion of the extract in the aqueous phase results in a homogeneous mixture, with the extract having good solubility in water. In this condition, the extract seemed to be partially protected in the aqueous phase, which certainly

helped to obtain uniform preparations (Derbal et *al*.,2024).

- ***Influence of different extract concentrations***

The extract was added at different concentrations, 0.25%, 0.5%, 1% and 3%. This variation in content did not lead to instability of the different preparations. The variation in extract content probably does not lead to any chemical modification of the surfactants used. Similar studies on the formulation of creams based on plant extracts show that the variation in the content of plant extracts has little influence on the homogeneity of the preparations (Tasleem et *al*., 2017; Naveed et *al*., 2012; Moldovan et *al*., 2017).

- ***Macroscopic characteristics***

The creams prepared were all homogeneous, brown in colour, with a characteristic shea butter odour and a semi-solid appearance. The homogeneous appearance of the preparations allowed them to spread well, thus promoting better adherence to the treatment (Martini, 2003).

- ***pH***

The pH is an important parameter in the formulation of creams to promote good chemical stability of the preparation. Indeed, when the pH value deviates from the stability pH, it could adversely affect the chemical stability and pharmacological activity of the extract and could lead to therapeutic failures (Le Hir et *al*., 2009). In addition, a pH too high above the pH of the site where the cream is applied can cause peeling, and if the pH is too low, the cream can -irritate (Hakim et *al*., 2020; Hernani et *al*., 2022).

The average rectal pH is 9.6; however, there is a wide range of rectal pH values (pH 7.2-12.1) (Hua, 2019). The pH of the formulations prepared was between 7.01 and 7.2. The pH of the creams is close to the rectal pH range. It has been found that varying the extract content does not affect the pH of the creams. A cream pH close to the pH of the extract and the site of administration stimulates immune cell activity and protects against invading micro-organisms (Percival et *al*., 2014).

- ***Viscosity***

The neutral cream containing no extract had the lowest viscosity (18250 mPas). The viscosity of the creams containing extract increased as the extracted content increased. The viscosities of the creams rose from 21227 (Cream 0.25 %) to 29414 for the cream with 3 % extract. This increase in viscosity is probably due to a reorganisation of the structure of the preparations. The incorporation of the extract in different proportions influenced the internal structure of the emulsion, leading to an increase in viscosity (Nunes et *al*., 2021). The extracts would therefore be made up of polysaccharide compounds that increase the viscosity of the preparations. Viscosity is also a function of the average size and distribution of the drops (Filipovic et *al*., 2017), dependent on the formulation and the equipment used (Pascal, 2007). This increase in the viscosity of creams favours good stability of the preparation by reducing the sedimentation rate due to gravity. According to the stock law, an increase in viscosity decreases the sedimentation rate and therefore makes it possible to have a stable preparation by avoiding phase separation.

The rheogram shows the flow curves of the preparations as the shear rate increases. There is a decrease in the emulsion system as the shear rate increases (rising curve), indicating a gradual breakdown of the formulation structure. Similar behaviour has been observed by some authors(Nunes et *al*., 2021; Ecaterina et *al*., 2018)

This type of behaviour is characteristic of non-Newtonian fluids of the rheo-fluidizing or pseudoplastic type (Imran et *al*., 2018; Esposito et *al*., 2021).

This decrease in viscosity under the effect of the shear rate is due to the semi-flexible molecular structure of the preparation (Nunes et *al*., 2021), molecular structuring is rapidly broken down droplets aligning at a high shear rate to support the formulation's ability to spread over the mucosa (Fabbron-Appas et *al*., 2021).

- ***Microscopic examination***

The size and polydispersity of the oil droplets are critical quality attributes of the emulsion drug product that can potentially affect the bioavailability of the drug (Patil et *al*., 2019). Figure 3 shows the globule size distribution of the prepared creams, reflecting a statistical inventory of the fragmentation of the dispersed phase, assessed by focusing the optical microscope. The dispersed particles were evenly distributed. Particles between 0-5 µm in size were the most represented, accounting for around 50 % of the particles in the different formulations. This predominance of small particles could therefore favour the stability of the preparations by reducing the sedimentation rate, which is a form of instability.

