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Chromametric assessment of drug skin tolerance: A comparative study between Africans and Caucasians skins

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Abstract

Background/Aims: During dermatological forms development, one of the simplest non-invasive techniques used to evaluate cutaneous tolerance of formulations is to monitor the color changes using a tristimulus chromameter. Most published tolerance studies involving chromametric measurements are performed on Caucasian subjects. However, in the context of drug formulation for African-type populations, it is not always relevant to transpose tolerance results obtained on Caucasians populations to African-type ones due to histological ethnic differences of the skin. The goal of this work was to assess whether tristimulus chromameter can be used to highlight color variations following the application of dermatological topics on black skin in order to validate skin tolerance studies made on African-type subjects.

Materials and Methods: After application of two commercial creams with opposite side effects (skin irritation and skin blanching) in both Africans and Caucasians populations, color variations were evaluated using a tristimulus chromameter in $L^*a^*b^*$ color system and compared between both populations. L^* indicating color brightness, a^* represents green and red directions and b^* represents blue and yellow directions.

Results: While skin irritation resulted in a significant increase of a^* parameter in both studied populations, the skin blanching resulted in a decrease of a^* associated with an increase of L^*.

Conclusion: We established that tristimulus chromameter can be used to achieve in vivo skin tolerance study of dermatologic formulations in Africans despite their dark skin even though it appeared less sensitive. This study can speed up the development of dermatological forms dedicated to Africans and/or Caucasians subjects.

KEYWORDS

dark skin, drug development, in vivo tolerance study, Tristimulus chromameter

1 | INTRODUCTION

The in vivo evaluation of cutaneous tolerance is of a huge importance in the development of cosmetic and dermatological pharmaceutical forms.[1] To assess in vivo cutaneous tolerance, non-invasive investigative techniques (NITs) are preferred due to time saving and the avoidance of damages about skin integrity on contrary to invasive techniques like biopsy of cutaneous tissue for histological examination.[2] Moreover, invisible early stages of skin disorders may be recognized using NIT.[3] In drug cutaneous tolerance studies, the common NIT are colorimetry or laser Doppler flowmetry to assess erythema, ultrasounds techniques to detect the formation of skin

edema or skin thickening and electrical techniques to assess skin water content.[4-6] Colorimetric NIT in particular are very useful for clinicians and researchers involved in dermatological and cosmetic fields.[7] Measurement of skin color is mainly used in skin erythema detection and grading. Skin erythema values are used as an index of inflammation mainly in the evaluation of therapeutic outcome in several dermatologic treatments.[1] Skin color measurements can be made by using two different principles. The first one is spectrophotometric which uses either a broadband (scanning) or selected wavelengths in the visible range with measurement of absorbance and reflectance. The second is based on tristimulus analysis of light reflected from skin structures.

Although the spectrophotometric scanning method gives detailed information about physical skin color properties, it is still expensive and laborious to use routinely.[8] Therefore, two types of lightweight and easy to handle instruments are now commonly used for quantification of skin color and erythema, namely a tristimulus colorimeter (Minolta Chromameter) and a narrow-band spectrophotometer (DermaSpectrometer, Cortex Technology).[9] Using a tristimulus chromameter, the skin surface is illuminated by a pulsed xenon arc lamp; the light is reflected perpendicular to the surface, collected and analyzed at 450 (blue), 560 (green), and 600 nm (red). Then, results are numerically expressed using the $L^*a^*b^*$ color system, as determined by the *Commission Internationale de l'Eclairage* (CIE). In $L^*a^*b^*$ system (Figure 1A), L^* parameter indicates color brightness (varying between a value of 0 for absolute black to 100 for absolute white) and a^* and b^* parameters, both ranged from −60 to + 60, are chromaticity coordinates (Figure 1B). While + a^* is the red direction and $-a^*$ the green direction, $+b^*$ and $-b^*$ represent yellow and blue directions, respectively. The center being achromatic, color saturation increases as point moves from the center.[10,11]

Several studies have reported the close links between chromameter a^* values and the presence of erythema after topical drug application.[12,13] However, most published tolerance studies involving chromametric measurements were performed on Caucasian subjects.[14] Some old guidelines even warn about the misleading outcomes of a chromametric investigation of irritation on dark-skinned people.[8] Indeed, it has been shown that the presence of melanin leads to a basal increase of a^* values which could be mistaken for the presence of an erythema.[15] Therefore, transposing results of drug cutaneous tolerance studies performed on Caucasians subjects to African ones are not relevant. Ethnic differences in cutaneous irritability have been well documented.[16] Black persons in general have less irritable skin than Caucasians of northern origin. A study has shown that subjects with light skin complexions (types 1 and 2) have high Ultraviolet B sensitivity and also hypersensitive skin to chemicals in general.[17] According to several authors, the stratum corneum of black subjects has more cell layers than white skins which induces a stronger skin barrier property to substances and, therefore, less irritable skin than in Caucasians.[18,19] We have to notice that these different behaviors in terms of irritability are dependent on irritant molecules tested.[20-22]

Given the remarkable advances in colorimetric tools which make chromameter able to detect even minute color variations, the question is whether or not tristimulus chromameter allows to detect intolerance reactions to dermatological topics on African-type populations in the context of drug formulation for this ethnic group.

