Potential Preventive Effects of *Curcuma longa* Gel Against Ultraviolet-Induced Actinic Keratosis in Balb/c Mice

Alwina V. Ubungen[1], Ellen Mae P. Abiqui, RPh, MSPharm, CPT[2], Beverly Bagayao-Barut, RPh[3], Avryl G. Flora[4], Kobe Bryant G. Gapate[5], Ivy Rose C. Orozco, RPh, CIP[6], Yumiko Lyka S. Uragami[7]

[1234567]College of Pharmacy, LORMA Colleges, City of San Fernando, La Union, Philippines
[1]alwina.ubungen@lorma.edu, [2]ellen.abiqui@lorma.edu, [3]beverly.bagayao@lorma.edu, [4]avryl.flora@lorma.edu, [5]kobebryant.gapate@lorma.edu, [6]ivyrose.orozco@lorma.edu, [7]yumikolyka.uragami@lorma.edu

Abstract

Actinic keratosis (AK), is a precancerous lesion formed on sun-exposed skin of individuals exposed to long-term ultraviolet (UV) light and may eventually progress to squamous cell carcinoma in the absence of treatment. In this study, the researchers examined the protective action of *Curcuma longa* gel from UVB-induced AK in Balb/c mice. Fifteen mice were first treated with three (3) different concentrations of gel (0.1%, 0.5%, 1.1%) and a positive and a negative control before being irradiated with UVB light from a 311nm UV lamp for four (4) hours on the first session, a 30-minute break, and another 4 hours for the second session, everyday. After fourteen (14) days of irradiation, the mice were subjected to histopathological analysis using 3 parameters namely, presence of cellular atypia, stratum corneum morphology, and epidermal thickness. The phytochemical analysis showed the presence of phenols, glycosides, reducing sugars, and quinones. The dermatological testing of the different concentrations to the 3 guinea pigs showed no erythema and edema, confirming it is safe for application. The preventive effects of *Curcuma longa* gel showed a dose-dependent effect, wherein the 1.1% of *Curcuma longa* gel was the most effective in preventing the presence of cellular atypia, the hallmark of AK, and also in preventing epidermal thickness, alongside 0.5% *Curcuma long* gel, making it the most effective concentration. Kruskal-Wallis and Dunn's post hoc analysis indicated that the most effective concentration (1.1%) was similar to the positive control for all analyzed parameters, and significantly better than the negative control. The 1.1% *Curcuma longa* gel's physicochemical properties were also evaluated. Having a deep yellow color, smooth texture, pH 5-6 along with a good spreadability and a viscosity of 4,970 cP. Based on this, it can be concluded that 1.1% of *Curcuma longa* gel is a good topical photoprotective formulation in the prevention of UVB-induced AK.

Keywords: Actinic keratosis; UVB radiation; *Curcuma longa*; Photoprotection; Curcumin

1. Introduction

Skin is regarded as the body's first and foremost line of defense against health threats such as pathogens, toxins, injury and UV light and helps maintain balance of water and temperature within the skin (Proksch et al., 2023). The stratum corneum is a "brick and mortar" barrier covering the uppermost layer of skin (Proksch et al., 2023) and is made up of corneocytes (bricks) and intercellular lipids (mortar) to prevent water loss and to provide an obstacle to entry of unwanted elements. These essential skin functions are shared with the scalp, but the scalps is different because it has more hair follicles and sebaceous glands, making it more oily, more sensitive and more vulnerable to barrier damage and conditions such as dandruff and seborrheic dermatitis. (Marquardt et al., 2021; Proksch et al., 2023).

UV is still the most critical of the environment affecting scalp structure. Both UVA and UVB light may penetrate skin, activating oxidative stress, DNA damage, inflammations, and hair follicles dysfunctions, while UVB can initiate direct damage at the epidermal level (Sakhiya et al., 2019; Proksch et al., 2023). Because hair intermittently blocks sunlight from the scalp and thereby damages barrier function, actinic damage and many other UV-induced diseases.(Arai et al., 2014; Sil et al., 2018).

For outdoor workers especially, such as construction workers, farmers and fishermen with a high level of sun exposure, this has had the most serious impact. Occupational UV doses are commonly over doses prescribed for skin, and reflective surfaces such as water, which exacerbate exposure (Modenese et al., 2019). Such risks have become particularly concerning in the case of the Philippines because of prevalent annual UV levels throughout the country and the high presence of UV-induced skin cancers in the Philippines, according to the Philippine Dermatological Society, between 2011 and 2021 2,102 basal cell carcinomas and 614 squamous cell carcinomas were reported, but probably a small percentage owing the absence of reports and poor access to care (Tan et al., 2022).

In terms of potential plant-based protection against UV-induced damages, *Curcuma longa* (turmeric) has shown an effective anti-UV-induced skin damage. The major ingredients in turmeric rhizomes including curcumin have various active compounds that serve as anti-oxidant and anti-inflammatory, as well as wound healing to neutralize reactive oxygen species, suppress pro-inflammatory signaling and inhibit collagen-degrading enzymes with approaches such as delivery in a nanoparticle, where challenges in terms of low water solubility, poor penetration and skin staining are circumvented (Wen et al., 2023; Goenka et al., 2021). However, there are considerable gaps in the existing data. Such studies largely consider general skin models and ignore the distinct characteristics of the scalp and hair follicles (Mayangsari et al., 2024). Additional strides are required in investigating curcumin based in vivo effects of uv-induced scalp damage, their mechanism of action, the effectiveness of a topical formulation of curcumin dosage sensitivity and long-term solubility of curcumin (Hosseini et al., 2018; Kantassa et al., 2025). Its low stability, water solubility and intense color have impeded the application of curcumin in patients and its use by patients (Wen et al., 2023; Goenka et al., 2021).

To address these knowledge and utility limitations, the present study will develop a scalp-specific *Curcuma longa* gel which will increase tropical delivery, stability and ease of care. It will be assessed based on a UV-resistant and UV-tolerant model on a scalp and its anti-UV action will be documented by histopathological analysis of oxidative stress, inflammation, and follicular injury markers (Heng et al., 2025; Kantassa et al., 2025). Given that the study is directed towards the scalp, this research may lead to more translational results, and support the formulation of a translatable alternative for the prevention of UV-induced diseases to the scalp.

2. Objectives

The objectives of the current study were the following three, to investigate if there is a prevention of actinic keratosis in the scalp in Balb/c mice after ultraviolet (UV) exposure to gel formulation based upon *Curcuma longa.* First objective, conduct a histopathological study of the histopathological examination on cellular atypia, structure of stratum corneum and epidermal thickness to determine the best concentration of *Curcuma longa* gel (0.1%, 0.5%, and 1.1%) in the prevention of actinic keratosis in Balb/c mice. Second, to ascertain how the best concentration was able to prevent it compared with either positive control or negative control for the same histopathological examining parameters. Third, to determine physicochemical properties of the most effective concentration of *Curcuma longa* gel on color, texture, pH, spreadability, and viscosity.

3. Materials and methods

This section describes the research procedures to investigate the preventive effects of *Curcuma longa* gel against UVB- induced Actinic Keratosis (AK) in BALB/c mice. Here the study has described the research design, duration of the study, locale, test animals and data collection techniques and other methods used in the study.

Research Design

An experimental research design was utilized in this research design as it permits controllable manipulation of factors such as; UV exposure and treatment with *Curcuma longa* to generate a relationship between causality in preventing the formation of ultraviolet-induced Actinic keratosis in Balb/c mice. It was an appropriate choice as experimental research design has proven to be an effective approach to test the hypothesis under strict conditions where specific influences of *Curcuma longa* in preventing damage from UV radiation can be observed. In an experimental design controlled dosage of *Cucuma longa* extract, positive control, negative control, and UV radiation were administered to the mice, to study and record cellular atypia, morphology of stratum corneum and epidermal thickness. An experimental research design was useful to know how *Curcuma longa* decreases damage induced by UV, where parameters of the preceding were reduced by the former and was in consistent with previous studies about antioxidant and anti inflammatory action of *Curcuma longa* (Aggarwal & Harikumar, 2009; Ceryn et al., Prasad et al., 2014).

Test Animals

For the in-vivo experiment, fifteen (15) Balb/c mice were used. This small sample size was selected so that the experiment would have accuracy and would not be wasteful of animal use. The Balb/c mice were purchased at a BAI-Certified pet shop at Pampanga. These mice were divided into three groups, experimental, positive control and negative control. The experimental groups received different concentrations of *Curcuma longa* gel (0.15, 0.5%, 1.1%), with the positive control receiving a commercially available scalp gel and the negative control receiving the Aloe vera base gel.

Collection and Preparation of the Plant Sample

Curcuma longa (turmeric plant) was collected from Barangay Mckinley, Galimuyod, Ilocos Sur and authenticated at Don Mariano Marcos Memorial State University (DMMMSU) - North La Union Campus, Sapilang, Bacnotan, La Union. Washed and dry rhizomes with air-oven at 60℃ for 3 hours. Ethanol was evaporated on a rotary evaporator at 40℃ producing a viscous turmeric rhizome extract (Kasta, 2020).

Phytochemical Testing

Phytochemical testing of the plant sample was conducted at Lorma Colleges Pharmacy Laboratory. Two widely reported phytochemical assays of curcumin in *Curcuma longa* were the potassium dichromate test and the ferric chloride test. The potassium dichromate test consisted in adding only a few drops of the solution to the extract, which turned dark as shown in the appendices as a positive reaction. Polyphenols such as curcumin in turmeric were oxidized by potassium dichromate, thus contributing to the characteristic dark born color of turmeric that confirmed the presence of phenolic compounds (Aboul-Fotouh et al., 2018). The ferric chloride test used a neutral 1% of ferric chloride solution with the extract turned bluish black due to colored complexes formed between the phenolic hydroxyl groups of ferric chloride ions. The color change added another confirmatory test with ferric chloride testing for the presence of polyphenols (Chaudhary et al., 2023).

Formulation

Curcuma longa extract was mixed into an Aloe vera base gel in developing the *Curcuma longa* gel. In order to conduct testing on the protective effects of *Curcuma longa* gel in Balb/c mice, topical applications of the gel with subsequent concentrations (0.1%, 0.5%, and 1.1%) were applied and UV light was irradiated to the animals (Goncalves et al., 2014; Pratiwi et al., 2021).

Acclimatization

Balb/c mice and guinea pigs were acclimatized at the Animal Laboratory of Lorma colleges for 14 days before transitioning to the environment. Balb/c mice and guinea pigs were kept in clean and dry condition at room temperature during the acclimatization period.

All animals were fed pellets along with ad libitum fresh water. All animals were housed in separate cages and properly labeled according to their respective treatment groups and tests. The Balb/c mice and guinea pigs were provided with fresh food and water twice daily, once in the morning and again in the afternoon. After the acclimatization period, the 15 Balb/c mice were divided into 5 experimental groups, while 3 guinea pigs were reserved for the patch and scratch tests. The mice were then assigned to their respective treatment groups for the study.

Dermatological Testing

Patch and scratch test for the *Cucuma longa* gel used three guinea pigs per concentration (0.1%, 0.5%, and 1.1%). At the start of the tests the guinea pigs were lightly pinned and shaven using a cloth size of around 4cm by 4cm of the upper part of their back or foreside to prevent injury of the skin. If there was any irritation caused by shaven skin then animals had a 24 hours opportunity to heal. The test article was then used onto the shaven skin and the application was covered with the gauze piece that was then applied with an adhesive tape as well. Different concentrations were applied to the different skin sites and a control/vehicle site. According to USP guidelines, patches are usually occluded for six hours. Application was removed, skin wiped clean, and reactions (erythema, edema, or lesions) were noted and graded at 24, 48, and 72 hours using a grading system like the Draize scale. The scratch test started with a shaved and cleaned test area. Parallel superficial scratches were made in the skin (superficial) but not deep enough for bleeding within a 1-2 cm region of the injured area (sterile needle). To obtain an allergic response score, the test article was attached to this abraded area for 15-20 minutes without occlusion, and the response was observed to include, redness, swelling, inflammation, which were scored to the 24, 48, and 72 hours range to determine seriousness of priority's at distinct times. For skin score the Draize scale was used.

In-vivo Testing

An ultraviolet light source (UVB light) that emits 311 nm was employed to expose the patients to radiation. The exposure was 5 days per week for 14 days. The Balb/c mice were kept in cages and placed 20 cm below the lamp to ensure that all animals receive the same amount of UV exposure. Each day, the mice underwent two uVB exposure sessions lasting 4 hours each, with a 30-minute break in between, following the protocol described by Alvariño et al. in (2021).

Before every UVB session, *Curcuma longa* gel was applied to the mice at the assigned concentrations, including the positive and negative control group. The gel was administered twice daily before each radiation session throughout the 14-day period. This setup ensured consistent UVB exposure among the animals and allowed the study to evaluate the potential protective or therapeutic effects of *Curcuma longa* gel against UVB-induced skin changes.

Histopathological Evaluation

Sampling was performed following the 3 weeks of concurrent application of concentrations and the control groups as well as the induction of the test animals.

Collection of samples was achieved by harvesting the skin tissues after the treatment for laboratory studies. Histopathological examination of the stored samples using skin biopsies revealed cellular atypia, altered stratum corneum morphology, epidermal thickness, and more indicating that the turmeric gel may exhibit protection at the tissue level (J, 2014). Histopathological examination was performed at Vet central Lab, San Juan City, Metro Manila.

