OPEN ACCESS

Orapuh Journal

ORIGINAL ARTICLE Journal of Oral & Public Health

Assessment of the photoprotective and antimicrobial activity of two dermatological creams based on Mathesia and oil of *Curcuma longa* L. (Zingiberaceae) on Albinos

Nyamangombe, G. L.[1], Mayele, B. M.[1], Nkasa, H. L.[2], Tshidibi, J. D.[1], Mpiana, E. M.[3], Masikini, F. B.[3], Mbokolo, G. I.[1], Mbembo, B. M.[1], Amogu, J. D.[1, 3, 4], & Mubwele, A.[2]

[1]*Department of Biology, Faculty of Science, University of Kinshasa, Democratic Republic of the Congo.*
[2]*Department of Chemistry, Faculty of Science, University of Kinshasa, Democratic Republic of the Congo.*
[3]*Center of Chemical, Biological, Radiological and Nuclear Excellence (CoE-CBRN), Ministry of Scientific Research and Technological Innovation, Democratic Republic of the Congo.*
[4]*National Committee for Protection against Ionizing Radiation (NCPIR), Ministry of Scientific Research and Technological Innovation, Kinshasa, Democratic Republic of the Congo.*

ARTICLE INFO

Received: *16 April 2024*
Accepted: *09 May 2024*
Published: *22 June 2024*

Keywords:
Albinism, Mathesia, *Curcuma longa*, anti-microbial, anti-inflammatory

Peer-Review: *Externally peer-reviewed*

Correspondence to:
Blanchard M. Mayele
blanchard.mayele@unikin.cd

To cite:
Nyamangombe, G. L., Mayele, B. M., Nkasa, H. L., Tshidibi, J. D., Mpiana, E. M., Masikini, F. B., Mbokolo, G. I., Mbembo, B. M., Amogu, J. D., & Mubwele, A. (2024). Assessment of the photoprotective and antimicrobial activity of two dermatological creams based on Mathesia and oil of *Curcuma longa L.* (Zingiberaceae) on Albinos. *Orapuh Journal, 5*(4), e1131.
https://dx.doi.org/10.4314/orapj.v5i4.31

ISSN: *2644-3740*

Published by Orapuh, Inc. (info@orapuh.org)

Editor-in-Chief: Prof. V. E. Adamu
Engelhardt School of Global Health & Bioethics,
Euclid University (Pôle Universitaire Euclide)

ABSTRACT

Introduction

The fragility and sensitivity of the skin in people with albinism (PWA) have necessitated extensive research across molecular genetics, dermatology, and cosmetology. These efforts aim to address the increased susceptibility of albino skin to sun damage and dermatological conditions.

Purpose

This study investigates the dermatological efficacy of two galenic formulations, one based on Mathesia and the other on *Curcuma longa* L. (Zingiberaceae) oil, assessing their antimicrobial, anti-inflammatory, and photoprotective properties for the skin of PWA.

Methods

Using freeze-drying techniques for Mathesia and slight modifications of Sahouli et al.'s method for extracting *Curcuma longa* L. oil, we developed two creams. Their macroscopic properties, pH levels, and tyrosine concentrations were analyzed. UV-visible spectrophotometry determined their sun protection factor (SPF). An antibiogram test assessed their antimicrobial activity, and a clinical test evaluated their efficacy on PWA with and without skin conditions.

Results

The study revealed that both creams had good texture and appropriate pH levels. However, neither cream provided sufficient photoprotection for the sensitive skin of PWA. The Mathesia-based cream demonstrated a higher antimicrobial efficacy compared to the turmeric oil-based and neutral creams. Clinical tests showed 75% of participants had very satisfactory results, with the turmeric oil-based cream showing the most significant overall efficacy.

Conclusion

The creams exhibited beneficial antimicrobial and anti-inflammatory properties but were inadequate for UV protection of albino skin. Future research should focus on increasing active ingredient concentrations or exploring alternative plants to enhance tyrosine content and SPF values, potentially offering better protection and therapeutic effects for PWA.

INTRODUCTION

Oculocutaneous albinism (OCA) is an autosomal recessive condition characterized by the absence or reduction of melanin in the skin, hair, and eyes (iris, choroid, and retinal pigment epithelium). The decrease or absence of melanin in the skin is associated with increased sensitivity to ultraviolet A and B radiation (leading to erythema and actinic keratosis) and a predisposition to skin cancers (basal and squamous cell carcinomas), particularly in black-skinned African albinos (Aquaron, 2000; King et al., 2001).

The general frequency of OCA is estimated to be around 1 in 20,000. However, the risk of skin degradation is higher in this population compared to most communities, considering that healthy skin boosts self-confidence and represents the individual's image. Therefore, albino skin requires significant care.

It is often observed that more sun protection and antimicrobial cosmetic products are manufactured by Western companies than by African ones. While the cosmetology industry has been booming in Africa, many products are geared towards skin lightening. Conversely, phytotherapy, known as "traditional medicine," is very popular in Africa. According to Kabena et al. (2021), nearly 80% of the populations in developing countries within the African region use traditional medicine (WHO, 2010; Kabena et al., 2021; Katunda et al., 2023). In this study, we developed two galenic formulations in the form of creams, with raw materials extracted from tropical plants: the aqueous phytomedicine MATHESIA and the oil of *Curcuma longa* L.

Nkasa et al. (2020) found that MATHESIA has strong antimicrobial properties. In a recent publication, they also reported that this phytomedicine has excellent healing properties. Additionally, Hombourger (2010) asserted that *Curcuma longa* L. has anti-inflammatory, antibacterial, and antiparasitic properties, confirming its traditional use for skin beautification. Other researchers have found that *Curcuma longa* also has lightening properties, inhibiting melanin synthesis (Nkasa et al., 2020; Nkasa et al., 2021; Hombourger, 2010).

The main objective of our work was to develop a sun and microbial protection product suitable for albinos, which could also induce melanization for healing and beautifying their skin. The specific objectives are to: formulate organic creams according to physicochemical and toxicological standards appropriate for the skin; evaluate the photoprotective and antimicrobial properties of these creams; assess the proven properties of Mathesia and Curcuma when integrated into a galenic formulation; and determine the chemical composition of the creams.