There was no significant difference ($p<0.05$) between the base cream (5.12 µm) and the 4 preparations containing the highest proportion of extract (5.01 µm). However, there was a significant difference ($p<0.05$) between the base formulation and the F1, F2 and F3 formulations

containing 0.25 %, 0.5 % and 1 % extract respectively. These results show that neither the presence of extract nor the proportion of extract in the formulations influences the particle size of the oily droplets and therefore the particle size distribution of the emulsion particles. Furthermore, the extract was added to the preparation in soluble form, which helps to reduce particle size. It should be noted that no particles of *Parkia biglobosa* powder were observed, which could justify that the *Parkia biglobosa* powder incorporated into the preparations was entirely solubilised.

Various studies (Franco-Gil et *al*., 2024) have demonstrated the value of small particles in the preparation of emulsions. Indeed, the size of the particles improves the absorption of the emulsions and therefore promotes the bioavailability of the cream.

The various cream formulations produced meet the specifications of the European Pharmacopoeia 10th Ed. However, the 1 % and 3 % creams appear to be the most optimal formulations, with a particle size distribution, pH and viscosity that promote better tolerance and stability of the cream. Biological activity will therefore make it possible to define the most suitable formulation for the treatment of diseases with an inflammatory component.

- ***Phytochemical study and biological activity***

The dose of the extract in the cream represents respectively 0.25 %, 0.5 %, 1 % and 3 % of the total mass of the preparations. Several studies have demonstrated the anti-inflammatory activity of flavonoids (Coulibaly et *al.,* 2020). Previous studies on the aqueous extract of *Parkia biglobosa* demonstrated the presence of flavonoids in the extract with evidence of its ability to reduce inflammation and pain (Ouedraogo et *al*., 2020). Flavonoids were therefore chosen as the tracer.

Phytochemical screening of the creams revealed the presence of flavonoids after revelation with the NEU reagent. This result proves that the emulsification technique used, the heat input and the order in which the extract was added during preparation did not influence the presence of flavonoids in the preparations.

The assay confirmed the presence of flavonoids in the preparations. The flavonoid content is dose-dependent. There was an increase in flavonoid content proportional to the proportion of extract in the emulsions.

Based on the promising biological activities of *Parkia biglobosa* trunk extracts, biological tests were carried out to identify the mechanism of action of the extracts (Active) contained in the emulsions.

Oxidative stress is considered to be an imbalance between the production of reactive oxygen species (ROS) and their elimination by protective mechanisms, which can lead to inflammation (Hussain et *al.,* 2016; Mancini et *al.,* 2016) or can maintain inflammation as in haemorrhoidal disease (Belemlilga et *al.,* 2019).

Two (02) antioxidant tests (ABTS and LPO) were used to assess the antioxidant power of *Parkia biglobosa* trunk bark preparations.

The ABTS antioxidant test was used to quantify the antiradical potential of the H-donor compounds contained in the preparations. The assessment of antioxidant activity by the ABTS method was determined on the basis of the inhibitory concentration (IC_{50}). This is the concentration of the preparations that caused 50% inhibition. The 3 % cream showed better anti-free radical activity with 9.57 µg/mL compared to the 0.25 %, 0.5 % and 1 % creams respectively. This difference in activity is due to the higher flavonoid content in the 3 % cream. The antioxidant activity of ABTS is dose-dependent. Flavonoids have antioxidant properties (Bouterfas et *al.,* 2016). The ABTS test was used to quantify the anti-free radical potential of the H- donor compounds (Tsvetkova et *al*., 2023) contained in the preparations and the result obtained allows this property to be attributed to the preparations. The extract maintained its anti-free radical activity (2.33 µg/mL) after incorporation into the base, thus confirming the anti-free radical activity by inhibition of the ABTS free radical.

To confirm the antioxidant activity, the inhibitory effect on lipid peroxidation of the preparations was assessed at a single concentration (150 µg/mL). Inhibition percentages ranged from 23.1 to 54.34%, with the 1 % cream showing the best activity. The Trolox used as a reference product showed 75.82% inhibition at a concentration of 150 µg/mL. It is well known that several inflammatory chemical reactions cause various types of tissue damage through lipid peroxidation (Chaki et *al.,* 2019). Creams containing *P.boglobosa* trunk bark extract could maintain and even improve the antioxidant effect, both by eliminating free radicals *in vitro* and by inhibiting the lipid peroxidation process. The antioxidant capacity of the various preparations thus reflects their ability to trap the free radicals formed during inflammation.