Physicochemical Properties

Once the ideal concentration of *Curcuma longa* gel was determined, the formulation was thoroughly subjected to physicochemical examination in order to determine the grade of *Curcuma longa* gel and its sustainability for use in scalp preparation. A wide range of tests were conducted to study the gel's color, texture, pH, spreadability, and viscosity, since each parameter affected its appearance, stability, and user acceptance.

In the first stage, visual observation of turmeric gel color was performed using natural light by six randomly selected pharmacy and non pharmacy students of LORMA Colleges. The respondents observed the homogeneity, strength and brightness of the gel's yellow appearance by highlighting any color differences or variability. Similarly, the texture was quantitatively evaluated in the same group by means of sensory evaluation, where participants rubbed or pressed the sample between their fingers in a manner that showed its smoothness, consistency, stickiness, and overall feel during the application to replicate a typical user experience (Deshmukh et al., 2025; Patel et al., 2016).

In addition to appearance, the pH of the gel was also determined by dipping a pH strip into the gel sample for two seconds and measuring the color result. This was crucial because scalp gels are typically considered to be mildly acidic (4.5 to 5.5), which is consistent with the intrinsic acidity of the skin and contributes to the barrier integrity and also the balance of microbiome in the scalp. Pratiwi et al. (2021) stressed how products in this range can lessen scratching of the scalp and encourage scalp health. Spreadability was assessed, as well, by affixing a small amount of gel to the skin surface and watching the extent to which it spreads when placed with small pressure or mass. Six randomly chosen participants participated in the activity and reported ease of spreading to evaluate the formulations profile and apply to the scalp without scalp use (Patel et al., 2016; Deshmukh et al., 2025).

Lastly, the turmeric gel was subjected to a rotational viscometer with a spindle #2 at 60 rpm to determine the viscosity. The gel's viscosity was measured based on the flow resistance of the gel by turning the spindle at the different speeds and measuring the value of the corresponding dial reading, making it easy to measure both the consistency and applicability of the gel's composition. Taken together, these physicochemical tests constituted a consolidated assessment of the gel's aesthetic performance, practical performance, and overall application on the topical scalp (Patel et al., 2016; Chandrasekar et al., 2020).

Treatment of Data

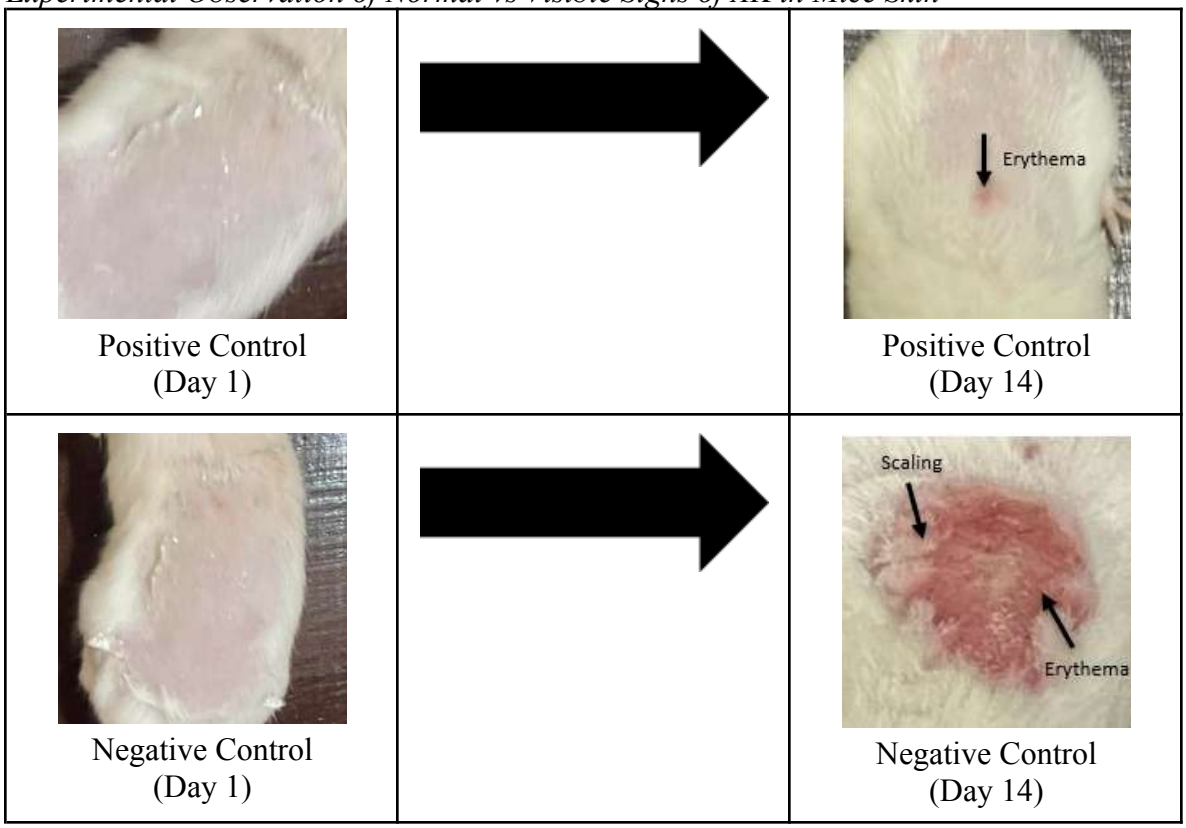
The histopathological findings have been studied through non-parametric statistics to interpret the preventive effects of *Curcuma longa* gel on UV. Descriptive statistics were used to determine the optimal concentration among 0.1%, 0.5%, and 1.1%, median and interquartile range, as the data were ordinal. The concentration with the absolute minimum mean for atypia cells, morphology of the stratum corneum and thickness of the epidermal was considered the most effective.

After identifying the best concentration, Kruskal-Wallis test was applied to assess significant differences in results for the most effective concentration, positive control and negative control. Subsequently Dunn's post hoc test was used to detect that the different groups differed in cellular atypia, stratum corneum morphology, and epidermal thickness. Once histopathologically appraised, a descriptively analysed formulation was found based on the physicochemical evaluation of color, texture, spreadability, pH and viscosity using a structured evaluation form.

4. Results

Figure 3.

Experimental Observation of Normal vs Visible Signs of AK in Mice Skin



Positive Control (Day 1) | Positive Control (Day 14)

Negative Control (Day 1) | Negative Control (Day 14)

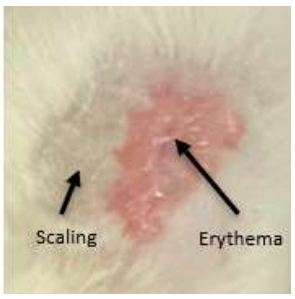
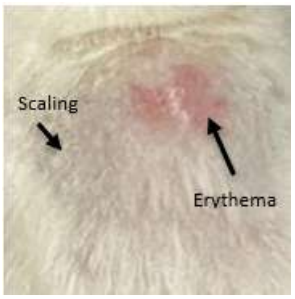
 0.1% Concentration (Day 1)		 0.1% Concentration (Day 14)
 0.5% Concentration (Day 1)		 0.5% Concentration (Day 14)
 1.1% Concentration (Day 1)		 1.1% Concentration (Day 14)

Table 4.

Histopathological Examination Results in terms of the Parameters

Group	Presence of Cellular Atypia	Stratum Corneum Morphology	Epidermal Thickness
	Score	Score	Score
T1 (0.1%)	2	1	1
	2	2	1
	2	2	2
T2 (0.5%)	1	2	1
	2	2	1
	2	2	1
T3 (1.1%)	1	2	1
	1	2	1
	2	2	1
Positive	1	1	1
	1	1	1
	1	2	1
Negative	4	4	5
	5	5	5
	5	5	5

Note: 1 = Absence of Parameter; 2 = Presence of Parameter and Normal Progression; 3 = Presence of Parameter and Mild Progression; 4 = Presence of Parameter and Moderate Progression; 5 = Presence of Parameter and Severe Progression

Table 5.

Median and Interquartile Range (Q3-Q1) of Histopathological Parameters of the Different Concentrations

Group	Presence of Cellular Atypia	Stratum Corneum Morphology	Epidermal Thickness
T1	2 (0)	2 (1)	1 (1)
T2	2 (1)	2 (0)	1 (0)
T3	1 (1)	2 (0)	1 (0)

Note: Values are presented as median (Q3-Q1), where Q3-Q1 represents the interquartile range. Severity scores: 1 = none; 2 = presence of the parameter

Table 6.

Median and Interquartile Range (Q3-Q1) of Histopathological Parameters of the Most Effective Concentrations vs the Positive and Negative Control

Group	Presence of Cellular Atypia	Stratum Corneum Morphology	Epidermal Thickness
T3	1 (1)	2 (0)	1 (0)
Positive	1 (0)	1 (1)	1 (0)
Negative	5 (1)	5 (1)	5 (0)

Note: 1 = Absence of Parameter; 2 = Presence of Parameter and Normal Progression; 3 = Presence of Parameter and Mild Progression; 4 = Presence of Parameter and Moderate Progression; 5 = Presence of Parameter and Severe Progression

Table 7.

The Kruskal-Wallis Analysis of the Scoring of the Histopathological Results

Parameter	df	ε^2	p	
Presence of Cellular Atypia	2	0.848	0.034	(There is a Significant Difference)
Stratum Corneum Morphology	2	0.861	0.032	(There is a Significant Difference)
Epidermal Thickness	2	1.000	0.018	(There is a Significant Difference)

Note: p-value <0.05 = There is a significant difference

Table 8.

Dunn's Post-Hoc Analysis of the Scoring of the Presence of Cellular Atypia

Pairwise Comparison		z	$p_{(unadj)}$	$p_{(Bonferroni)}$	
T3 (1.1%)	Positive	-0.492	0.622	1.000	
T3 (1.1%)	Negative	1.969	0.049	0.147	
Positive	Negative	2.462	0.014	0.041	(There is a Significant Difference)

Note: p-value <0.05 = There is a significant difference

Table 9.

Dunn's Post-Hoc Analysis of the Scoring of Stratum Corneum Morphology

Pairwise Comparison		z	$p_{(unadj)}$	$p_{(Bonferroni)}$	
T3 (1.1%)	Positive	-0.943	0.346	1.000	
T3 (1.1%)	Negative	1.650	0.099	0.297	
Positive	Negative	2.593	0.010	0.041	(There is a Significant Difference)

Note: p-value <0.05 = There is a significant difference

Table 10.

Dunn's Post-Hoc Analysis of the Scoring of Epidermal Thickness

Pairwise Comparison		z	$p_{(unadj)}$	$p_{(Bonferroni)}$	
T3 (1.1%)	Positive	0.00	1.000	1.000	
T3 (1.1%)	Negative	-2.45	0.014	0.043	(There is a Significant Difference)
Positive	Negative	-2.45	0.014	0.043	(There is a Significant Difference)

Note: p-value <0.05 = There is a significant difference

Table 11.

The Physicochemical Characteristics of the Most Effective Concentration

Physicochemical Characteristics	Evaluation
Color	Deep yellow
Texture	Smooth
pH	pH 5-6
Spreadability	Very easy
Viscosity	4,970 cP

5. Discussion

In accordance with the researcher's findings, erythema and edema gradually emerged more clearly as the days of UVB induction progressed, which was clearly shown in Figure 3, especially with the negative control. However, for the positive control and the different concentrations of *Curcuma longa* gel, the skin of the mice remained intact throughout the research period. Showing small or no apparent signs of irritation or ulceration. The preservation of skin integrity may be linked with the anti-inflammatory and antioxidant properties of *Curcuma longa*, which can lead to scavenging of reactive oxygen species (ROS), suppression of NF-kB activation, and suppression of cytokine release (Gupta et al., 2020; Liu et al., 2025). The gradual rise in redness and subtle increases in the layer of thickness of the skin that could be seen in the negative control mice showed an efficient induction of AK-like processes. These results confirm that early-stage AK confirms the experimental model and underscored the preventive effect of the treatments.

The histopathological data is presented in Table 4, and a concentration-dependent preventive effect is visible, with clearly different scores for different groups. In T1 (0.1%), cells were consistently seen to have cellular atypia, scoring 2, which is also a characteristic of keratinocytes having normal shape with small nuclear remodeling, indicating that in the presence of UV exposure showed some level of stress, but the treatment was able to prevent the progression of atypia. Stratum corneum morphology ranged from score 1 (no alteration) to score 2 (neat thin, compact, basket-weaved keratin), indicating that the outer part of the stratum corneum was effectively intact. Likewise, epidermal thickness ranged between score 1 (normal thin epidermis) and score 2 (typical thin epidermis with mild thickening) indicating that some mice maintained a normal epidermis with signs of acanthosis in some but still in very early stages.

In T2 (0.5%), a higher and reproducible preventive role appears in terms of the histopathological parameters compared with the lowest dose. Two mice still exhibited atypia at score 2, indicating normal morphology of keratinocytes with minor nuclear changes, tey, one mouse presented at score 1 (absence of atypia), indicating full preservation of keratinocyte morphology. This gradual shift toward score 1 indicates that the treatments were starting to better counteract UV-induced precancerous changes. The stratum corneum morphology retained score 2 (normal thin, compact keratin) for all mice, indicative of intact barrier free of hyperkeratotic changes. Meanwhile, epidermal thickness was uniformly scored 1 (normal thin epidermis), indicating total protection against acanthosis or thickening.