METHODS

Plant material

The dermo-cosmetic creams that are the subject of our study are made from active ingredients of plant origin, specifically *Curcuma longa* L. and *Acacia sp.* Mathesia is a hydro-alcoholic extract solution of Acacia plants, manufactured by the Industrial and Technological Group (GITCO), Kinshasa, DR Congo. It contains the following metabolites: saponin, tannins, flavonoids, total polyphenols, and reducing sugars (Nkasa et al., 2020). This product underwent lyophilization and was incorporated into one of our creams to analyze its effectiveness on the skin. The turmeric powder used in this work was purchased at the Somba Zigida market. This powder was used to extract the oil, which was incorporated into one of the creams to analyze its effectiveness on the skin.

Microbial material

The *Staphylococcus aureus* strain 3068, obtained from a wound swab, was used for the antibiogram test.

Lyophilization of Mathesia

Freeze-drying, by definition, is the drying of a product in the frozen state. The desired goal in freeze-drying is the same as for all other dehydration processes: the preservation of biological products by lowering the water activity of the product. It is carried out according to two processes: sublimation (primary drying) and desorption (secondary drying) (Shishehgarha, 1999).

The freeze-drying technique was conducted at the Analytical Chemistry Laboratory of the Department of Chemistry, Faculty of Science, University of Kinshasa. We began by freezing the Mathesia solution in a freezer. The freeze-drying experiment was carried out in a Freezer Dry brand laboratory freeze dryer with a 25 L capacity at -43°C. We attached a vial containing our frozen Mathesia to a vacuum valve for approximately 12 hours to allow the freeze-drying process to occur. The results were expressed by calculating the density and yield using the following mathematical expressions:

$p = m/V$ and $Ydt = (m_2/m_1) * 100$.

Extraction of turmeric oil

The oil was extracted using the principle of hydrodistillation. This principle states that when an aqueous solution is heated, the water vaporizes. This steam breaks down the plant cells, releasing the molecules of interest. The most volatile of these molecules are carried away by the steam, which is then cooled in a condenser, and the various substances are collected in containers (Souhila & Souhiha, 2014).

This procedure took place at the Laboratory of Organic and Energetic Chemistry (LACOREN), located in room A28 of the Faculty of Sciences, Department of Chemistry, University of Kinshasa. Initially, we weighed 1 kg of turmeric powder on a GRAM AHZ precision scale. The powder was then macerated with 310 mL of petroleum ether for 3 days on a stirrer rotating at a speed of 100 revolutions per minute. The mixture was then decanted using a separating funnel to separate the waste (powder) from the liquid obtained, called macerate. The macerate was placed in a flask, which was then placed in a distillation apparatus. Note that the method used is cold distillation. The results were expressed by calculating the yield using the following mathematical expression:

$\text{Yield} = (m_2/m_1) * 100$.

Preparation of dermo-cosmetic creams

In general, the development of emulsions is guided by the intended function of the product, the desired sensory properties, ease of use (the viscosity of the product), and stability (physical, chemical, and microbiological). For cosmetic and protective dermo-creams, the emulsion must be W/O.

We heated 5 kg of our dairy fat in a saucepan to melt it. We then added the ingredients while stirring the solution with a mixer. When the consistency of our solution changed, we added the active ingredients (Mathesia or Turmeric Oil). Still using a mixer, we stirred the emulsion until it thickened. Potting took place immediately after achieving the desired consistency.

This procedure also took place at the Laboratory of Organic and Energetic Chemistry (LACOREN), located in room A28 of the Faculty of Sciences, Department of Chemistry. The results were expressed according to the sensory characteristics, pH, weight, and microscopic observation of our emulsions.

Sun protection effectiveness test

This test was carried out using a UV-Vis spectrophotometer. It is based on the Lambert-Beer law, which states that the absorbance (A) of a fairly dilute solution of a colored species is proportional to the concentration (C) of this species for a given wavelength and path length. The Sun Protection Factor (SPF) measures a sunscreen's effectiveness against UVB-induced sunburn.

The procedure was conducted at LACOREN. We prepared dissolved solutions of our creams, i.e., 0.025 g of cream in 500 mL of isopropanol. Placed in quartz tubes, we measured the absorbance of isopropanol (the blank) and then our cream solutions at preferential wavelengths of UV rays. The SPF calculation followed the formula:

$SPF = CF \times 290320EE(\lambda) \times I\lambda \times Abs(\lambda)$ (Sayer et al., 1979).

Tyrosine assay

For this procedure, we opted for a spectrophotometric assay based on the Lambert-Beer law, as tyrosine, an amino acid with phenolic radicals, absorbs UV light at a wavelength of 280 nm (Inkoto et al., 2020). This procedure was also conducted at LACOREN. We prepared dissolved solutions of our creams in isopropanol (0.025 g of cream in 500 mL of isopropanol). We then prepared our tyrosine standard solution by dissolving 500 mg of naturally occurring tyrosine (SOLAR®) in 1000 mL of water at room temperature. Using a UV-Visible spectrophotometer (BIO-RAD Smartspec®), we measured the blank of our standard tyrosine solution and then its transmittance at 280 nm to verify the theory. Subsequently, we measured the transmittance of our dissolved cream solutions at 280 nm to verify the presence of tyrosine in our creams. The concentration was calculated using the formula:

$C = A / (\varepsilon \times L)$ (mol/L).

This step was performed in one of the bacteriology laboratories of University Clinics of the University of Kinshasa. The test was performed using *Staphylococcus* *aureus* strain 3068. The creams were melted at 37°C in an oven. To compare and retain only the best result, neutral blotting discs were soaked in melted cream, then placed on the Muller-Hinton agar medium already seeded with the bacteria. Cefoxitin was also applied. After that, we placed our petri dishes in a SOCIMED SARL IN-010 incubator for 24 hours. Note that the test was repeated three times for each cream.

Clinical test

The purpose of a clinical trial is to provide scientific proof of the clinical efficacy of treatments or therapeutic implementations based on proven facts and not on assumptions or theoretical reasoning (pharmacomedical.org). For this purpose, we proceeded with a sampling of PVA at the Pauline Orphanage Albinos located in the town of Limete, 12th Street Residential, in the City-Province of Kinshasa, Democratic Republic of the Congo. We provided everyone with a cream depending on the exterior appearance of their skin (presence or absence of erythema or other ailments). The sixty-four individuals listed applied the creams for one month. We took photos of our volunteers before and after the use of our creams. Knowing that ethical issues could arise, we previously obtained research authorization from the Dean of the Faculty of Science of the University of Kinshasa, which was recorded and received by the coordinator of the Pauline Albino Foundation.