Conclusion

The pharmacotechnical study of creams based on aqueous extract of *Parkia biglobosa* Jacq. trunk bark determined their characteristics for use in the treatment of inflammation due to hemorrhoidal attacks. The creams, containing 0.25 to 3 % extract, have an acceptable pharmacotechnical profile, with a pH and viscosity suitable for therapeutic use. The fine particle size allows for good absorption of the active ingredient. Previous studies have demonstrated the extract's efficacy. This biological activity of the extract could be due to the presence of phenolic compounds. Therefore, to confirm the presence of active ingredients in the creams, a tracer (flavonoids) was chosen. Phytochemical tests revealed the presence of the tracer (flavonoids) and determined its content in the preparations. Evaluation of antioxidant activity revealed that both preparations have the ability to reduce the ABTS radical and inhibit lipid peroxidation. This study shows that the aqueous extract retained its antioxidant and anti-inflammatory properties in the different preparations. The results obtained in this work remain experimental, and one of the main challenges lies in the stability and in vivo efficacy of the creams.

Références

Abdel-Hameed El-Sayed Saleh, 2009. « Total phenolic contents and free radical scavenging activity of certain Eyptian Ficus species leaf samples ». *Food Chemistry,* **114** (juin), 1271-77. https://doi.org/10.1016/j.foodchem.2008.11.005

Abdel-Razek, A. G., Abo-Elwafa, G. A., Al-Amrousi, E. F., Badr, A. N., Hassanein, M. M. M., Qian, Y., Siger, A., Grygier, A., Radziejewska-Kubzdela, E., & Rudzińska, M., 2023. Effect of Refining and Fractionation Processes on Minor Components, Fatty Acids, Antioxidant and Antimicrobial Activities of Shea Butter. *Foods (Jounal)*, ***12***(8), 1626. https://doi.org/10.3390/foods12081626

Adewale A, Winston A.M, Olivia C., 2011. Ethnopharmacological survey and *in vitro* evaluation of wound-healing plants used in South-Western Nigeria. *Journal of Ethnopharmacology,* **137** (1), 50-56. DOI: 10.1016/j.jep.2011.03.073

Airaodion A.I., Emmanuel O.O., 2020. Ameliorative Effect of *Parkia Biglobosa* (African Locust Bean) against Egg-Yolk Induced Hypertension. *International Journal of Bio-Science and Bio-Technology,* **12** (5), 17-25.

Arts M.J. T. J., J. Sebastiaan Dallinga, Hans-Peter Voss, Guido R. M. M. Haenen, et Aalt Bast., 2004. A New Approach to Assess the Total Antioxidant Capacity Using the TEAC Assay. *Food Chemistry* **4** (88), 567-70. https://doi.org/10.1016/j.foodchem.2004.02.008.

Atchadé C, Ouedraogo S, Traore T, Yameogo J, Sombié B, Zime-Diawara H, Ouedraogo N, et Semdé R., 2024. Essai de formulation de suppositoires à base d'extraits aqueux des écorces de tronc de *Parkia biglobosa* Jacq. (Fabaceae-Mimosoideae) pour la prise en charge de l'inflammation due à la crise hémorroïdaire. *Journal Africain de Technologie Pharmaceutique et Biopharmacie (JATPB),* **3**, 8-20. DOI: 10.57220/jatpb.v3i1.178

Belemlilga M.B, Traoré T.K, Boly G.A.L, Ouédraogo N, Traoré A, Lompo M, Ouédraogo S, et Guissou I.P., 2019. « Evaluation of Antioxidant, Anti-Inflammatory and Analgesic Activities of Leaves of *Saba Senegalensis* (A.DC) Pichon (Apocynaceae) ». *European Journal of Medicinal Plants* no.48364, 27(3), 1-12 ; DOI: 10.9734/ejmp/2019/v27i330116

Bouterfas K., Z. Mehdadi, M. M. Elaoufi, A. Latreche, et W. Benchiha., 2016. « Antioxidant activity and total phenolic and flavonoids content variations of leaves extracts of white horehound (*Marrubium Vulgare* Linné) from Three Geographical Origins ». *Annales Pharmaceutiques Francaises,* **74** (6), 453-62. https://doi.org/10.1016/j.pharma.2016.07.002

Burlando B, Silvio P, et Laura C., 2019. « Nutritional and medicinal properties of underexploited legume trees from West Africa ». *Critical Reviews in Food Science and Nutrition,* 59 (sup1): S178-88. https://doi.org/10.1080/10408398.2018.1551776