For T3 (1.1%), the histopathological profile shows the most protective effect among the groups treated, which closely resembles the positive control. Cellular atypia was absent in two (score 1), was present in one but within normal range (score 2), showing no degeneration of keratinocyte morphology and prevention of progression toward precancerous nuclear changes. The stratum corneum morphology was preserved in a consistent way at score 2 (normal thin, compact, basket-weaved keratin), thus indicating that the outer barrier did not undergo hyperkeratosis or parakeratosis. On the other hand, epidermal thickness was equally scored 1 (normal thin epidermis) throughout all mice, which demonstrated complete prevention for cases of acanthosis or thickening.

And for effective protection, their scores clearly mean its skin architecture remains intact in non-damaging conditions which is clearly why the positive control group is used as the benchmark. All mice presented absent atypia (score 1), in which nuclear morphology of keratinocytes remained normal without any enlargement, hyperchromasia, or pleomorphism. The stratum corneum morphology achieved mostly 1 (absent alteration), where it scored 2 in one mouse, corresponding to a normal thin, compact, basket-weaved keratin layer. On the other hand, thickness of the epidermis is consistently scored 1 (normal thin epidermis) on all samples indicating no acanthosis or thickening. In contrast, the negative control group had the worst UV-induced damage, recording cellular atypia scores 4-5, meaning severe nuclear pleomorphism, prominent nucleoli, and abnormal mitotic figures. The morphology of the stratum corneum was similarly compromised (score 4-5), characterised by thickened, dense keratin with parakeratosis and scaling, and epidermal thickness scored 5 consistently, which reflects marked acanthosis and papillomatosis. These findings corroborate the damaging effect of UV without protection.

The histopathological features utilized to determine whether *Curcuma longa* gel attenuated UV-induced AK-related changes in cellular atypia, stratum corneum

morphology, and epidermal thickness were summarized in Table 5. These three measures capture the structural changes observed during early AK and were scored to enable comparison of protective results of various gel concentrations.

The presence of cellular atypia is the most important market because it is the earliest and primary indicator of AK. Medians of T1 and T2 were 2, indicating atypia, but was within normal range. This means T1 included no variations so that all samples had the same result and T2 had a variation with one sample without atypia. The lowest median score of 1 suggested no atypia for T3, suggesting better protection against UV-induced keratinocyte damage. Such a pattern confirms also a dose-dependent effect where a higher *Curcuma longa* concentration has much better prevention for atypical nuclear changes. Similar effects were observed in the stratum corneum, a corneum area frequently affected in AK via parakeratosis, hyperkeratosis and irregular keratinization. Median scores of 2 were reported for all treatment groups, but T1 had a few deviations, reaching 1 for one sample, while T2 and T3 were the same between all samples. While T1 has a small advantage within one sample, there is no superiority in stratum corneum changes compared to the cellular atypia, with stratum corneum changes secondary only to the primary lesion. For epidermal thickness, all groups achieved the median score of 1, meaning they were all effective in preventing epidermal thickening but T2 and T3 were more consistent than T1.

T3 emerges as the most effective concentration overall when these three parameters are combined. It provided the best protection with regard to cellular atypia, preserved epidermal thickness, and preserved stratum corneum well. While T1 can benefit from better stratum corneum morphology, T3 is particularly important, as preventing cellular atypia becomes a stronger predictor of AK prevention. These effects of *Curcuma longa* are primarily attributed to its antioxidant, anti-inflammatory and photoprotective effects, which helped in preventing the occurrence of the different parameters.

Median and interquartile values for three histopathological parameters (presence of cellular atypia ,stratum corneum morphology, epidermal thickness) for the T3 (1.1%) were presented in Table 6 of this study being compared to the group with positive and negative controls. For cellular atypia, T3 demonstrated a median of 1 (1), very close to the positive control, with a median of 1(0), far lower than the negative control, with a median of 5 (1). This means T3 had a significant effect decreasing cellular atypia, almost mirroring the protective effect of the positive control. Regarding stratum corneum morphology, the median of T3 was 2 (0) which was marginally higher than the positive control with a median of 1 (1) but to a lesser extent than the negative control having a median 5 (1). This indicates that T3 had retained keratin structure but preserved the barrier similar to the positive control. On epidermal thickness, T3 had a median value of 1 (0) similar to the positive control and significantly less than negative control at 5 (0). This supports that T3 utterly prevents UV-induced thickening, which is exactly the mechanism of the curcumin as an antioxidant and an anti-inflammatory agent. In general, the table shows that the T3 (1.1%) gave robust protection at all parameters, and most resembled the positive control. The low median scores and small difference over time demonstrated its effectiveness in preventing UV- induced precancerous changes, especially in maintaining normal epidermal thickness and preventing cellular atypia (Gupta et al., 2020; Liu et al., 2025).

Due to the characteristics of the data, Kruskal-Wallis test was used to examine the histopathological scores (presence of cellular atypia, stratum corneum morphology, and epidermal thickness) between treatment groups. The computed p-values for all three

parameters, 0.034 for cellular atypia, 0.032 for stratum corneum morphology, and 0.018 for epidermal thickness, fall below the significance (0.05) level for treatment group shown in Table 7, thereby confirming that the group, versus the positive and negative controls' differences in the parameters are statistically significant. Effect sizes (ε^2) were then computed to quantify the strength of those differences ($\varepsilon^2 = 0.848, 0.861, 1.000$), indicating very strong to perfect associations. This evidence shows that the concentration of *Curcuma longa* gel has a strong and significant effect on inhibition of the histopathological changes characteristic for AK.

Kruskal-Wallis test for cellular atypia demonstrated that the difference between at least 1 group was significant, however it did not show the contribution of any of these groups. To determine these pairs, Dunn's post-hoc test coupled with Bonferroni correction was performed which enabled a pairwise comparison and adjusted for type I error between tests.

Comparison between T3 and the positive control presented in Table 8 revealed no statistically significant differences. The result was $z = -0.492$; unadjusted $p = 0.622$; Bonferroni corrected $p = 1.000$. This indicates that the 1.1% *Curcuma longa* gel yielded cellular atypia to nearly identical levels with the protected or healthy conditions. In comparison with the negative control, there was a greater benefit to T3. The z value in this case was 1.969 with the adjustment from Bonferroni, the p value was 0.147, and the result was not statistically significant. Even if it had no statistical significance, the positive Z value was still sufficient to explain that T3 showed better function than negative control to prevent atypical cellular changes. Comparisons between the positive control and negative control showed significant effects even after the Bonferroni correction. The z value was 2.462 and the unadjusted p value was 0.014 with the correct p-value of 0.041. This demonstrates a successful response of the positive controls against UV-induced cellular atypia, while that of negative controls exhibited a severe injury. Collectively, this supports the protective effect of T3 as the observed results were reasonably similar to those observed for the positive control.

Dunn post hoc test analysis (Table 9) showed consistency between the T3 (1.1% *Curcuma longa* gel) and positive control ($z = 0.943$, $p =$ value 1.000), demonstrating T3 had the results similar to those observed for the same preventive treatment of stratum corneum morphology preservation.T3 obtained an apparent positive z = value of 1.650 and a p=0.297) when compared to the negative control (not statistically significant). This upward trend suggests that T3 was always superior to the untreated groups, suggesting that T3 possessed improvements in morphology biologically significant if not statistically significant. In contrast, the positive control compared against negative control is significant ($z = 2.593$, $p = 0.041$) indicating good protection as given the positive treatment against UV damage while the absence of the induced larger alterations of the structure. Collectively, these findings indicate that T3 had a similar effect to that positive control, and that it did indeed show a promising, though not statistically confirmed, benefit compared to the negative group.

For epidermal thickness, Dunn's post hoc analysis found no difference in effect between T3 (1.1% *Curcuma longa* gel) compared with the positive control ($z = 0.00$, $p = 1.000$), confirming that T3 remained without significant differences, keeping epidermal thickness as healthy as standard treatment. This ideal alignment evidences the potent preventative capacity of the 1.1% supplement in preventing the abnormal thickening. T3 vs.

the negative control indicated a significant difference (z = 2.45, unadjusted p= 0.014; corrected p= 0.043), although in the negative control group as a result of ultraviolet damage, the skin became thicker. The z value is negative indicating worse survival in untreated mice. Likewise, the positive control vs. negative control comparison yielded identical z values (z = 2.45, p = 0.014; corrected p = 0.043) that confirmed treatments had greater protection against UV-induced thickening versus non-treatment

In all parameters (presence of cellular atypia, stratum corneum morphology, epidermal thickness) T3 reflected the same preventive effect as the positive control, and was significantly superior to that of the negative control; with statistical evidence for increased epidermal thickness. Overall, combining these findings indicates that the 1.1% concentration is the most effective formulation, strengthening the therapeutic capacity of *Curcuma longa* at UV- induced AK.

The physicochemical determination of the most effective concentration of *Curcuma longa* gel reveals that the quality of the formulations greatly influences clinical efficacy and potential for consumers acceptance. The deep yellow color observed in all samples indicates that the existence of curcuminoids, particularly curcumin, that in turn, resulted in turmeric characteristics pigmentation and visually indicates the content of its bioactive constituents (El-Saadony et al., 2023; Salem et al.,2022). Evaluators reported greater spreadability and smooth texts with confirmed successful homogenization, allowing the curcumin to be delivered evenly to the scalp (spreading the product freely), promoting user comfort. The pH measured for the gel was 5-6 in accordance with the natural scalp microbials equilibrium following dermatological practices recommending that lightly acidic formulations promote scalp health and product safety (Pratiwi et al., 2021). Moreover, the viscosity of the 4,970 cP is within the acceptable range suggested for topical gels, and strikes a balance stability and ease of application, a value also stressed in cosmetic science literature to be important for the performance of the product (Nardi-Ricart et al., 2018). Collectively, these physicochemical properties of this particular gel ingredient that optimized gel concentration has a positive impact on therapeutic efficacy as well as on requirements for cosmetic as well as pharmaceutical formulations, further supporting its performance as a safe, stable, and consumer friendly form of interaction.

6. Conclusion

The 1.1% *Curcuma longa* gel (T3) could be described as the optimal concentration for protecting against UV-induced actinic keratosis, which could be justified from the results of the study. Phytochemical screening determined the existence of antioxidant and anti-inflammatory active compounds. No irritation occurred in skin tests performed on guinea pigs, demonstrating that the gel was safe for skin even sensitive to UV radiation. Physical checks of the untreated mice in the UVB-induced mouse model showed the control animals developing redness, swelling, and AK-like effects whereas the treated groups showed well-preserved skin with few irritations, clearly portraying the protective performance of the gels. Hence, the therapeutic potential of *Curcuma longa* gel is furthered substantiated, which is also consistent with literature suggesting the antioxidant and anti-inflammatory effects of curcumin to reduce UV-mediated photo damages (Li et al., 2016; Threskeia et al., 2023).

The results verify that *Curcuma longa* gel has a robust and dose-dependent protective effect to UV-induced actinic keratosis at the 1.1% concentration (T3), being the highest. T3 did not only inhibit cellular atypia, a characteristic of AK, but also avoided the thickening of epidermis and retained the integrity of the stratum stratum corneum which was only equivalent with the positive and with a remarkable decrease of epidermal thickness ($p = 0.043$). Although at lower concentration partial protection was gained, only T3 achieved a sustained reproducible preventive effect compared to reference treatment, thus, 1.1% gel formulation exhibited efficacy and usability together with its suitable physicochemical properties (stable color, uniform texture and ph, good spreading and viscosity). Accordingly, we find that *Curcuma longa* gel at 1.1% concentration is a safe, stable, and effective natural therapy for the prevention of UV-induced AK with similar properties as well as greater performance compared to other treatments.

7. Acknowledgements

We extend our heartfelt appreciation and gratitude to everyone who contributed to the successful completion of this research endeavor. Special thanks to our esteemed Dean, Ellen Mae P. Abiqui, RPh, MSPharm, CPT©, for her unwavering support, guidance and dedication to nurturing her students. We are deeply grateful to our research instructor, Ma'am Ivy Rose C. Orozco, RPh, CIP, for her patience, expertise, and encouragement throughout the research process. We also sincerely thank our research adviser, Ma'am Bevery Bagayao-Barut, for her invaluable mentorship, guidance, and constant support. Our heartfelt appreciation goes to our invaluable respected panel members, Dean Ellen Mae P. Abiqui, RPh, MSPharm, CPT©, Ma'am Rhoda Lumang-ay, RPh, MSPharm, and Ma'am Denilyn L. Munar, RPh, MSPharm, for their insightful suggestions and constructive feedback. We are also thankful to Sir Iwyne Abenis for his expertise and assistance in statistical analysis. Special recognition is given to Sir Jerald MAcapagal for his reliable support during laboratory procedures and experiments. We express our deepest gratitude to our beloved parents for their unconditional love, sacrifices, and unwavering encouragement. We are also thankful to our classmates, friends, and research team members for their dedication, cooperation, and support throughout this journey. No words can fully express our sincere gratitude to everyone who helped make this research possible.

To God be the glory.

The Researchers,
Ubungen, Alwina V.
Flora, Avryl G.
Gapate, Kobe Bryant G.
Uragami, Yumiko Lyka S.