RESULTS

Mathesia freeze-drying results

Table 1:
Mathesia density value freeze-dried

m (g)	V (l)	ρ (g/L)
2,81	0,2830408	9

Table 1 shows that the density of Mathesia, after freeze-drying, has a value of 9g/L, which is directly proportional to the mass of Mathesia obtained after freeze-drying and inversely proportional to the initial volume of Mathesia.

Table 2:
Freeze-drying yield value

m_1 (g)	m_2 (g)	R (%)
283,0408	2,81	0,99

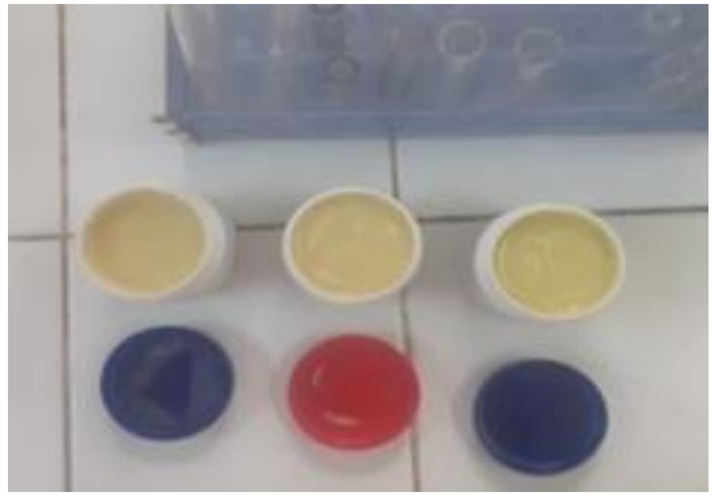
Table 2 above tells us that the performance of the lyophilization is very low, with a value of 0.99%.

Results of Turmeric Oil Extraction

The value of the yield of the extraction of Turmeric oil is equal to 2%. This described result that the amount of oil obtained is very small compared to the gross mass of the raw material.

Results of the preparation of creams

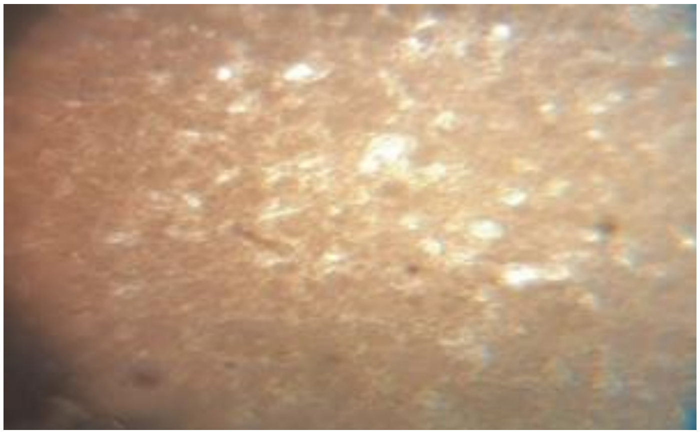
Picture 1:
Creams based on turmeric, *Mathesia* and without principle active



Picture 2:
Microscopic view of cream based on *Mathesia* G: x100

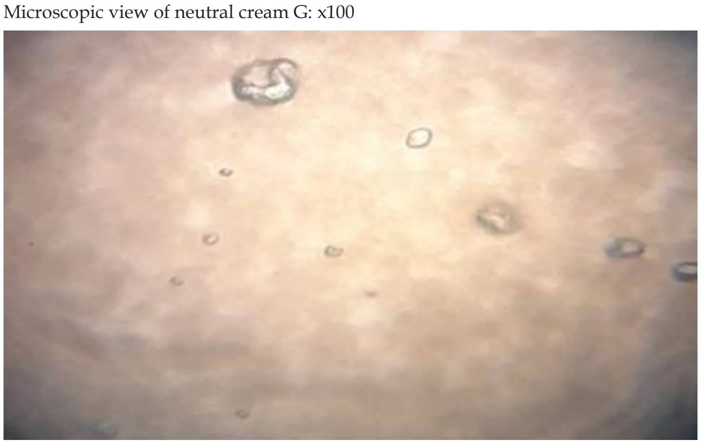
This microscopic observation (Photo 2) of the *Mathesia*-based cream describes the emulsion as being of the W/O type (water in oil).

Picture 3:
Microscopic view of coconut oil cream Turmeric G: x100



This microscopic observation of oil-based cream of Turmeric, describes the emulsion as being of the W/O, though hard to pin down because of the compact texture of this emulsion **(Picture 3)**.

Picture 4:
Microscopic view of neutral cream G: x100



This microscopic observation of neutral cream describes the emulsion as being of the W/O type **(Picture 4)**.

Table 4:
Table showing different creams' Properties sensory

Sensory Properties	Mathesia based cream	Tumeric oil based cream	Neutral cream (without principle asset)
Color	Off-white	Yellow	Off-white
Smell	Pleasant	Smell reminding the oil ether	Pleasant
Texture	Creamy	Compact	Creamy

Out of our three emulsions, those that come closest commercial body creams are those based on Mathesia and the one without active ingredient.

Table 5:
Table showing different creams' with respect to pH of the skin

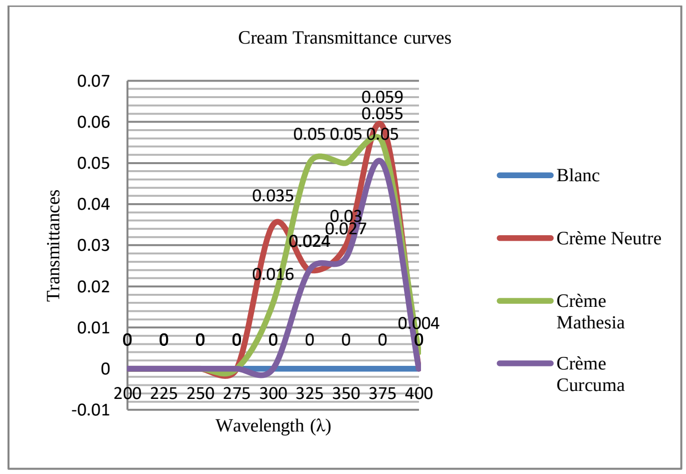
Types of pH Cream	pH
Mathesia Cream	5
Curcuma Cream	5
Neutral Cream	5

Table 5 shows that our different creams respect the pH value of the skin which is also 5.