Chaki T, Naoyuki H, Yusuke Y, Shunsuke T, Yasuyuki T, et Michiaki Y., 2019. « Lipid Emulsion, but not propofol, induces skeletal muscle damage and lipid peroxidation ». *Journal of Anesthesia,* **33** (6), 628-35. https://doi.org/10.1007/s00540-019-02676-8

Cisse H, Issaka O, Oumarou S, et Mipro H., 2023. « Analyse de La Chaîne de Valeur Du Soumbala et État Des Populations de *Parkia Biglobosa* (Jacq.) G. Don En Zone Sud Soudanienne Du Burkina Faso : Cas de La Province Du Houet ». *International Journal of Biological and Chemical Sciences,* **17** (1), 200-219. https://doi.org/10.4314/ijbcs.v17i1.15

Coulibaly A, Kabre W.L, Traore T, Atchadé C, Boly A.G, Mariam N, Ouedraogo N, Martin K, et Sawadogo R., 2020. « Phytochemical Screening, Anti-inflammatory and Analgesic Activities of Root Barks from *Acacia macrostachya* Reichenb. Ex DC. (Fabaceae) ». *Annual Research & Review in Biology*, 76-83. https://doi.org/10.9734/arrb/2020/v35i730249

Derbal L., Tlaghi K., Zerb H., 2024. Développement d'une crème anti-acnéique à base d'extraits végétaux, Mémoire de fin d'etudes en vue de l'obtention du Diplôme de Docteur en Pharmacie, *Université Mouloud Mammeri Faculté de Médecine*, https://dspace.ummto.dz/server/api/core/bitstreams/7a2275f9-f6c0-4cfa-b020-27f2fb2db451/content

Ecaterina G, Céline P, Géraldine S,. 2018. Spreading behavior of cosmetic emulsions: Impact of the oil phase ». *Biotribology*, **16** (décembre), 17-24. https://doi.org/10.1016/j.biotri.2018.09.003

European Directorate For The Quality Of Medicines &, Healthcare Of The Council Of Europe (EDQM), 2019). European Pharmacopoeia Tenth Edition. Vol. 1. France: *Council Of Europe*

Esposito T, Teresa M, Francesca S, Giulia A, Patrizia G, Rosa V.P, Raffaele I, et Rita P.A., 2021. « Development, characterization, and clinical investigation of a new topical emulsion system containing a *Castanea sativa* spiny burs active extract ». *Pharmaceutics*, 13 (10), 1634. https://doi.org/10.3390/pharmaceutics13101634

Fabbron-Appas C, Tolomei, Preeti P, Harendra S. P, Caroline C.S, Marcelo D.D, Newton A.F, Patricia S.L, Regina L.F. et Vânia R.L.S., 2021. « Impact of Different Emollient Esters on Body Emulsions: Sensory, Physicochemical, and Biometrological Characterization ». *Journal of Sensory Studies*, **36** (4), e12660. https://doi.org/10.1111/joss.12660

Fafunké T, Atindogbe A, Fortuné A, Fonton H,, 2016. Caractérisation de la répartition spatiale de *Parkia Biglobosa* (Jacq.) R. Br. au Bénin, *REV. CAMES* - **04** (01), 59-67.

Filipovic M., M. Lukic, S. Djordjevic, V. Krstonosic, I. Pantelic, G. Vuleta, et S. Savic., 2017. « Towards satisfying performance of an O/W cosmetic emulsion: screening of reformulation factors on textural and rheological properties using general experimental design ». *International Journal of Cosmetic Science*, **39** (5), 486-99. https://doi.org/10.1111/ics.12402

Franco-Gil A. Merci, A. Martins, J. Marto, SM Ribeiro, 2024. Emollients in dermatological creams: Early evaluation for tailoring formulation and therapeutic performance ». *International Journal of Pharmaceutics*, **653**, 123825, 1-13 https://doi.org/10.1016/j.ijpharm.2024.123825

Hakim Z.R, Dewi M, et Pri I.U. (2020) « Formulasi dan uji sifat fisik sediaan lulur krim dari ekstrak etanol daun sirsak (*Annona muricata* L.) serta Penentuan Aktivitas Antioksidannya ». *Jurnal Sains Farmasi & Klinis* **7** (2): 135-42. https://doi.org/10.25077/jsfk.7.2.135-142.2020

Hernani , Halimatussa D, Dan S.S, 2022. The Quality of Cream Formulated From Gambier Leaf Extract, *IOP Conf. Series: Earth and Environmental Science*, 1024, 012010 doi:10.1088/1755-1315/1024/1/012010