8. References

Aboul-Fotouh, G., El-Nour, R. A., Farag, E., & Boughdady, W. (2018). Histological study on the possible protective effect of curcumin on potassium dichromate-induced hypothyroidism in adult male albino rats. The Egyptian Journal of Histology, 41(2), 220–235. https://doi.org/10.21608/ejh.2018.13844

Aggarwal, B. B., & Harikumar, K. B. (2009). Potential therapeutic effects of curcumin, the anti‐inflammatory agent, against neurodegenerative, cardiovascular, pulmonary, metabolic, autoimmune and neoplastic diseases. International Journal of Biochemistry & Cell Biology, 41(1), 40–59. https://www.sciencedirect.com/science/article/abs/pii/S1357272508002550

Ansary, T. M., Hossain, M. R., Kamiya, K., Komine, M., & Ohtsuki, M. (2021). Inflammatory Molecules Associated with Ultraviolet Radiation-Mediated Skin Aging. International Journal of Molecular Sciences, 22(8), 3974. https://doi.org/10.3390/ijms22083974

Arai, K. Y., Sugimoto, M., Ito, K., Ogura, Y., Akutsu, N., Amano, S., Adachi, E., & Nishiyama, T. (2014). Repeated folding stress‐induced morphological changes in the dermal equivalent. *Skin Research and Technology*, *20*(4), 399–408. https://doi.org/10.1111/srt.12131

Brand, R. M., Wipf, P., Durham, A., Epperly, M. W., Greenberger, J. S., & Falo, L. D. (2018). Targeting mitochondrial oxidative stress to mitigate UV-Induced skin damage. Frontiers in Pharmacology, 9. https://doi.org/10.3389/fphar.2018.00920

Bhatt, H., Thomas, S., & Vishwakarma, S. (2021). Unravelling the nature of intra-molecular hydrogen bonds in curcumin using in situ low temperature spectroscopic studies. *Spectrochimica Acta Part a Molecular and Biomolecular Spectroscopy*, *259*, 119903. https://doi.org/10.1016/j.saa.2021.119903

Ceryn, J., Lesiak, A., Sobolewska‐Sztychny, D., Noweta, M., Ciążyńska, M., & Narbutt, J. (2025). Actinic keratosis: comprehensive review of current treatments and emerging therapeutic innovations. Advances in Dermatology and Allergology/Postępy Dermatologii i Alergologii, 42(3), 221–231. https://pubmed.ncbi.nlm.nih.gov/40672735/

Chandrasekar, R., et al. (2020). Formulation and Evaluation of a Polyherbal Anti-acne Gel. Research Journal of Pharmaceutical Technology, 13(10), 4924-4929.

Chaudhary, S., Kumar, N., Singh, P., & Pandey, S. (2023). *Curcuma longa* (Turmeric): Ethnomedicinal uses and pharmacological potential. Journal of Ethnopharmacology. https://doi.org/10.1016/j.jep.2023.115462

Deshmukh, C. D., et al. (2025). Evaluation Parameter of Herbal Gel. Quest Journals Journal of Research in Pharmaceutical Sciences.

D'Orazio, J., Jarrett, S., Amaro-Ortiz, A., & Scott, T. (2013). UV radiation and the skin. International Journal of Molecular Sciences, 14(6), 12222-12248. https://doi.org/10.3390/ijms140612222

Du, F., Li, J., Zhang, S., Zeng, X., Nie, J., & Li, Z. (2024). Oxidative stress in hair follicle development and hair growth: Signalling pathways, intervening mechanisms and potential of natural antioxidants. Journal of Cellular and Molecular Medicine, 28(12). https://doi.org/10.1111/jcmm.18486

El‐Saadony, M. T., Yang, T., Korma, S. A., Sitohy, M., Abd El‐Mageed, T. A., Selim, S., Al Jaouni, S. K., et al. (2023). Impacts of turmeric and its principal bioactive curcumin on

human health: Pharmaceutical, medicinal, and food applications: A comprehensive review. Frontiers in Nutrition, 9, 1040259. https://doi.org/10.3389/fnut.2022.1040259

Fan, W., Rokohl, A. C., Guo, Y., Chen, H., Gao, T., Kakkassery, V., & Heindl, L. M. (2021). *Narrative review: mechanism of ultraviolet radiation-induced basal cell carcinoma.* Frontiers of Oral and Maxillofacial Medicine, 5, 9. https://doi.org/10.21037/fomm-21-31

Flores, Z. (2021). *Functional and integrative approach to dermatology: Useful tips for your practice* [PDF]. ResearchGate. ISSN 2094-201X

Fuloria, S., Mehta, J., Chandel, A., Sekar, M., Rani, N. N. I. M., Begum, M. Y., Subramaniyan, V., Chidambaram, K., Thangavelu, L., Nordin, R., Wu, Y. S., Sathasivam, K. V., Lum, P. T., Meenakshi, D. U., Kumarasamy, V., Azad, A. K., & Fuloria, N. K. (2022). *A Comprehensive Review on the Therapeutic Potential of Curcuma longa Linn. in Relation to its Major Active Constituent Curcumin.* Frontiers in Pharmacology, 13. https://doi.org/10.3389/fphar.2022.820806

George, C. D., Lee, T., Hollestein, L. M., Asgari, M. M., & Nijsten, T. (2024). Global epidemiology of actinic keratosis in the general population: A systematic review and meta‐analysis. British Journal of Dermatology, 190(4), 465–476. https://doi.org/10.1093/bjd/ljad371p

Gherardini, J., Wegner, J., Chéret, J., Ghatak, S., Lehmann, J., Alam, M., Jimenez, F., Funk, W., Böhm, M., Botchkareva, N. V., Ward, C., Paus, R., & Bertolini, M. (2019). *Transepidermal UV radiation of scalp skin ex vivo induces hair follicle damage that is alleviated by the topical treatment with caffeine.* International Journal of Cosmetic Science, 41(2), 164–182. https://doi.org/10.1111/ics.12521

Goenka, S., Johnson, F., & Simon, S. R. (2021). Novel chemically modified curcumin (CMC) derivatives inhibit tyrosinase activity and melanin synthesis in B16F10 mouse melanoma cells. *Biomolecules*, *11*(5), 674. https://doi.org/10.3390/biom11050674

Gómez-Estaca, J., Balaguer, M., López-Carballo, G., Gavara, R., & Hernández-Muñoz, P. (2017). Improving antioxidant and antimicrobial properties of curcumin by means of encapsulation in gelatin through electrohydrodynamic atomization. *Food Hydrocolloids*, *70*, 313–320. https://doi.org/10.1016/j.foodhyd.2017.04.019

Gonçalves, G. M. S., Da Silva, G. H., Barros, P. P., Srebernich, S. M., Shiraishi, C. T. C., De Camargos, V. R., & Lasca, T. B. (2014). Use of *Curcuma longa* in cosmetics: extraction of curcuminoid pigments, development of formulations, and in vitro skin permeation studies. Brazilian Journal of Pharmaceutical Sciences, 50(4), 885–893. https://doi.org/10.1590/s1984-82502014000400024

Gravetter, F. J., & Wallnau, L. B. (2016). *Statistics for the behavioral sciences* (10th ed.). Cengage Learning.

Greenwald, M. B. Y., Frušić-Zlotkin, M., Soroka, Y., Sasson, S. B., Bitton, R., Bianco-Peled, H., & Kohen, R. (2017). Curcumin Protects Skin against UVB-Induced Cytotoxicity via the Keap1-Nrf2 Pathway: The Use of a Microemulsion Delivery System. Oxidative Medicine and Cellular Longevity, 2017(1). https://doi.org/10.1155/2017/5205471

Guo, C., Ning, X., Zhang, J., Zhang, C., Wang, J., Su, L., Han, J., & Ma, N. (2023). Ultraviolet B radiation induces oxidative stress and apoptosis in human lens epithelial cells by activating NF-κB signaling, which down-regulates sodium vitamin C transporter 2 (SVCT2) expression. Cell Cycle, 22(12), 1450–1462. https://doi.org/10.1080/15384101.2023.2215084

Gupta, S. C., Prasad, S., Tyagi, A. K., & Aggarwal, B. B. (2020). Curcumin, a component of turmeric: From farm to pharmacy. BioFactors, 46(1), 2–13. https://doi.org/10.1002/biof.1639

Heerfordt, I. M., Nissen, C. V., Poulsen, T., Philipsen, P. A., & Wulf, H. C. (2016). Thickness of Actinic Keratosis Does Not Predict Dysplasia Severity or P53 Expression. Scientific Reports, 6, 33952. https://www.nature.com/articles/srep33952

Hewlings, S. J., & Kalman, D. S. (2017). Curcumin: A review of its effects on human health. Foods, 6(10), 92. https://doi.org/10.3390/foods6100092

Hosseini, A., & Hosseinzadeh, H. (2018). *Antidotal or protective effects of Curcuma longa (turmeric) and its active ingredient, curcumin, against natural and chemical toxicities: A review.* Biomedicine & Pharmacotherapy, 99, 411–421. https://doi.org/10.1016/j.biopha.2018.01.072

Iweala, E. J., Uche, M. E., Dike, E. D., Etumnu, L. R., Dokunmu, T. M., Oluwapelumi, A. E., Okoro, B. C., Dania, O. E., Adebayo, A. H., & Ugbogu, E. A. (2023). *Curcuma longa* (Turmeric): Ethnomedicinal uses, phytochemistry, pharmacological activities and toxicity profiles—A review. *Pharmacological Research - Modern Chinese Medicine*, *6*, 100222. https://doi.org/10.1016/j.prmcm.2023.100222

Jin, X. (2018). Curcumin and dietary polyphenol research: Beyond drug discovery. Acta Pharmacologica Sinica, 39(3), 324–333. https://doi.org/10.1038/aps.2017.179

Kantasa, T., Yeerong, K., Klinjan, P., Takuathung, M. N., Settakorn, K., Chuamanochan, M., Tovanabutra, N., Ampasavate, C., & Koonrungsesomboon, N. (2025). *Therapeutic potential of curcumin and novel formulations in psoriasis treatment: evidence and future prospects.* Drug Design Development and Therapy, Volume 19, 5387–5414. https://doi.org/10.2147/dddt.s520555

Kantor, R., & Silverberg, J. I. (2017). Environmental risk factors and their role in the management of atopic dermatitis. Expert Review of Clinical Immunology, 13(7), 701-713. https://doi.org/10.1080/1744666X.2017.1349893

Kasprzak-Drozd, K., Niziński, P., Hawrył, A., Gancarz, M., Hawrył, D., Oliwa, W., Pałka, M., Markowska, J., & Oniszczuk, A. (2024). *Potential of curcumin in the management of skin diseases.* International Journal of Molecular Sciences, 25(7), 3617. https://doi.org/10.3390/ijms25073617

Kasraee, B. (2017). The Measurement of Skin Color. In *Discrimination Between Cutaneous Pigmentation and Erythem* (pp. 49–54). https://doi.org/10.1007/978-3-319-32383-1_6

Kasta, G. (2020). Antimicrobial Activity of Ethanol Extract of Rhizome Turmeric (*Curcuma Longa* L.) for Growth of Escherichia coli, Staphylococcus aureus, and Candida albicans. Asian Journal of Pharmaceutical Research and Development, 8(3), 5–8. https://doi.org/10.22270/ajprd.v8i3.712

Keurentjes, A. J., de Witt, K. D., Jakasa, I., Rüther, L., Kemperman, P. M. J. H., Kezic, S., & Riethmüller, C. (2020). Actinic keratosis and surrounding skin exhibit changes in corneocyte surface topography and decreased levels of filaggrin degradation products. Experimental Dermatology, 29(5), 462–466. https://onlinelibrary.wiley.com/doi/10.1111/exd.14089

Krisanti et al., (2024). Effect of narrowband ultraviolet B (311 nm) exposure on skin carcinogenesis in Wistar rats. Journal of Advanced Veterinary and Animal Research, 11(4), 1105–1113. https://doi.org/10.5455/javar.2024.k861

Krismayogi, G. A., Ratnayanti, I. D., Linawati, N. M., Wiryawan, I. S., Sugiritama, I. W., & Wahyuniari, I. A. I. (2018, March 25). *Purple cabbage Extract cream effect on the erythema score of male Wistar rats' back skin exposed to UV-B radiation*. Biomedical and Pharmacology Journal. https://dx.doi.org/10.13005/bpj/1378

Lee, J. W., Ratnakumar, K., Hung, K., Rokunohe, D., & Kawasumi, M. (2020). *Deciphering UV‐induced DNA damage responses to prevent and treat skin cancer.* Photochemistry and Photobiology, 96(3), 478–499. https://doi.org/10.1111/php.13245

Lin, W., Chen, Y., Kuo, H., Kumar, S., Abomughaid, M. M., & Kumar, K. J. S. (2025). Ultraviolet B-induced oxidative damage in human skin keratinocytes is alleviated by Pinus morrisonicola leaf essential oil through activation of the Nrf2-dependent antioxidant defense system. Redox Report, 30(1). https://doi.org/10.1080/13510002.2025.2527427

Liu, M., Wang, J., Song, Z., & Pei, Y. (2025). Regulation mechanism of curcumin-mediated inflammatory pathway and its clinical application: a review. Frontiers in Pharmacology, 16. https://doi.org/10.3389/fphar.2025.1642248

Liu, X., Zhang, R., Shi, H., Li, X., Li, Y., Taha, A., & Xu, C. (2018). *Protective effect of curcumin against ultraviolet A irradiation-induced photoaging in human dermal fibroblasts.* Molecular Medicine Reports. https://doi.org/10.3892/mmr.2018.8791

Makati Medical Center. (2025, September 19). *Dermatology Clinic in the Philippines* | Makati Medical Center. https://www.makatimed.net.ph/service/dermlaser-phototherapy-center/

Manasa, P. S. L., Kamble, A. D., & Chilakamarthi, U. (2023). *VariExtraction Techniques of Curcumin: A Comprehensive Review*. ACS Omega, 8(38), 34868–34878. https://doi.org/10.1021/acsomega.3c04205

Marquardt, C. A., Pokorny, V. J., Kang, S. S., Cuthbert, B. N., & Sponheim, S. R. (2021). Posttraumatic stress symptom dimensions and brain responses to startling auditory stimuli in combat veterans. Journal of Abnormal Psychology, 130(5), 455–467. https://doi.org/10.1037/abn0000552

Marques, E., & Chen, T. M. (2023). Actinic keratosis. In StatPearls. StatPearls Publishing. https://www.ncbi.nlm.nih.gov/books/NBK557401/

Mayangsari, E., Mustika, A., Nurdiana, N., & Samad, N. A. (2024). *Comparison of UVA vs UVB Photoaging Rat Models in Short-term Exposure.* Medical Archives, 78(2), 88. https://doi.org/10.5455/medarh.2024.78.88-91

Montgomery, D. C. (2017). *Design and analysis of experiments* (9th ed.). Wiley.