Photo protective efficacy results

Measurement of the transmittances of creams

Figure 1:
Cream transmittance curves



(*Note*: *Some of the labels are written in French)*

Figure 1 above provides information on the values of transmittances of our different creams, at lengths of UV-visible waves, denoting all our creams as well have a higher transmittance value at the wavelength of 375 nm.

Sun protection factor (SPF)

The different FPS values were obtained from the formula of Sayer et al.

Table 5:
Table showing the pH of each of the Creams

	315	1,432	0,0837	0,1198584	
	320	1,357	0,018	0,024426	
TOTAL			**1**	**1,4912086**	**14,91 ± 0,23**

Table 6:
Mathesia Cream SPF

λ (nm)	A	EE x I	A x EE x I	FPS Calculé
290	0	0,015	0	
295	0	0,0817	0	
300	1,796	0,2874	0,5161704	
305	1,699	0,3278	0,5569322	
310	1,469	0,1864	0,2738216	

Table 7:
Turmeric Oil Cream SPF

λ (nm)	A	EE x I	A x EE x I	FPS Calculé
290	0	0,015	0	
295	0	0,0817	0	
300	1,796	0,2874	0,5161704	
305	1,699	0,3278	0,5569322	
310	1,469	0,1864	0,2738216	
315	1,432	0,0837	0,1198584	
320	1,357	0,018	0,024426	
TOTAL		1	1,4912086	**14,91 ± 0,23**

Table 8:
Neutral Cream SPF (without active ingredient)

λ (nm)	A	EE x I	A x EE x I	FPS Calculé
290	0	0,015	0	
295	0	0,0817	0	
300	1,456	0,2874	0,4184544	
305	1,481	0,3278	0,4854718	
310	1,553	0,1864	0,2894792	
315	1,569	0,0837	0,1313253	
320	1,602	0,018	0,028836	
		1	1,3535667	**13,53 ± 0,19**

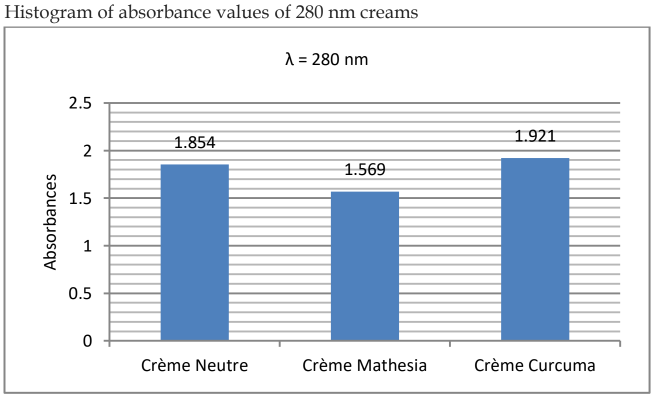
Kruskal-Wallis H Test
Kruskal-Wallis H (equivalent to Chi-square)
Degree of Freedom : 2
P-value = 0,3679

These different tables tell us that the cream based on Mathesia has a higher protection factor than the other two creams. The cream based on Mathesia has an SPF of around 14, while that based on turmeric oil and the one without active ingredient have an SPF value of around 13. According to the Kruskal-Wallis test, the p-value is equal to 0.36. The latter being greater than 0.05, we conclude that there is no statistically significant difference between the values of the sun protection factors of the different creams.

Tyrosine assay

Measurement of the absorbance of creams at 280 nm

Figure 2:
Histogram of absorbance values of 280 nm creams



(*Note*: Some of the labels are written in French)

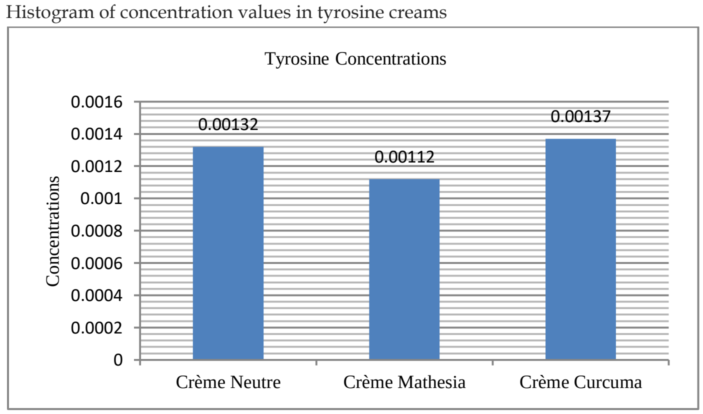
Kruskal-Wallis H Test
Kruskal-Wallis H (equivalent to Chi-square)
Degree of freedom2
P-value = 0,3679

Absorbance values at 280 nm wavelength are those marking the presence of compounds with a nucleus aromatic, mainly from the phenolic compound that is tyrosine. The turmeric oil cream has an absorbance of 1.921, which is the highest value compared to the other two creams, and the absorbance value of the tyrosine contained in the cream. Of same, for the cream based Similarly, for the cream based on Mathesia and that without active ingredient (Neutral), the absorbance values of Tyrosine are 1.569 and 1.854 respectively.

According to the Kruskal-Wallis test, the probability is 0.36, i.e., greater than 0.05, indicating that there is no significant difference between these absorbance values.

Tyrosine concentration in creams

Figure 3:
Histogram of concentration values in tyrosine creams



(*Note*: Some of the labels are written in French)

Test de Kruskal-Wallis H
Kruskal-Wallis H (equivalent to Chi-square)
Degree of Freedom: 2
P-value = 0,3679

Figure 3 above tells us that the cream containing a higher tyrosine value would be cream based on Turmeric oil with a high concentration at 0.00137 molar. There is no significant difference between the different concentrations, depending on the results of the Kruskal-Wallis test below, where the probability is 0.36 (value greater than 0.05).