Houndonougbo J. S. H., B. Kassa, S. Mensah, V. K. Salako, R. Glèlè Kakaï, et A. E. Assogbadjo., 2020. « A Global Systematic Review on Conservation Nd Domestication of *Parkia Biglobosa* (Jacq.) R. Br. Ex G. Don, an Indigenous Fruit Tree Species in Sub-Sahara African Traditional Parklands: Current Knowledge and Future Directions ». *Genetic Resources and Crop Evolution* **67** (4), 1051-66. https://doi.org/10.1007/s10722-020-00892-w

Hua Susan., 2019. « Physiological and Pharmaceutical considerations for Rectal Drug Formulations ». *Frontiers in Pharmacology* **10**. https://www.frontiersin.org/articles/10.3389/fphar.2019.01196

Hussain Tarique, Bie Tan, Yulong Yin, Francois Blachier, Myrlene C. B. Tossou, et Najma Rahu., 2016. « Oxidative Stress and Inflammation: What Polyphenols Can Do for Us? » *Oxidative Medicine and Cellular Longevity*, 2016, 7432797. https://doi.org/10.1155/2016/7432797

Imran S, Muhammad N, Shakeel I, Muhammad S, Sidra H, Muhammad K.S, Rasool F., Naveed A., Muhammad H.I, Muhammad H.S., 2018. Phytocosmeceutical formulation development, characterization and its *in-vivo* investigations » *Biomedicine & Pharmacotherapy*, **107**, 806-17. https://doi.org/10.1016/j.biopha.2018.08.024

Kagambega W., Belem H., Meda R. N.-T., Koama B. K., Drabo A.-F., Kabore J., Traore A., Ouédraogo G. A., Benedec D., Hanganu D., Vlase L., Vlase A.-M., Voştinaru O., Mogoşan, C., Oniga I., 2022. Polyphenolic Profile, Anti-Inflammatory and Anti-Nociceptive Activities of Some African Medicinal Plants. *Plants*, ***11***(10), 1377. https://doi.org/10.3390/plants11101377

Kandeda A.K, Soline M, Symphorien T.M, Kouamouo J., et Dimo T., 2022. « Aqueous extract of *Parkia Biglobosa* (Jacq.) R. Br. (Fabaceae) exerts antiepileptogenic, anti-amnesic, and

anxiolytic-like effects in mice via mechanisms involving antioxidant and anti-inflammatory pathways ». *Frontiers in Pharmacology,* **13**, 995881. https://doi.org/10.3389/fphar.2022.995881

Kumaran A., et Karunakaran R.J., 2007. « *In vitro* antioxidant activities of methanol extracts of five phyllanthus species from India ». *LWT - Food Science and Technology,* **2** (40), 344-52. https://doi.org/10.1016/j.lwt.2005.09.011

Le Hir A, Chaumeil JC, Brossard D., 2009. « Pharmacie galénique : Bonnes pratiques de fabrication des médicaments. 9th edition. *Paris: Masson* p. 377 »

Lipiński K, Magdalena M, Zofia A, et Cezary P., 2017. « Les polyphénols dans la nutrition des animaux monogastriques – Une revue ». *Annals of Animal Science,* **17** (1), 41-58. https://doi.org/10.1515/aoas-2016-0042

Mamyrbekova-bekro J, Akhanovna, Boua B, Benson, Kouassi K.C, et Békro Y.A, 2013. Sur l'analyse qualitative et pharmacologique de 2 plantes anti- hypertensives utilisées à N'gramanssabo en Côte d'Ivoire, *Nature & Technologie B- Sciences Agronomiques et Biologiques*, **08,** /Janvier 2013, 02 -12, 11

Mancini A, Chantal D.S, Sebastiano R, Giulio O, Andrea S, Elisabetta M, et Diego C., 2016. « Thyroid hormones, oxidative stress, and inflammation ». *Mediators of Inflammation,* 2016, 6757154. https://doi.org/10.1155/2016/6757154

Martini M.C., 2003. « Introduction à la dermopharmacie et à la cosmétologie 1ère édition. France: Edité par Ed. Médicales internationales, *Lavoisier*, 305-306».