Mo, Z. (2024). *Advancements in dermatological applications of curcumin*. Antioxidants, 13(2), 256. https://pmc.ncbi.nlm.nih.gov/articles/PMC11100965/

Moringa-O. (2023, October 19). *What is Scalp Psoriasis? What You Need to Know*. Moringa-O2. https://moringa-o2.com/what-is-scalp-psoriasis-and-ways-to-treat-it/

Modenese, A., Ruggieri, F. P., Bisegna, F., Borra, M., Burattini, C., Della Vecchia, E., Grandi, C., Grasso, A., Gugliermetti, L., Manini, M., Militello, A., & Gobba, F. (2019). Occupational exposure to solar UV radiation of a group of fishermen working in the Italian North Adriatic Sea. *International Journal of Environmental Research and Public Health*, *16*(16), 3001. https://doi.org/10.3390/ijerph16163001

Nardi-Ricart, A., Linares, M. J., Villca-Pozo, F., Pérez-Lozano, P., Suñé-Negre, J. M., Bachs-deMiquel, L., Roig-Carreras, M., Suñé-Pou, M., Nofrerias-Roig, I., & García-Montoya, E. (2018). A new design for the review and appraisal of semi-solid

dosage forms: Semi-solid Control Diagram (SSCD). *PLoS ONE*, *13*(9), e0201643. https://doi.org/10.1371/journal.pone.0201643

Nie, Y., & Li, Y. (2025). *Curcumin: a potential anti-photoaging agent*. Frontiers in Pharmacology, 16. https://doi.org/10.3389/fphar.2025.1559032

Patel, M., et al. (2016). Development and Evaluation of Topical Herbal Gel. Journal of Pharmacy Research, 10(10), 618-623.

Peng, Y., Ao, M., Dong, B., Jiang, Y., Yu, L., Chen, Z., Hu, C., & Xu, R. (2021). Anti-Inflammatory effects of curcumin in the inflammatory diseases: Status, limitations, and countermeasures. Drug Design Development and Therapy, Volume 15, 4503–4525. https://doi.org/10.2147/dddt.s327378.

Pfeifer, G. P. (2020). *Mechanisms of UV-induced mutations and skin cancer*. Genome Instability & Disease, 1(3), 99–113. https://doi.org/10.1007/s42764-020-00009-8

Pillon, A., Gomes, B., Vandenberghe, I., Cartron, V., Cèbe, P., Blanchet, J., Sibaud, V., Guilbaud, N., Audoly, L., Lamant, L., & Kruczynski, A. (2017). Actinic keratosis modelling in mice: A translational study. *PLoS ONE*, *12*(6), e0179991. https://doi.org/10.1371/journal.pone.0179991

Prasad, S., Gupta, S. C., Tyagi, A. K., & Aggarwal, B. B. (2014). Curcumin, a component of golden spice: from bedside to bench and back. *Biotechnology advances*, *32*(6), 1053–1064. https://doi.org/10.1016/j.biotechadv.2014.04.004

Pratiwi, D., Sidoretno, W. M., & Aisah, N. (2021). The Combination of Turmeric (Curcuma domestica) Rhizome Extract and Collagen in A Serum Formulation as an Antioxidant. *Borneo Journal of Pharmacy*, *4*(1), 36–42. https://doi.org/10.33084/bjop.v4i1.1578

Proksch, E., Zdzieblik, D., & Oesser, S. (2023). The oral intake of specific bovine-derived bioactive collagen peptides has a stimulatory effect on dermal matrix synthesis and improves various clinical skin parameters. Cosmetics, 12(2), 79. https://doi.org/10.3390/cosmetics12020079

Psoriasis : management. (2025, June 24). MIMS Philippines. https://www.mims.com/philippines/disease/psoriasis/management

Raza, A., Ali, M. A., Yusof, Y. A., Nasir, A., & Muneer, S. (2018). Effect of different drying treatments on concentration of curcumin in raw *Curcuma longa* L. *Food Research, 2*(6), 500–504. https://doi.org/10.26656/fr.2017.2(6).109

Radiation: Ultraviolet (UV) radiation. (2025, November 12). https://www.who.int/news-room/questions-and-answers/item/radiation-ultraviolet-%28uv%29

Rima. (2025, September 15). *Effective Treatments for Scalp Psoriasis Flare-Ups* | Svenson. Svenson. https://svenson.com.ph/blog/how-to-treat-scalp-psoriasis/

Ryser, S., Schuppli, M., Gauthier, B., Hernandez, D. R., Roye, O., Hohl, D., German, B., Holzwarth, J. A., & Moodycliffe, A. M. (2013). UVB-Induced skin inflammation and cutaneous tissue injury are dependent on the MHC Class I–like protein, CD1D. Journal of Investigative Dermatology, 134(1), 192–202. https://doi.org/10.1038/jid.2013.300

Saadé, N. E., Farhat, O., Rahal, O., Safieh-Garabedian, B., Le Bars, D., & Jabbur, S. J. (2008). *Ultraviolet-induced localized inflammatory hyperalgesia in awake rats and the role of sensory and sympathetic innervation of the skin.* Brain, Behavior, and Immunity, 22(2), 245–256. https://doi.org/10.1016/j.bbi.2007.08.002

Sakhiya, J., Sakhiya, D., Modi, M., Gandhi, S., & Daruwala, F. (2019). Prevalence, severity and associated factor of androgenetic alopecia in the dermatology outpatient clinic: A

retrospective study. IP Indian Journal of Clinical and Experimental Dermatology, 5(4), 280–287. https://doi.org/10.18231/j.ijced.2019.060

Salem, M. A., El‑Shiekh, R. A., Fernie, A. R., & Alseekh, S. (2022). Metabolomics‑based profiling for quality assessment and revealing the impact of drying of Turmeric (Curcuma longa L.). Scientific Reports, 12, 10288. https://doi.org/10.1038/s41598‑022‑13882‑y

Sarafian, G., Afshar, M., Mansouri, P., Asgarpanah, J., Raoufinejad, K., & Rajabi, M. (2015). Topical Turmeric Microemulgel in the Management of Plaque Psoriasis: A Clinical Evaluation. Iranian journal of pharmaceutical research: IJPR, 14(3), 865–876.

Savalei, V. (2019). A comparison of several approaches for controlling measurement error in small samples. Psychological Methods, 24(3), 352–370. https://doi.org/10.1037/met0000181

Sebetić, K. et al. (2008, October 1). *UV damage to the hair*. PubMed. https://pubmed.ncbi.nlm.nih.gov/19138021/

Singh, G., Maurya, S., & De Lampasona, M. P. (2013). Turmeric, the golden spice. In Herbal Medicine: Biomolecular and Clinical Aspects (2nd ed.). CRC Press. https://www.ncbi.nlm.nih.gov/books/NBK92752/

Sil, B. C., Moore, D. J., & Lane, M. E. (2018). Use of LC‑MS analysis to elucidate by‑products of niacinamide transformation following in vitro skin permeation studies. *International Journal of Cosmetic Science*, *40*(5), 525–529. https://doi.org/10.1111/ics.12486

Slavova-Kazakova, A. K., Angelova, S. E., Veprintsev, T. L., Denev, P., Fabbri, D., Dettori, M. A., Kratchanova, M., Naumov, V. V., Trofimov, A. V., Vasil'ev, R. F., Delogu, G., & Kancheva, V. D. (2015). Antioxidant potential of curcumin-related compounds studied by chemiluminescence kinetics, chain-breaking efficiencies, scavenging activity (ORAC), and DFT calculations. Beilstein Journal of Organic Chemistry, 11, 1398–1411. https://doi.org/10.3762/bjoc.11.151

Srivastava, J. K., Shankar, E., & Gupta, S. (2015). Chamomile: A herbal medicine of the past with a bright future. Molecular Medicine Reports, 3(6), 895–901. https://pubmed.ncbi.nlm.nih.gov/21132119/

Tan, N. M. G., Arevalo, M. V. P. N., Eala, M. A. B., & Siripunvarapon, A. H. (2022). *Skin cancer in the Philippines: The Filipino narrative*. JAAD International, 8, 163–164. https://doi.org/10.1016/j.jdin.2022.05.007

Tang, X., Yang, T., Yu, D., Xiong, H., & Zhang, S. (2024). *Current insights and future perspectives of ultraviolet radiation (UV) exposure: Friends and foes to the skin and beyond the skin.* Environment International, 185, 108535. https://doi.org/10.1016/j.envint.2024.108535

Threskeia, A., Khaerunnisa, S., Al-Khazaleh, A. K., & Mukono, I. S. (2024). The photoprotective effect of curcumin on skin exposed to ultraviolet radiation. *Biomolecular and Health Science Journal*, *7*(2), 145–151. https://doi.org/10.4103/bhsj.bhsj_19_24

Trueb, R., Henry, J., Davis, M., & Schwartz, J. (2018). *Scalp condition impacts hair growth and retention via oxidative stress*. International Journal of Trichology, 10(6), 262. https://doi.org/10.4103/ijt.ijt_57_18

Truong, D. H., Dinh, T. T., Trinh, T. M. D., Pham, T. H. M., Pham, M. Q., Gawlik-Dziki, U., & Dao, D. Q. (2025). HOO radical scavenging activity of curcumin I and III in

physiological conditions: a theoretical investigation on the influence of acid–base equilibrium and tautomerism. RSC Advances, 15(8), 5649–5664. https://doi.org/10.1039/d4ra07769e

Vaughn, A. R., Branum, A., & Sivamani, R. K. (2016). *Effects of turmeric (Curcuma longa) on skin health: A systematic review of the clinical evidence.* Phytotherapy Research, 30(8), 1243–1264. https://doi.org/10.1002/ptr.5640

Venkateshwari, T., Ganapathy, S., Arulmari, R., & Vijayakumary, P. (2021). Effect of drying temperature on the curcumin content of turmeric rhizomes (*Curcuma longa* L.). *The Pharma Innovation Journal, 10*(10), 2349–2351. ISSN (P): 2349-8242

Verma, S. B., & Wollina, U. (2009). *Ultraviolet Light-Induced Leukoderma of the Scalp Associated with Androgenetic Alopecia: Senescent Actinic Depigmentation of the Scalp.* Journal of Cutaneous Medicine and Surgery, 13(5), 262–265. https://doi.org/10.2310/7750.2009.08080

Villanueva, E. Q. (2022). Epidemiologic profile of skin tumors in the Philippine General Hospital: A descriptive cross‐sectional study. Health Science Reports, 5(2), e360. https://doi.org/10.1002/hsr2.360

Vollono, L., Falconi, M., Gaziano, R., Iacovelli, F., Dika, E., Terracciano, C., Bianchi, L., & Campione, E. (2019). *Potential of curcumin in skin disorders.* Nutrients, 11(9), 2169. https://doi.org/10.3390/nu11092169

Wang, G., Zhou, X., Pang, X., Ma, K., Li, L., Song, Y., Hou, D., & Wang, X. (2025). Pharmacological effects, molecular mechanisms,s and strategies to improve bioavailability of curcumin in the treatment of neurodegenerative diseases. Frontiers in Pharmacology, 16. https://doi.org/10.3389/fphar.2025.1625821

Wen, F., Li, P., Yan, H., & Su, W. (2023). Turmeric carbon quantum dots enhanced chitosan nanocomposite films based on photodynamic inactivation technology for antibacterial food packaging. *Carbohydrate Polymers*, *311*, 120784. https://doi.org/10.1016/j.carbpol.2023.120784

World Health Organization: WHO. (2020, May 4). *Ultraviolet radiation.* https://www.who.int/health-topics/ultraviolet-radiation#tab=tab_1

World Health Organization. (2022). *Ultraviolet radiation and the INTERSUN programme.* https://www.who.int/initiatives/intersun-programme