Antimicrobial Activity

Table 9:
Antibiogram test results for creams on *S. aureus*

Mathesia based cream	
	Results
FOX	S
Trial 1	S
Trial 2	R
Trial 3	S
Witness	R
Cream based on turmeric oil	
	Results
FOX	S
Trial 1	R
Trial 2	R
Trial 3	S
Witness	R
Neutral Cream (without active ingredient)	
	Results
FOX	S
Trial 1	R
Trial 2	R
Trial 3	S
Witness	R

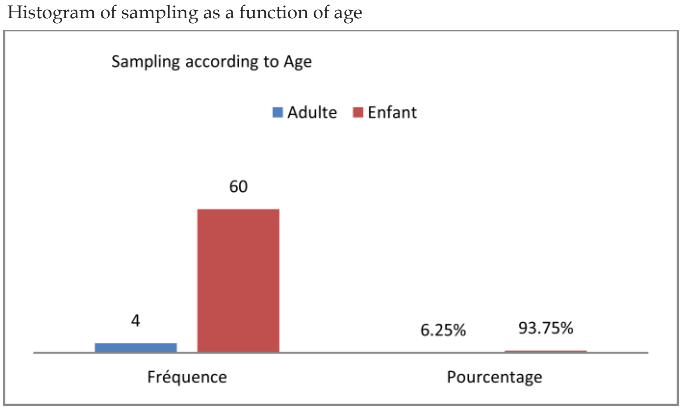
S: Sensitive; R: Resistant

The **Table** above shows the results of the antibiogram test on *Staphylococcus aureus* 3068 from wound swabs, indicating the sensitivity of this bacterial strain against our creams. With three trials per cream, the strain of *S. aureus* seems to be more sensitive to the cream based on Mathesia, with resistance observed in three trials. In contrast, the cream based on Turmeric oil and the neutral cream (without active ingredient) showed resistance in two out of three tests each. The strain is logically sensitive to Cefoxitin (FOX), used as the reference antibiotic, and resistant to the control disc soaked in distilled water.

Analysis of clinical results

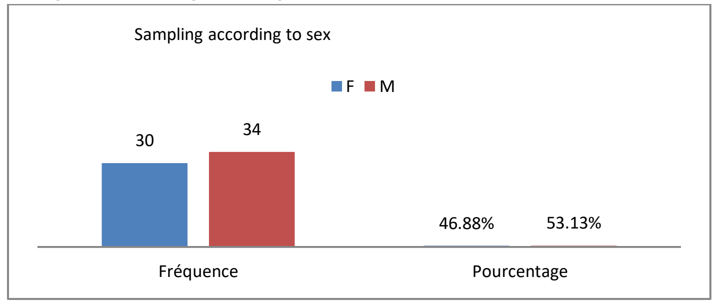
Sampling:

Figure 4:
Histogram of sampling as a function of age



(*Note*: Some of the labels are written in French)

Figure 5:
Histogram of sampling according to sex

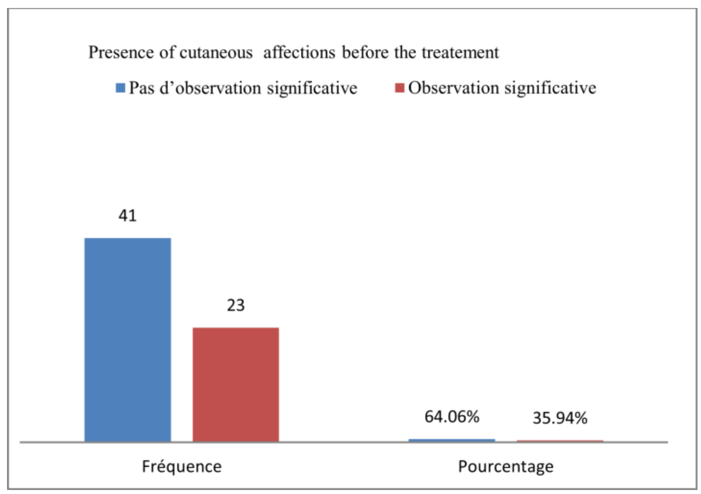


(*Note*: Some of the labels are written in French)

Figures 4 and **5** show the frequencies of individuals sampled for clinical testing of our ointments. A total of 64 individuals participated, including 4 adults (6.25% of the sample) and 60 children (93.75%). Additionally, there were more males (53.13%) than females (46.88%).

Processing:

Figure 6:
Statistical histogram of individuals with ailments and without ailments before treatment



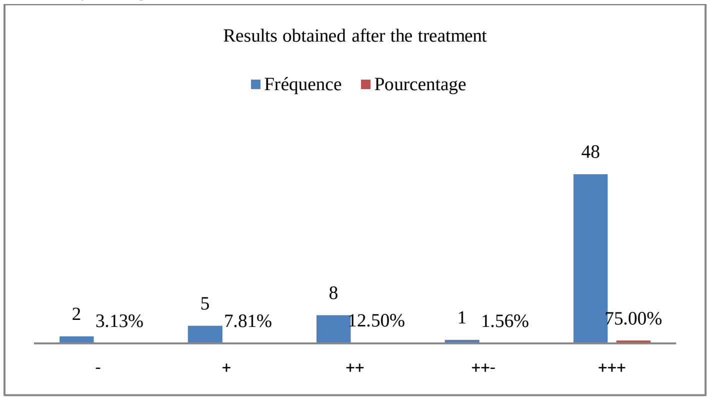
(*Note*: Some of the labels are written in French)

Figure 6 shows the statistical distribution of individuals with and without ailments before treatment. Out of the 64 individuals, 41 had no particular condition (64.06%), and 23 had conditions (35.94%).

Results obtained after treatment

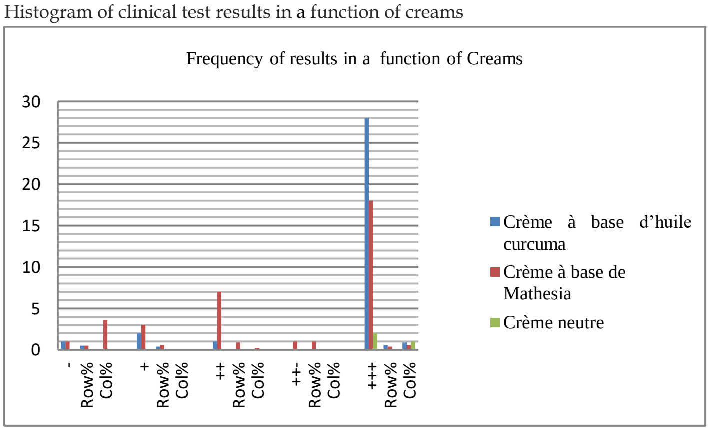
Figures 7 and **8** present the frequency histogram of results obtained after treatment and clinical test results as a function of creams, respectively.