Moldovan M., Lahmar A, Bogdan C, Părăuan S, Tomuță I, et Crişan M., 2017. « Formulation and evaluation of a water-in-oil cream containing herbal active ingredients and ferulic acid ». *Clujul medical (1957),* **90** (2). https://doi.org/10.15386/cjmed-668

Naveed A, Khan A, Muhammad S, Ahmed M, Khan H, Rasool F, et Saeed T., 2012. « Formulation and characterization of a cream containing *Terminalia chebula* extract ». *Forschende Komplementärmedizin / Research in Complementary Medicine, **19** (1), 20–25.* https://doi.org/10.1159/000335823

Nunes A, Gonçalves L., Joana M., Margarida M.A, Alexandra N. Silva, Pedro Pinto, Marta M, Carmo F, et Margarida H.R., 2021. « Investigations of olive oil industry by-products extracts with potential skin benefits in topical formulations ». *Pharmaceutics*, **13** (4), 465. https://doi.org/10.3390/pharmaceutics13040465

Ohkawa H, Ohishi N, et Yagi K., 1979. « Assay for lipid peroxides in animal tissues by thiobarbituric acid reaction » *Analytical Biochemistry,* **95** (2), 351-58. https://doi.org/10.1016/0003-2697(79)90738-3

Ouedraogo N, Atchadé C., Traore T, Ouédraogo B, Boly A, Kabré W.L.M, Yoda J, Kini F.B, Lompo M., Ouedraogo M. and Ouedraogo S., 2020. « Anti-inflammatory activity of extracts from *Parkia biglobosa* (Jacq.) R.Br. Ex G.Don. (Fabaceae-Mimosoideae) trunk bark ». *Journal of Pharmacology and Toxicology,* **16**, 1-8. https://doi.org/10.3923/jpt.2021.1.8

Patil S.M., Vincent Li, Jiangnan Peng, Darby Kozak, Jin Xu, Bing Cai, David A. Keire, et Kang Chen., 2019. « A Simple and Noninvasive DOSY NMR Method for Droplet Size Measurement of Intact Oil-In-Water Emulsion Drug Products ». *Journal of Pharmaceutical Sciences* **108** (2), 815-20. https://doi.org/10.1016/j.xphs.2018.09.027

Pascal Wehrlé (2007) Pharmacie galénique : formulation et technologie pharmaceutique. Collection Etudes et Diplômes en pharmacie 1er Edition, *Maloine* . p.124-125.

Percival S.L., McCarty S, John A. H, et Emma J.W., 2014. « The effects of PH on wound healing, biofilms, and antimicrobial efficacy ». *Wound Repair and Regeneration,* **22** (2), 174-86. https://doi.org/10.1111/wrr.12125

Saleh, Mohammed S. M., Juriyati J, Satirah Z, Ahmad Y.A, Nor H.M, et Yusof K.., 2021. « Genus Parkia: Phytochemical, medicinal uses, and pharmacological properties ». *International Journal of Molecular Sciences,* **22** (2), 618. https://doi.org/10.3390/ijms22020618

Sombie P. A. E. D., Hilou A, Coulibaly A.Y, Tibiri A, Kiendrebeo M, et Nacoulma O.G., 2011. « Brain protective and erythrocytes hemolysis inhibition potentials from galls of *Guiera senegalensis* J.F. Gmel (Combretaceae) ». *Journal of Pharmacology & Toxicology,* **6** (4), 361-70. https://doi.org/10.3923/jpt.2011.361.370

Tasleem F, et Shehla I., 2017. « Evaluation of anti-inflammatory and other biological activities of flavonoid based cream formulation for topical application using *in vitro* model. » *International journal of Pharmceutical Sciences and Research*, **8**, 4388-95.

Termote C, Nicanor O.O, Bettina S.D, Guissou B, Parkouda C., et Vinceti B., 2022. « Nutrient composition of *Parkia biglobosa* pulp, raw and fermented seeds: a systematic review ». *Critical Reviews in Food Science and Nutrition,* **62** (1), 119-44. https://doi.org/10.1080/10408398.2020.1813072

Tsvetkova D., Kostadinova I, Landzhov B, Vezenkov L, Marinov L, Ivanova I., 2023,

Application of ABTS method for assessment of radical- binding effect of Creatine monohydrate. *J Adv Pharm Educ Res*., **13**(2), 92- 8. https://doi.org/10.51847/rxgOGbIUkJ

Wagner H. et Sabine B., 1996. *Plant Drug Analysis: A Thin Layer Chromatography Atlas*. Berlin, Heidelberg: *Springer Berlin Heidelberg* https://doi.org/10.1007/978-3-642-00574-9.