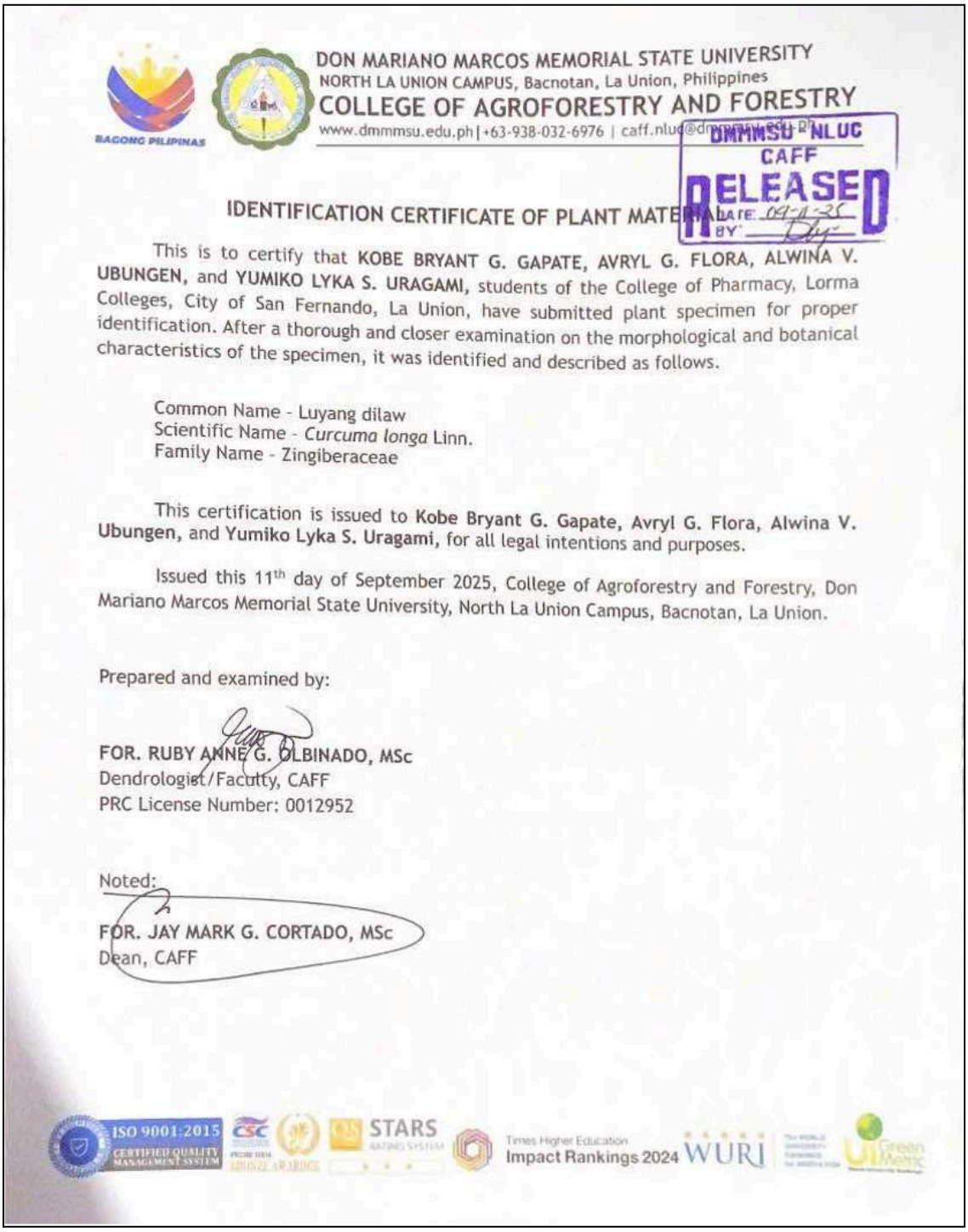
Yang, J., et al. (2020). A review of advances in influencing factors of acne. Frontiers in Cell and Developmental Biology, 8, 567941. https://doi.org/10.3389/fcell.2020.567941

Yousry, C., Saber, M. M., & Abd-Elsalam, W. H. (2022). *A Cosmeceutical Topical Water-in-Oil Nanoemulsion of Natural Bioactives: Design of Experiment, in vitro Characterization, and in vivo Skin Performance Against UVB Irradiation-Induced Skin Damages*. International Journal of Nanomedicine, Volume 17, 2995–3012. https://doi.org/10.2147/ijn.s363779

Zhai, X., Gong, M., Peng, Y., & Yang, D. (2021). *Effects of UVUV-Induced Photoaging on the hair follicle cycle of C57BL6/J mice.* Clinical Cosmetic and Investigational Dermatology, Volume 14, 527–539. https://doi.org/10.2147/ccid.s310487

9. Appendices

APPENDIX A
Certificate of Plant Identification



DON MARIANO MARCOS MEMORIAL STATE UNIVERSITY
NORTH LA UNION CAMPUS, Bacnotan, La Union, Philippines
COLLEGE OF AGROFORESTRY AND FORESTRY
www.dmmmsu.edu.ph | +63-938-032-6976 | caff.nluc@dmmmsu.edu.ph

DMMMSU - NLUC
CAFF
RELEASED
DATE: 09-11-25
BY:

IDENTIFICATION CERTIFICATE OF PLANT MATERIAL

This is to certify that **KOBE BRYANT G. GAPATE, AVRYL G. FLORA, ALWINA V. UBUNGEN,** and **YUMIKO LYKA S. URAGAMI,** students of the College of Pharmacy, Lorma Colleges, City of San Fernando, La Union, have submitted plant specimen for proper identification. After a thorough and closer examination on the morphological and botanical characteristics of the specimen, it was identified and described as follows.

Common Name - Luyang dilaw
Scientific Name - *Curcuma longa* Linn.
Family Name - Zingiberaceae

This certification is issued to **Kobe Bryant G. Gapate, Avryl G. Flora, Alwina V. Ubungen,** and **Yumiko Lyka S. Uragami,** for all legal intentions and purposes.

Issued this 11th day of September 2025, College of Agroforestry and Forestry, Don Mariano Marcos Memorial State University, North La Union Campus, Bacnotan, La Union.

Prepared and examined by:

FOR. RUBY ANNE G. OLBINADO, MSc
Dendrologist/Faculty, CAFF
PRC License Number: 0012952

Noted:

FOR. JAY MARK G. CORTADO, MSc
Dean, CAFF

APPENDIX B
BAI Certificate of the Researcher

Republic of the Philippines
Department of Agriculture
BUREAU OF ANIMAL INDUSTRY
Visayas Avenue, Brgy. Vasra, Quezon City

ANIMAL RESEARCH CLEARANCE

NAME OF INSTITUTION : **LORMA COLLEGES**	**REFERENCE NO :** *AR - 2026 - 0262*
	DATE/VENUE : March 2026 - June 2026 Lorma Colleges
BUSINESS ADDRESS : Carlatan, San Fernando City, La Union	**LEAD RESEARCHER/VETERINARIAN/IACUC CHAIR:** **Ubungen, Alwinn V., et.al.** - Researcher **Ivy Rose C. Orozco, RPh, CIP** – Research Adviser **Conrado A. Apusen III, RPh, CPS, MMHA** – IACUC Chair

Pursuant to the provisions of Republic Act 8485 or the Animal Welfare Act of 1998 as amended by RA 10631 and DA-Administrative Order (AO) No. 40, series of 1999, on the Rules and Regulations on the Scientific Procedure Using Animals, this Permit is hereby issued to **LORMA COLLEGES** with BAI Registration No. **LAF - 0005** after completing the req uirements to conduct the research/procedure entitled **"Potential Preventive Effects of *Curcuma longa* Against Ultraviolet-induced Actinic keratosis on the Scalp in Balb/c Mice"** on the date and venue stipulated above.

The Institution is hereby reminded to observe the provisions of DA-AO no. 40 s.1999.

Prepared on April 20, 2026.

Approved By Authority of the Director

JANICE SY GARCIA, DVM
Officer-in-Charge,
Animal Health and Welfare Division

4/20/26

RF AHWD-49 Animal Research Clearance
Rev. No. 03
April 19, 2023

APPENDIX C
BAI Certificate of the Animal Source

Republic of the Philippines
Department of Agriculture
BUREAU OF ANIMAL INDUSTRY
Visayas Avenue, Brgy. Vasra, Quezon City

CERTIFICATE OF REGISTRATION

also termed as

LICENSE TO OPERATE

in consonance with the World Organisation for Animal Health (WOAH) and Organisation for Economic Cooperation and Development (OECD)

Issued to

DM RODENTS ANIMAL FARM

Laboratory Animal Production Facility (Rat & Mouse)

LAP - 0039

Purok 1, Bulaon, San Fernando, Pampanga

This facility is registered with the Bureau of Animal Industry pursuant to the provisions of the RA 3639 an Act creating the BAI, EO No. 292 Series of 1987 Administrative Code of 1987, EO No. 338 Series 2001 Agriculture and Fisheries Modernization Act, RA 8485 otherwise known as Animal Welfare Act of 1998, as amended by RA 10631 and RA 10611 Food Safety Act.

Date of Issuance	Valid Until
May 08, 2025	May 08, 2026

Signed by the Authority of the Director:

JOANNA MARIE P. DAVID, DVM
Veterinarian III
Animal Health and Welfare Division

RF AHWD-48 Animal Facility Registration Certificate
Rev. No. 02
April 19, 2023

APPENDIX D
Certificate of Exemption from Review

LORMA COLLEGES

LC-REC Form #039
CERTIFICATE OF EXEMPTION FROM REVIEW

CERTIFICATION OF EXEMPTION FROM REVIEW

REC Reference #: 2026-072

To: Avryl G. Flora, Kobe Bryant G. Gapate, Alwina V. Ubungen, Yumiko Lyka S. Uragami

From: LORMA Colleges - Research Ethics Committee

Date: April 22, 2026

This is to certify that the Research Proposal entitled, "POTENTIAL PREVENTIVE EFFECTS OF *CURCUMA LONGA* AGAINST ULTRAVIOLET-INDUCED ACTINIC KERATOSIS ON THE SCALP IN BALB/C MICE" submitted by Avryl G. Flora, Kobe Bryant G. Gapate, Alwina V. Ubungen and Yumiko Lyka S. Uragami of College of Pharmacy has been reviewed by the Research Ethics Committee of LORMA Colleges and found that all ethical considerations are in place to conduct the research in the stated locale of the study. Hence, this research proposal is exempted from review.

JEROME P. VERA, LPT
Chairman, LC-REC

APPENDIX E

Timetable

Parts	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June
INTRODUCTION Background of the Study											
Conceptual Framework											
Operational Paradigm											
Statement of the Problem, Statement of Hypothesis											
Scope and Limitation											
METHODOLOGY Research Design and Method, Population and Locale of the Study											
Data Gathering Tools, Data Gathering Procedures, Ethical Considerations, Treatment of Data											
Filing of BAI Permit to Handle Test Animals											
Filing of LC-REC Approval Letter											
Perform Data Gathering											
RESULTS AND DISCUSSION											
CONCLUSIONS AND RECOMMENDATIONS											
Thesis Approval											
Bound Manuscript											
Copyright/Patent Filing											

APPENDIX F
Collection of *Curcuma longa* Sample

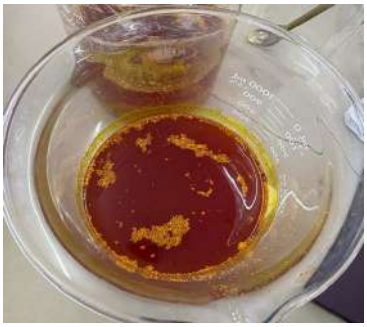
APPENDIX G
Materials, Equipment, Reagents

Materials and Equipment
Hot Air Oven Rotary Evaporator Analytical Balance pH paper/ pH strips Brookfield viscometer Mortar and Pestle Test Tubes Filter Paper Erlenmeyer Flask Glass Funnel Beakers Stirring Rod Spatula Water Bath
Chemicals and Reagents
Ethanol Ferric Chloride Lead Acetate Potassium Dichromate Anthrone Reagent Benedict's Solutions Chloroform Concentrated Sulfuric Acid Acetic Anhydride Glacial Acetic acid

APPENDIX H
Curcuma longa Preparation and Extraction

Preparation and Drying of *Curcuma longa*	
	
	
	

Extraction of *Curcuma longa*	
	

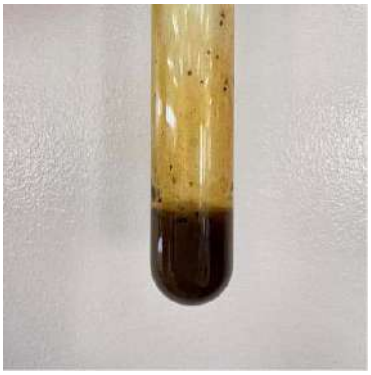
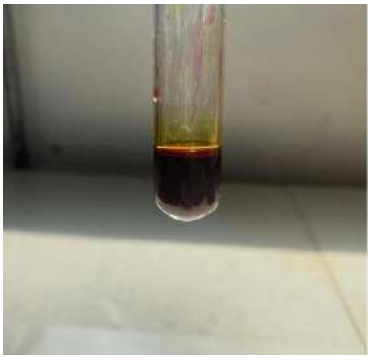
Removing Ethanol using Rotary Evaporator	
	

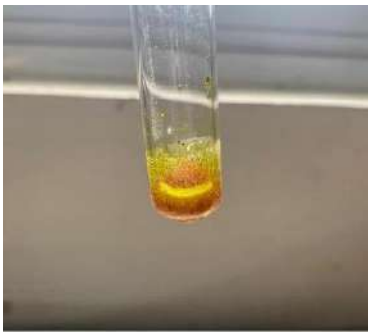
APPENDIX I
Formulation of the *Curcuma longa* Gel

Formulation	
	

Final Product	
	

APPENDIX J
Phytochemical Results

	Photo	Result
Lead Acetate Test		(+) Formation of red precipitate
Potassium Dichromate Test		(+) Formation of dark colored solution
Test for Steroids		(-) No blue-green color formation indicated the absence of steroids.