Figure 7:
Frequency histogram of the results obtained after treatment



(*<u>Note</u>: Some of the labels are written in French)*

Figure 8:
Histogram of clinical test results in a function of creams



(*<u>Note</u>: Some of the labels are written in French)*

Table 10:
Table of results according to creams administered

Results	Types of Cream administered			
	Cream based on turmeric oil	**Cream based on MATHESIA**	**Neutral Cream**	**Total**
-	1	1	0	**2**
Row%	50,00%	50,00%	0,00%	100,00%
Col%	3,33%	3,58	0,00%	3,13%
+	2	3	0	**5**
Row%	40,00%	60,00%	0,00%	100,00%
Col%	3,33%	10,71%	0,00%	7,81%
++	1	7	0	**8**
Row%	12,50%	87,50%	0,00%	100,00%
Col%	3,33%	25,00%	0,00%	12,50%
++-	0	1	0	**1**
Row%	0,00%	100,00%	0,00%	100,00%
Col%	0,00%	3,57%	0,00%	1,56%
+++	28	18	2	**48**
Row%	58,33%	37,49%	4,17%	100,00%
Col%	90,00%	57,14%	100,00%	75,00%
TOTAL	**32**	**30**	**2**	**64**
Row%	50%	46,87%	3,13%	100,00%
Col%	100,00%	100,00%	100,00%	100,00%

Summary of Results

- **Very satisfactory (excellent) result**s: 75% (48 individuals) had no irritation or condition after treatment.
- **Negative results**: 3.13% (2 individuals) were not sensitive to the treatment.

Detailed Analysis by Cream Type

Table 10 provides a detailed analysis of the results according to the type of cream administered. Of the 64 individuals:

i. 32 (50%) used the cream based on Turmeric oil.
ii. 30 (46.87%) used the cream based on Mathesia.
iii. 2 (3.13%) used the neutral cream.

Out of the 48 individuals with very satisfactory results:

a) 28 used the cream based on Turmeric oil.
b) 18 used the cream based on Mathesia.
c) 2 used the neutral cream.

This indicates that:

A. 90% of those who used the cream based on Turmeric oil had excellent results (+++).
B. 100% of those who used the neutral cream had excellent results (+++).
C. 57.14% of those who used the cream based on Mathesia had excellent results (+++).

Conversely, 2 individuals (3.13%) showed totally negative results, with one using the cream with Turmeric oil and the other using the cream based on Mathesia.

Table 11:
The analysis of variance of the clinical results

Analyse de variance: un facteur

RAPPORT DÉTAILLÉ

Groupes	Nombre d'échantillons	Somme	Moyenne	Variance
Crème à base d(huile de curcuma	5	32	6,4	146,3
Crème à base de Mathesia	5	30	6	51
Crème neutre	5	2	0,4	0,8

ANALYSE DE VARIANCE

Source des variations	Somme des carrés	Degré de liberté	Moyenne des carrés	F	Probabilité	Valeur critique pour F
Entre Groupes	112,5333333	2	56,26666667	0,852094902	0,450782748	3,885293835
A l'intérieur des groupes	792,4	12	66,03333333			
Total	904,9333333	14				

(*<u>Note</u>: Some of the labels are written in French)*

Table 11 shows the analysis of variance of the clinical results, indicating no significant difference between the results obtained, as the probability of 0.45 is greater than 0.05, and the F value (0.85) is less than 1.

The analysis of variance of the clinical results

The analysis of variance of the clinical results, indicates no significant difference between the results obtained (0.45), as the probability of 0.45 is greater than 0.05, and the F value (0.85) is less than 1.

DISCUSSION

Using the freeze-drying technique as reported by Shishehgarha (1999) resulted in a low yield (0.99%) of Mathesia powder extract. Similarly, obtaining turmeric oil by the method of Sahouli et al. (2014) (slightly modified) did not yield a significant amount of turmeric oil (only 2%).

These low yields of Mathesia powder and turmeric oil resulted in an insufficient quantity of these two elements as active ingredients in the formulation of our creams.

However, the macroscopic parameters of our various creams are encouraging, indicating good homogeneity (or texture), especially for the cream based on turmeric oil, even though microscopic observation did not show two phases. The creams were whitish, except for the one based on turmeric oil, which took on a yellowish hue due to curcumin, a main phenolic pigment of turmeric that gives it this yellow-orange hue (Hombourger, 2010). The smell of our creams was not enhanced by adding perfumes, as is the case in many industrial cosmetic formulations. Tranchant et al. (2005) state that perfumes can modify the texture of the emulsion since their addition is a function of temperature (Kabena et al., 2020).

Using pH papers, we were able to measure the pH of each of the creams. Whether it was the cream based on turmeric oil, Mathesia, or the neutral cream, each had a pH equivalent to 5. This value is close to the pH of the skin, which Haftek (2016) states ranges between 4.5 and 7, reassuring us that our creams are not dangerous or irritating to the skin, particularly for those with albinism (Haftek, 2016).

The formulation of our creams was intended to facilitate their use by individuals with albinism. Thus, the rest of the tests and analyses focused on identifying photoprotective properties suitable for their skin as well as bacteriological properties. This is important because oculocutaneous albinism (OCA) is an autosomal recessive condition characterized by an absence or reduction in the amount of melanin, primarily in the skin. This condition is associated with increased sensitivity to UVA and UVB rays, which causes erythema followed by actinic keratosis and a predisposition to skin cancer, particularly in black-skinned African albino subjects (Aquaron, 2000; King et al., 2001).

Solar cell protection efficiency tests were carried out using UV-visible spectrophotometry to find the transmittance values at UV-specific wavelength slices due to the danger they represent for the skin when exposed to the sun for extended periods (Aubin and Humbert, 2001). The transmittance values obtained allowed us to calculate the absorbency of our creams and the sun protection factor (SPF), calculated according to the formula of Sayre et al. (1979). Since this formula only calculates the SPF at wavelengths ranging from 290 to 320 nm, we limited ourselves to finding the SPF for UVB, which has wavelength values ranging between 320 and 280 nm.

The SPF values found were 14.91 for the Mathesia-based cream, 13.19 for the turmeric oil-based cream, and 13.53 for the neutral cream (see **Tables 10, 11,** and **12**). In vivo, these SPF values may correspond to SPF values of 25 for the Mathesia-based cream and 20 for the other two, according to the labeling conditions for sunscreen products by the French Health Products Safety Agency (AFSSAPS, 2006).

According to the Fitzpatrick classification, phototypes I (extremely sensitive skin) and II (very sensitive skin) must apply SPF sun protection creams indicating values between 50 and 30. Literature tells us that the skin of albinos is of phototype I and II for those who synthesize a small amount of melanin. These two statements show that neither the cream based on Mathesia nor that based on Turmeric oil is only suitable for protecting the skin of PVA against UVB (and/or UVA). However, these two creams would be more suitable for people with phototype IV (dark skin) and V (dark skin).

The dosage of tyrosine in our creams indicates the presence of this amino acid in all creams. We used L-Tyrosine® (in free form) as a standard for the spectrophotometric assay of this amino acid. Tyrosine is a phenolic ring amino acid and promoter of melanogenesis. This enzyme is considered both the main enzyme in melanogenesis and a target of mechanisms regulating pigment production (Lacour, 1992). Its presence in our creams could indicate the induction of melanogenesis in albinos.

The cream based on turmeric oil contains a high concentration of tyrosine (0.00137 M) compared to that based on Mathesia and that without an active ingredient, although the difference between the values is not significant. In a 2009 study, researchers applied turmeric extract to skin damaged by long-term low-dose ultraviolet rays. They found that this turmeric extract protected against UV rays while preventing the formation of pigmentation caused by UV. Our data lead us to reconsider their last hypothesis because the presence of tyrosine could mean the production, even if insignificant, of melanin.

Our creams based on Mathesia, Turmeric oil, and those without an active ingredient have also been subjected to a bacterial efficacy test to confirm or invalidate an antimicrobial action on the skin. The antibiogram test was performed on Muller Hilton agar against *S. aureus* strain 3068 wound suppuration incubated at 37°C. The results obtained are satisfactory: out of three tests, two were positive for the cream based on Mathesia (bacteria sensitive to cream). This result corroborates the results obtained by Nkasa et al. (2020), which confirm the antimicrobial activity of Mathesia, the effect of which remains effective even in small quantities in a galenic formulation.

As for the turmeric oil-based cream, out of the three antibiogram tests, only one was positive. This result allows us to confirm the studies carried out by several researchers, including Hombourger (2010), who claim that curcumin has antimicrobial, anti-inflammatory, and anti-cancer effects. Similarly, the neutral cream, although without an active ingredient, gave a positive result in all three tests. It can therefore be concluded that the elements of the formulation, such as the excipients, can play a particular therapeutic role.

To confirm these results in vitro, we carried out a clinical test that consisted of the distribution and application of creams by PWA with or without skin conditions. The results obtained were satisfactory: out of 100% of the sample, 75% responded very favorably to the treatment, and only 3.13% (i.e., two individuals) did not react favorably to the treatment (see **Figure 8** and **Table 10**). Depending on the creams tested, of the 100% of the very favorable (excellent) results obtained, 58.33% came from the turmeric-based cream, 37.49% from the Mathesia-based cream, and 4.17% from the neutral cream. Given the diversity of lesions encountered (see **Table 10**) and the effects that the different creams had on the skin of albino individuals, the cream based on turmeric oil proves to be the most effective, confirming the various properties attributed to turmeric. The Mathesia-based cream also performed well, reinforcing the findings of Nkasa et al. (2021), which indicate that Mathesia has good anti-inflammatory, antimicrobial, and other beneficial properties similar to turmeric.

The ANOVA analysis of the results obtained shows that the differences between the groups are minimal, given that the value of F is 0.85 (<1) and the value of p is 0.45 (>0.05), considering that there was not an equal distribution of creams (i.e., 2 individuals for the neutral cream, 30 for the one based on Mathesia, and 32 for the one based on turmeric oil). This statistical analysis allows us to conclude that there is no significant difference between the clinical results according to our different creams and that they act almost equally. The proof is that even for tyrosine concentrations, absorbance values, or sun protection factor (SPF) values, the Kruskal-Wallis statistical test proves that there is no significant difference between the different values. Therefore, the effects of these creams can be considered equivalent. In any case, our creams have proven their bacteriological effectiveness on albino skin, although they are not suitable for sun protection but can induce weak melanization.

CONCLUSION AND OUTLOOK

For several decades now, the fragility and sensitivity to which the skin of albinos is subject have generated a great deal of research in the molecular field. Research interest in this skin anomaly extends from molecular genetics to cosmetology and dermatology. We therefore tried to contribute to this body of knowledge by testing two galenic formulations: one based on Mathesia and the other on Turmeric oil.

These two active principles have a well-known reputation from microbiological and immunological perspectives, making it interesting for us to test their dermatological effectiveness in a galenic form for therapeutic purposes for PWA. These tests confirmed the various properties attributed to them, particularly their antimicrobial and anti-inflammatory properties.

Living essentially in a tropical country, people with albinism are more exposed to sun damage and tropical dermatological conditions compared to Western albino subjects. However, regardless of the climatic region, albino subjects are very susceptible to contracting skin cancers, mainly due to strong exposure to the sun and poorly treated lesions. Problems with sun exposure affect almost all skin types, which has led to the creation of sun protection products. Products with SPF 50 or 50+ are recommended for the protection of ultra-sensitive skin, such as that of albinos. In our work, we wanted to determine if, apart from the anti-inflammatory and antimicrobial properties of Mathesia and *Curcuma longa* L., these products could have photoprotective properties suitable for the skin of PWA. Unfortunately, that was not the case. However, we were able to highlight that the photoprotective properties of Mathesia and *Curcuma* would be more suitable for matte and dark skin.

Although the clinical tests of our creams have been encouraging, the field of research remains vast, particularly regarding the production of melanin in albinos. In our work, we aimed to create these dermatological creams to stimulate melanin production via an external contribution. This led us to include tyrosine, a precursor of melanogenesis, in our creams. Although the presence of tyrosine was verified, its quantity was too minimal to induce significant melanin production in people living with albinism.