Test for Quinones		(+) Formation of red coloration indicating the presence of quinones
Anthrone Test		(-) No blue-green coloration in the solution indicated the absence of anthrone
Plant Sample with Water		(+) Formation of yellow to orange color indicated the absence of curcumin
Benedict's Test		(+) Formation of brick-red indicated the presence of Benedict's test.

Test for Glycoside		(+) Formation of reddish-brown ring at the junction indicated the presence of glycosides.
Test for Terpenoids		(+) The Black interface between the two solutions indicated the presence of terpenoids.
Ferric Chloride Test		(+) Formation of dark-colored solution

APPENDIX K
Patch and Scratch Test of the Guinea Pigs

Photodoc	Description
	Shaving and cleaning the skin of guinea pig
	Scratching the cleaned skin using a needle

	Applying the assigned concentration (gel)
	Covering the applied site with gauze
  	After 24hrs of applied *Curcuma longa* gel

APPENDIX L
Induction of Ultraviolet light to the back of the mice

Shaving and cleaning the skin of the mice	Applying the assigned gel concentration
	
Exposure to UV light for four hours	**Rest for 30 minutes, followed by another four hours of UV exposure**
	

Induction of Balb/c mice					
Day	**Treatment Group (0.1%)**	**Treatment Group (0.5 %)**	**Treatment Group (1.1%)**	**Positive Control Group**	**Negative Control Group**
1	M1 				
					
					
3					
					

					
6					
					
					
7					
					

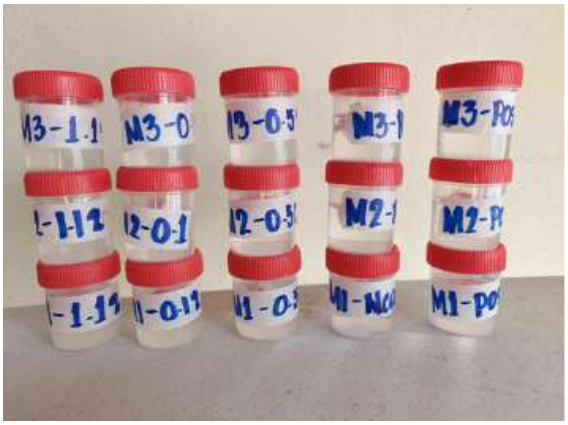
					
9					
					
					
12					
					

					
14					
					
					

Legend: M1 = Mouse 1; M2 = Mouse 2; M3 = Mouse 3

APPENDIX M

Collection of Skin Specimen for the Histological Examination



APPENDIX N
Histopathological Examination Results

GROUP	MOUSE NO	LAB NO	HISTOLOGICAL EVALUATION					
			Cellular Atypia		Stratum Corneum		Epidermal Thickness	
			Presence	Score	Presence	Score	Presence	Score
0.10%	1	26-H0614	+	0	+	0	+	0
	2	26-H0615	+	0	-	NA	-	NA
	3	26-H0616	+	0	+	0	-	NA
0.50%	1	26-H0617	+	0	+	0	-	NA
	2	26-H0618	+	0	+	0	-	NA
	3	26-H0619	-	NA	+	0	-	NA
1.10%	1	26-H0620	+	0	+	0	-	NA
	2	26-H0621	-	NA	+	0	-	NA
	3	26-H0622	-	NA	+	0	-	NA
Positive	1	26-H0623	-	NA	-	NA	-	NA
	2	26-H0624	-	NA	+	0	-	NA
	3	26-H0625	-	NA	-	NA	-	NA
Negative	1	26-H0626	+	3	+	2	+	3
	2	26-H0627	+	3	+	3	+	3
	3	26-H0628	+	2	+	3	+	3

VERONICA A. MATAWARAN, DVM, MS, PCVPH, FPCPP
Board Secretary & Treasurer/ Veterinary Pathologist
PRC License No: 1115

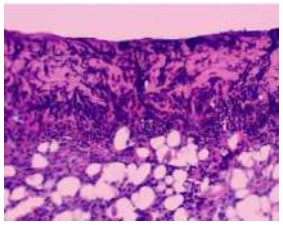
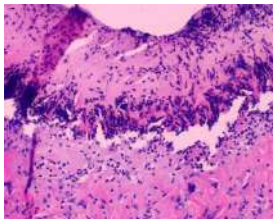
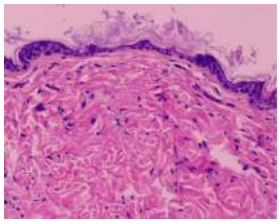
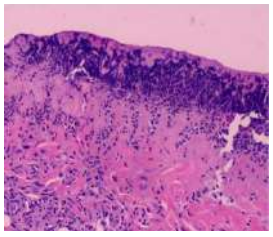
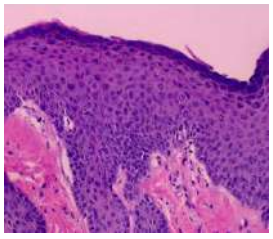
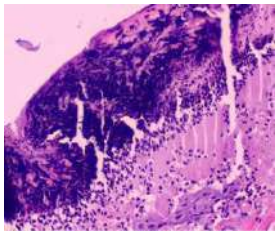
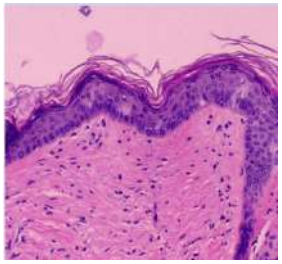
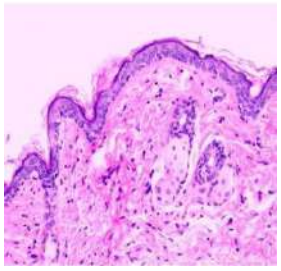
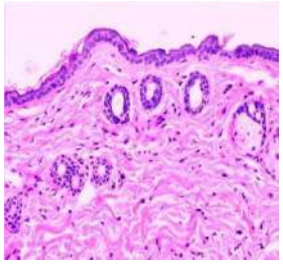
FLORISA M. VILORIA, DVM, FPCVPH, MLE[SM], MBA, HonDVSc.
Chairman and Managing Director
PRC Lic. No. 04079

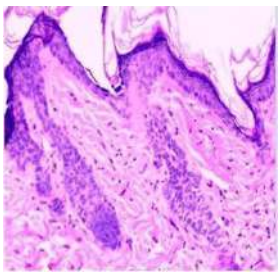
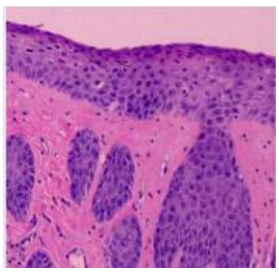
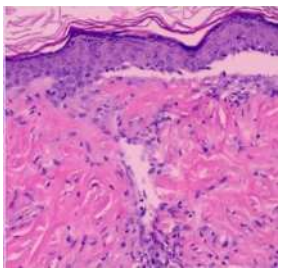
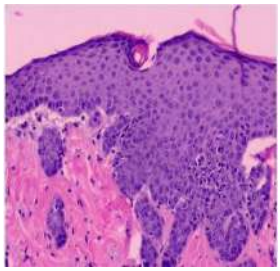
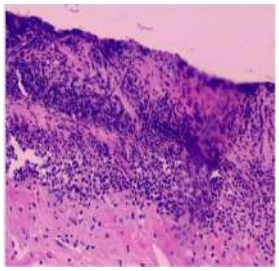
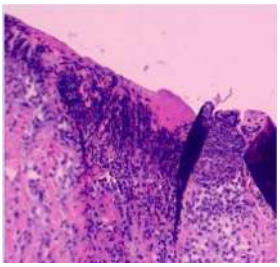
Scoring Basis

SCORING/ GRADING PARAMETERS					
Presence of Cellular Atypia		Stratum Corneum		Epidermal Thickness	
Score	Description	Score	Description	Score	Description
+	Present	+	Present	+	Present
-	Absent	-	Absent	-	Absent
0	**None:** Normal keratinocyte morphology	0	**Normal:** Thin, compact, basket-weave keratin	0	**Normal:** Typical thin epidermis
1	**Mild atypia:** Slight nuclear enlargement, mild hyperchromasia, minimal pleomorphism	1	**Mild alteration:** Slight thickening (mild hyperkeratosis)	1	**Mild thickening:** Slight acanthosis
2	**Moderate atypia:** nuclear pleomorphism, increased nuclear-cytoplasmic ratio, irregular chromatin	2	**Moderate alteration:** hyperkeratosis, possible parakeratosis	2	**Moderate thickening:** Clear acanthosis with elongated rete ridges
3	**Severe atypia:** Marked pleomorphism, prominent nucleoli, abnormal mitotic figures	3	**Severe alteration:** Marked thickening, dense keratin, prominent parakeratosis or scaling	3	**Severe thickening:** Marked acanthosis, possible papillomatosis

Scoring Accelerated

Original	Accelerated
N/A	1
0	2
1	3
2	4
3	5

Groups	Results		
Group 1 - 0.1% Control Treated *(Curcuma longa gel)*			
Group 2 - 0.5% Control Treated *(Curcuma longa gel)*			
Group 3 - 1.1% Control Treated *(Curcuma longa gel)*			

Positive Control (Commercially available)			
Negative Control (Aloe Vera Gel)			

APPENDIX O
Patch and Scratch Test Primary Irritation Index Result

Results of Patch Test to Determine the Primary Irritation Index of Curcuma longa Gel

Guinea Pig No.	Reaction	Score for Skin Reaction		
		Curcuma longa Gel		
		24 h	48 h	72 h
1 (0.1%)	Erythema	0	0	0
2 (0.5%)	Erythema	0	0	0
3 (1.1%)	Erythema	0	0	0
Score of Primary Irritation		0/3 = 0		

Score: 0 = No erythema

Results of Scratch Test to Determine the Primary Irritation Index of Curcuma longa Gel

Guinea Pig No.	Reaction	Score for Skin Reaction		
		Curcuma longa Gel		
		24 h	48 h	72 h
1 (0.1%)	Erythema	0	0	0
2 (0.5%)	Erythema	0	0	0
3 (1.1%)	Erythema	0	0	0
Score of Primary Irritation		0/3 = 0		

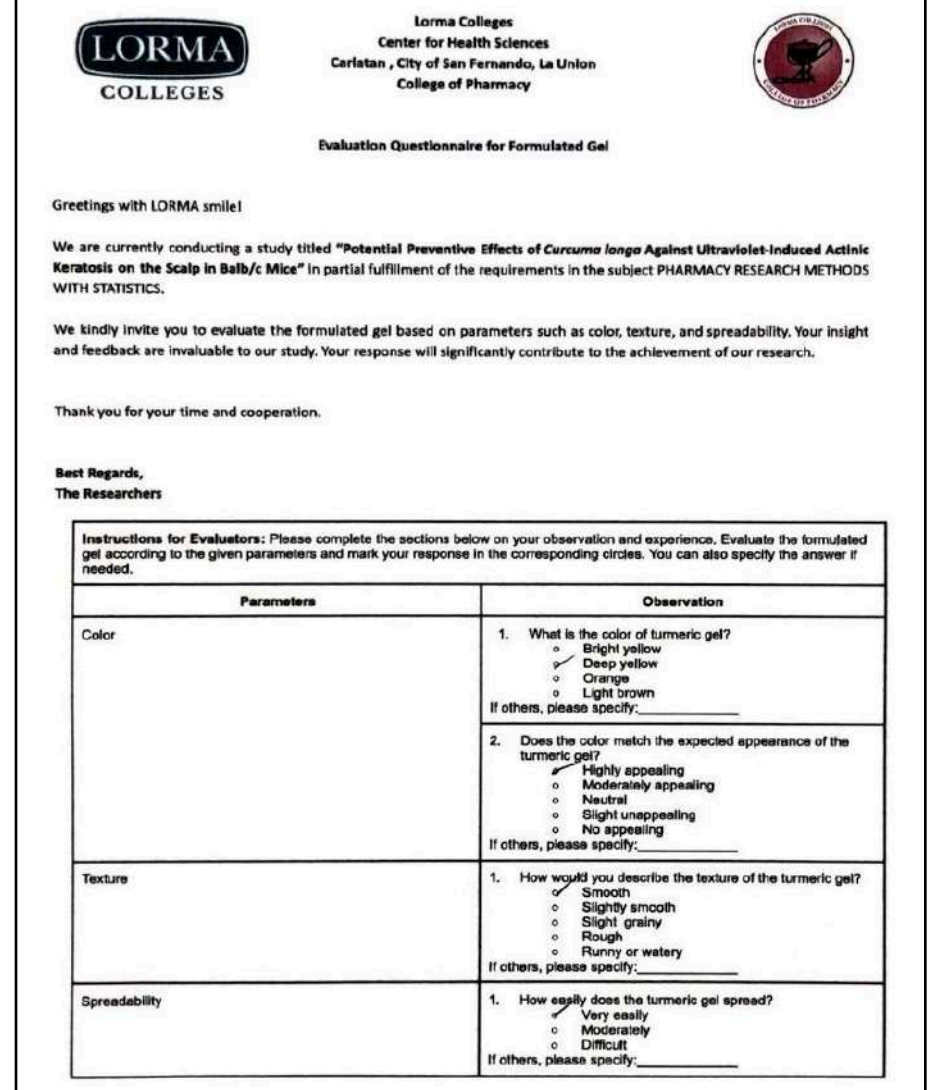
Score: 0 = No edema

Primary Irritation Index (PII) Computation

Patch Test	
Formula	Total Score = Average of SPI Values Total Score for Erythema
Solution	$\frac{0}{3} = 0$
Results	0

Scratch Test	
Formula	Total Score = Average of SPI Values Total Score for Edema
Solution	$\frac{0}{3} = 0$
Result	0
Primary Irritation Index (PII)	
Formula	Primary Irritation Index = ½ (Average of the Patch + Average of the Scratch)
Solution	Primary Irritation Index = ½ (0+0) = 0
Result	0

APPENDIX P
Evaluation Sheet for the Physicochemical Evaluation of *Curcuma longa* Gel

Respondent No.	Photo Documentation
1	

LORMA COLLEGES

Lorma Colleges
Center for Health Sciences
Carlatan , City of San Fernando, La Union
College of Pharmacy

Evaluation Questionnaire for Formulated Gel

Greetings with LORMA smile!