From all the above, we think it would be possible for future research to increase the amount of active ingredients in creams or to change the plants (or extracts) used as active ingredients to estimate new values of tyrosine concentration and sun protection factor. Additionally, the diversity of medicinal plants in the tropics offers a large scope for research to find better values of the sun protection factor suitable for people living with albinism and to create products that more effectively address their skin carcinoma issues.

Acknowledgments: We gratefully acknowledge the contribution of Professor Jean-Paul Koto-te-Nyiwa Ngbolua in interpreting the results of this study.

Ethical Approval: Not applicable

Conflicts of Interest: None declared.

ORCID iDs:

Nyamangombe, G. L.[1]:	https://orcid.org/0009-0002-6620-6143
Mayele, B. M.[1]:	https://orcid.org/0009-0000-6828-9478
Nkasa, H. L.[2]:	https://orcid.org/0009-0004-8464-0802
Tshidibi, J. D.[1]:	https://orcid.org/0009-0007-4744-7271
Mpiana, E. M.[3]:	https://orcid.org/0009-0000-0750-308X
Masikini, F. B.[3]:	https://orcid.org/0009-0008-7643-4709
Mbokolo, G. I.[1]:	https://orcid.org/0009-0007-1083-1560
Mbembo, B. M.[1]:	https://orcid.org/0000-0001-7775-0705
Amogu, J. D.[1,3,4]:	https://orcid.org/0000-0002-2658-154X
Mubwele, A.[2]:	Nil identified

REFERENCES

AFSSAPS. (2006). *Produits cosmétiques de protection solaire. Rapport de synthèse élaboré par le groupe de réflexion de l'Afssaps sur les produits de protection solaire.* Paris.

Aquaron, R. (2000). L'albinisme Humain: Aspect cliniques génétiques cellulaires biochimiques et moléculaires. Travail du Laboratoire de Biochimie et de Biologie Moléculaire Faculté de Médecine. Médecine Tropicale.

Bene, K., Camara, D., Soumahoro, I. A., Kanga, Y., & Zirihi, G. N. (2017). Formulation galénique d'une pommade antimicrobienne à base d'un extrait hydroalcoolique de Bersama abyssinica Fresen. *Ethnopharmacologia, n°58*, 60-69.

Haftek, M. (2016). *Biologie Cutanée*. Chapitre 4: Sébum et film hydrophilique. Ed. MatriX, pp. 45-50.

Hombourger, C. (2010). Le Curcuma de l'épice au médicament. Thèse pour Doctorat en Pharmacie. Université HENRI POINCARE - NANCY 1 Faculté De Pharmacie. France (pp. 4-11).

Humbert, P. (2001). *Rayonnement ultraviolet et peau*. Ed. John Libbey.

Inkoto C. L., Masengo C. A., Falanga C. M., Mbembo, B. W. B., Amogu, J. J. D., Mahenda, I. S. M., Kayembe, J. P. K., Mpiana, P. T., & Ngbolua, K. N. (2020). A mini-review on the phytochemistry and pharmacology of the plant *Carica papaya* L. Britain *Interational of Extract Sciences (Bioflex)*. *3*(663-675).

Kabena, N. O., Nyakembe, E. N., Amogu, J. J. D., Asamboa, L. S., Lengbiye, E. L., Mboloko, E. J., Pius, T., Mpiana, & Felicien, L. (2020). Spermicidal and Antibacterial Effects of Oncoba Welwitchii Oliv. (Salicaceae). *European Journal of Medicinal Plants, 31*(17), 59-67.

Katunda, R., Amogu, J. J., Nzundu, J. P., Mukeba, F., Dianzuangani, D., Mutwale, P., Kabena, O., & Lukoki F. (2023). Phytochemical and mineral profiling of anti-fertlizer plants used by pygmy women in the town of Mbandaka in the Democratic Republic of the Congo : case of *Ipomoea involucrata* P. Beauv. and *Piptadeniastrum africanum* (Hook.f.) Brenan. *Internatioal Journal of Agricultural Research, Innovation and Technology (IJARIT)*. Vol. 13, 2(64-69).

King, R. A., Townsend, D., Oetting, W. A., et al. (2001). Temperature sensitive tyrosinase associated with peripheral pigmentation in oculocutaneous albinism. *J. Clin. Invest; 87*: 1046 - 1053.

Lacour J. O. (1992). Albinisme oculo-cutané. Ann. Pédiatr. *Paris, Revue générale 39*, 7 : 409 -418.

Nkasa, L., Inkoto, C. L., Muzomwe, M. J. C., Masengo, I. E., Muzomwe, C. M., Mulenga, M., & Taba, K. M. (2020). Phytochemical screening and antibacterial activity of phytomedicine Mathesia, a drug used against buruli ulcer in the Democratic Republic of the Congo (DRC). Article Accepted on 10/01/2020. EJPMR, 7(2), 52-56.

Nkasa, L.-H., Kadinekene, K. J., Kiabanzawoko, O., Tchey, B., Kimbonza, S., Lunguya, M. O., Karhemere, B., Mulenga, M. C., Muyembe, T. J. J., Kayembe, S. J., & Taba, K. M. (2021). In Vivo Evaluation of Anti-Mycobacterial Activity of a Phytomedicine "MATHESIA" on *Mycobacterium ulcerans*: Influence of Alkalinity on the Activity of Antibiotics Used in the Treatment of Buruli Ulcer. *Open Journal of Medical Microbiology, 11*, 47-57.

Shishehgarha, M. (1999). Étude de l'effet de la lyophilisation sur le volume et la couleur des petits fruits. Département de science des aliments et de la nutrition, Faculté des sciences de l'agriculture et de l'alimentation, Université de Laval (p. 129).

Souhila, L., & Souhila, R. (2014). Étude de l'efficacité de l'activité des huiles essentielles de *Curcuma longa* L. comme un biopesticide cas antifongique. Université Abou Bekr Belkaïd-Tlemcen, Faculté des Sciences de la Nature et de la Vie et des Sciences de la Terre et de l'Univers à Département d'Agroforesterie (p. 165).

World Health Organisation (WHO). (2010). *Classification mondiale de la médecine traditionnelle.* Article of 7 December 2010.