We are currently conducting a study titled **"Potential Preventive Effects of *Curcuma longa* Against Ultraviolet-Induced Actinic Keratosis on the Scalp in Balb/c Mice"** in partial fulfillment of the requirements in the subject PHARMACY RESEARCH METHODS WITH STATISTICS.

We kindly invite you to evaluate the formulated gel based on parameters such as color, texture, and spreadability. Your insight and feedback are invaluable to our study. Your response will significantly contribute to the achievement of our research.

Thank you for your time and cooperation.

Best Regards,
The Researchers

Instructions for Evaluators: Please complete the sections below on your observation and experience. Evaluate the formulated gel according to the given parameters and mark your response in the corresponding circles. You can also specify the answer if needed.

Parameters	Observation
Color	1. What is the color of turmeric gel? o Bright yellow ✓ Deep yellow o Orange o Light brown If others, please specify:_____
	2. Does the color match the expected appearance of the turmeric gel? ✓ Highly appealing o Moderately appealing o Neutral o Slight unappealing o No appealing If others, please specify:_____
Texture	1. How would you describe the texture of the turmeric gel? ✓ Smooth o Slightly smooth o Slight grainy o Rough o Runny or watery If others, please specify:_____
Spreadability	1. How easily does the turmeric gel spread? ✓ Very easily o Moderately o Difficult If others, please specify:_____

2

LORMA COLLEGES

Lorma Colleges
Center for Health Sciences
Carlatan , City of San Fernando, La Union
College of Pharmacy

Evaluation Questionnaire for Formulated Gel

Greetings with LORMA smile!

We are currently conducting a study titled **"Potential Preventive Effects of *Curcuma longa* Against Ultraviolet-Induced Actinic Keratosis on the Scalp in Balb/c Mice"** in partial fulfillment of the requirements in the subject PHARMACY RESEARCH METHODS WITH STATISTICS.

We kindly invite you to evaluate the formulated gel based on parameters such as color, texture, and spreadability. Your insight and feedback are invaluable to our study. Your response will significantly contribute to the achievement of our research.

Thank you for your time and cooperation.

Best Regards,
The Researchers

Instructions for Evaluators: Please complete the sections below on your observation and experience. Evaluate the formulated gel according to the given parameters and mark your response in the corresponding circles. You can also specify the answer if needed.

Parameters	Observation
Color	1. What is the color of turmeric gel? ○ Bright yellow ✓ Deep yellow ○ Orange ○ Light brown If others, please specify:_____
	2. Does the color match the expected appearance of the turmeric gel? ○ Highly appealing ✓ Moderately appealing ○ Neutral ○ Slight unappealing ○ No appealing If others, please specify:_____
Texture	1. How would you describe the texture of the turmeric gel? ✓ Smooth ○ Slightly smooth ○ Slight grainy ○ Rough ○ Runny or watery If others, please specify:_____
Spreadability	1. How easily does the turmeric gel spread? ✓ Very easily ○ Moderately ○ Difficult If others, please specify:_____

3

LORMA COLLEGES

Lorma Colleges
Center for Health Sciences
Carlatan , City of San Fernando, La Union
College of Pharmacy

Evaluation Questionnaire for Formulated Gel

Greetings with LORMA smile!

We are currently conducting a study titled **"Potential Preventive Effects of *Curcuma longa* Against Ultraviolet-Induced Actinic Keratosis on the Scalp in Balb/c Mice"** in partial fulfillment of the requirements in the subject PHARMACY RESEARCH METHODS WITH STATISTICS.

We kindly invite you to evaluate the formulated gel based on parameters such as color, texture, and spreadability. Your insight and feedback are invaluable to our study. Your response will significantly contribute to the achievement of our research.

Thank you for your time and cooperation.

Best Regards,
The Researchers

Instructions for Evaluators: Please complete the sections below on your observation and experience. Evaluate the formulated gel according to the given parameters and mark your response in the corresponding circles. You can also specify the answer if needed.

Parameters	Observation
Color	1. What is the color of turmeric gel? o Bright yellow ✓ Deep yellow o Orange o Light brown If others, please specify:_____
	2. Does the color match the expected appearance of the turmeric gel? ✓ Highly appealing o Moderately appealing o Neutral o Slight unappealing o No appealing If others, please specify:_____
Texture	1. How would you describe the texture of the turmeric gel? ✓ Smooth o Slightly smooth o Slight grainy o Rough o Runny or watery If others, please specify:_____
Spreadability	1. How easily does the turmeric gel spread? ✓ Very easily o Moderately o Difficult If others, please specify:_____

4

Lorma Colleges
Center for Health Sciences
Carlatan , City of San Fernando, La Union
College of Pharmacy

Evaluation Questionnaire for Formulated Gel

Greetings with LORMA smile!

We are currently conducting a study titled **"Potential Preventive Effects of *Curcuma longa* Against Ultraviolet-Induced Actinic Keratosis on the Scalp in Balb/c Mice"** in partial fulfillment of the requirements in the subject PHARMACY RESEARCH METHODS WITH STATISTICS.

We kindly invite you to evaluate the formulated gel based on parameters such as color, texture, and spreadability. Your insight and feedback are invaluable to our study. Your response will significantly contribute to the achievement of our research.

Thank you for your time and cooperation.

Best Regards,
The Researchers

Instructions for Evaluators: Please complete the sections below on your observation and experience. Evaluate the formulated gel according to the given parameters and mark your response in the corresponding circles. You can also specify the answer if needed.

Parameters	Observation
Color	1. What is the color of turmeric gel? ○ Bright yellow ○ Deep yellow ✓ Orange ○ Light brown If others, please specify:_____
	2. Does the color match the expected appearance of the turmeric gel? ○ Highly appealing ✓ Moderately appealing ○ Neutral ○ Slight unappealing ○ No appealing If others, please specify:_____
Texture	1. How would you describe the texture of the turmeric gel? ○ Smooth ○ Slightly smooth ○ Slight grainy ✓ Rough ✓ Runny or watery If others, please specify:_____
Spreadability	1. How easily does the turmeric gel spread? ✓ Very easily ○ Moderately ○ Difficult If others, please specify:_____

5

Lorma Colleges
Center for Health Sciences
Cariatan , City of San Fernando, La Union
College of Pharmacy

Evaluation Questionnaire for Formulated Gel

Greetings with LORMA smile!

We are currently conducting a study titled **"Potential Preventive Effects of *Curcuma longa* Against Ultraviolet-Induced Actinic Keratosis on the Scalp in Balb/c Mice"** in partial fulfillment of the requirements in the subject PHARMACY RESEARCH METHODS WITH STATISTICS.

We kindly invite you to evaluate the formulated gel based on parameters such as color, texture, and spreadability. Your insight and feedback are invaluable to our study. Your response will significantly contribute to the achievement of our research.

Thank you for your time and cooperation.

Best Regards,
The Researchers

Instructions for Evaluators: Please complete the sections below on your observation and experience. Evaluate the formulated gel according to the given parameters and mark your response in the corresponding circles. You can also specify the answer if needed.

Parameters	Observation
Color	1. What is the color of turmeric gel? ✓ Bright yellow o Deep yellow o Orange o Light brown If others, please specify:_____
	2. Does the color match the expected appearance of the turmeric gel? ✓ Highly appealing o Moderately appealing o Neutral o Slight unappealing o No appealing If others, please specify:_____
Texture	1. How would you describe the texture of the turmeric gel? ✓ Smooth o Slightly smooth o Slight grainy o Rough o Runny or watery If others, please specify:_____
Spreadability	1. How easily does the turmeric gel spread? ✓ Very easily o Moderately o Difficult If others, please specify:_____

6	

LORMA COLLEGES

Lorma Colleges
Center for Health Sciences
Carlatan , City of San Fernando, La Union
College of Pharmacy

Evaluation Questionnaire for Formulated Gel

Greetings with LORMA smile!

We are currently conducting a study titled **"Potential Preventive Effects of *Curcuma longa* Against Ultraviolet-Induced Actinic Keratosis on the Scalp in Balb/c Mice"** in partial fulfillment of the requirements in the subject PHARMACY RESEARCH METHODS WITH STATISTICS.

We kindly invite you to evaluate the formulated gel based on parameters such as color, texture, and spreadability. Your insight and feedback are invaluable to our study. Your response will significantly contribute to the achievement of our research.

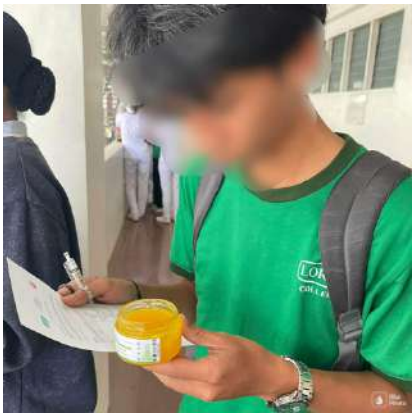
Thank you for your time and cooperation.

Best Regards,
The Researchers

Instructions for Evaluators: Please complete the sections below on your observation and experience. Evaluate the formulated gel according to the given parameters and mark your response in the corresponding circles. You can also specify the answer if needed.

Parameters	Observation
Color	1. What is the color of turmeric gel? o ✓ Bright yellow o Deep yellow o Orange o Light brown If others, please specify:_____
	2. Does the color match the expected appearance of the turmeric gel? o ✓ Highly appealing o Moderately appealing o Neutral o Slight unappealing o No appealing If others, please specify:_____
Texture	1. How would you describe the texture of the turmeric gel? o Smooth o ✓ Slightly smooth o Slight grainy o Rough o Runny or watery If others, please specify:_____
Spreadability	1. How easily does the turmeric gel spread? o ✓ Very easily o Moderately o Difficult If others, please specify:_____

APPENDIX Q
Photodocumentation of the Evaluation Survey



10. Author(s)

Alwina V. Ubungen is a Pharmacy student at Lorma Colleges. Her academic journey has been marked by excellence and commitment to leadership, having served as a Secretary and an Assistant Chief Apothecary for the Junior Philippine Pharmacists Association - LORMA Chapter, last academic year 2024-2025 and year 2025-2026, respectively, and earning various honorable distinctions.

Ellen Mae P. Abiqui, RPh, MSPharm, CPT, is the Dean of the College of Pharmacy at LORMA Colleges and also the Higher Education Academic Director. Her passion for learning and dedication to her field are clear in the path she had taken, becoming a Pharmacist and earning her Master of Science in Pharmacy at Saint Louis University, Baguio City, and achieving her CPT-certification at LORMA Colleges. Each milestone reflects not just her academic excellence but also her commitment to growing and excelling in her profession.

Beverly Bagayao-Barut, RPh, is an academic coordinator of the College of Pharmacy at LORMA Colleges. Her academic excellence is evident through her various distinctions and credentials, being a Lormanian Pharmacist and a holder of Master of Science in Pharmacy from Saint Louis University, Baguio City, which signifies her dedication and commitment to excellence.

Avry G. Flora is a Pharmacy student at Lorma Colleges. Her dedication to academic growth and professional development is reflected in her active participation in various seminars inside and beyond the department, including Rotaract activities, as well as her involvement in numerous school events throughout her academic journey.

Kobe Bryant G. Gapate is a Pharmacy student at Lorma Colleges. He is focused on his studies and continues to work hard to improve his knowledge and skills in the field of healthcare. He aims to grow into a competent and compassionate professional who can contribute positively to patient care.

Ivy Rose C. Orozco, RPh, CIP, is the Research Coordinator of the College of Pharmacy at LORMA Colleges. She earned her bachelor's degree in the University of Santo Thomas, and later pursued her Certified Immunization Pharmacist (CIP) credential through the Philippine Pharmacists Association. This reflects her drive to learning and dedication to advancing patient care.

Yumiko Lyka S. Uragami is a Pharmacy student at Lorma Colleges. She is committed to continuing learning and growth in the field of healthcare. She strives to develop her skills and knowledge to provide compassionate, professional and patient-centered care while making a meaningful contribution to the medical community.