In this study, we analyzed the variations of skin color parameters measured in an African population after application of two creams which, as side effects, induce, respectively, erythematous-type irritation reaction and blanching reaction and we compared to results obtained in a Caucasian population in order to validate or not tolerance studies directly performed on subjects of African-type by chromameter measurements.

2 | MATERIALS AND METHODS

2.1 | Subjects and chemicals

Prior to subjects' recruitment, the study received approval by the ethic committee of the University Hospital of Liege in Belgium, ethics committee approval No B707201836499. After checking inclusion criteria, each participant was enrolled after signing an informed consent document. The study was performed on ten healthy African volunteers (six males, four females; mean age 34 years) and ten healthy Caucasian volunteers (three males, seven females; mean age 36 years). The study was performed in accordance with Helsinki Declaration of the World Medical Association.

Two commercial creams were used in this study. THERMOCREAM® (Laboratoires STEROP) is a muscular and articular pains relief cream whose API are menthol (5.75% w/w), methyl salicylate (5.75% w/w), and capsicum oleoresin (0.7% w/w). These active pharmaceutical ingredients are well known to induce erythematous-type irritation side effect in Caucasians. DIPROSONE® cream (MSD-) contains betamethasone propionate, a corticosteroid used as anti-inflammatory or antipruritic, which also induces a blanching effect in Caucasians due to local vasoconstriction.[23,24]

2.2 | Test protocol

During this study, two different tests were simultaneously performed, a skin irritation induction test via the application of THERMOCREAM® and a skin blanching induction test via the application of DIPROSONE® cream.

To achieve that, three skin sites square shaped 4 cm^2 were accurately defined on the anterior part of all participants forearm. The position of the sites was determined in such a way that the centers of two adjacent squares were at least 4 cm apart and that all the squares were confined in the area of the anterior part of the forearm delimited since 3 cm under the antecubital fossa to 3 cm above the wrist. Hairy areas, naevi and visible blood vessels were avoided. One out of the three predefined sites serving as control, the two others received an application of 90 mg of the two different creams. The excess of THERMOCREAM® was removed 20 minutes after application whereas the excess of DIPROSONE® cream was removed after

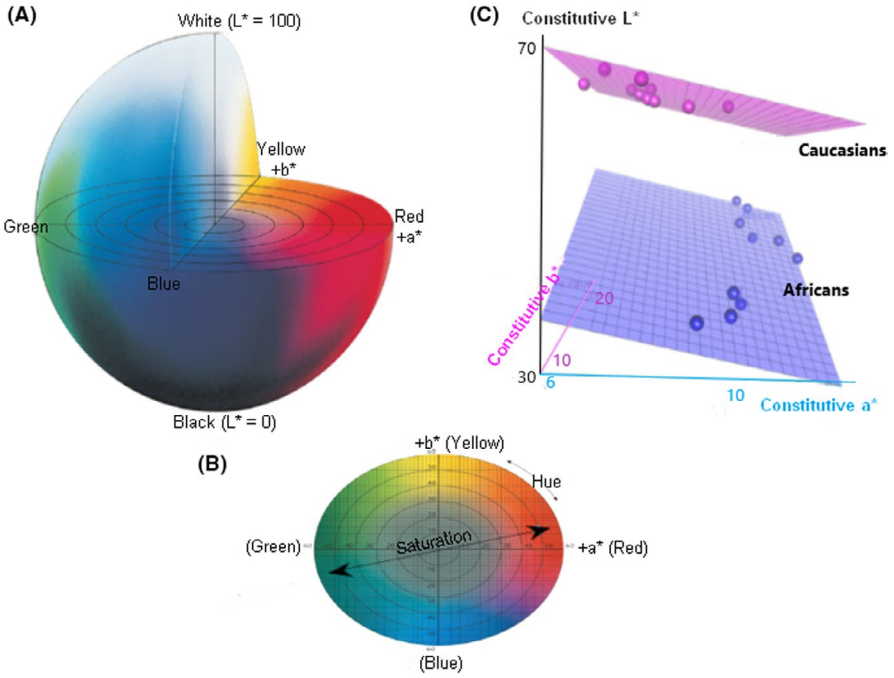

FIGURE 1 CIELab solid color space (A); a^*b^* chromaticity diagram (B) and generated Three-dimensional scatterplot (C) of constitutive skin color parameters values in both African (N = 10, blue plots) and Caucasian (N = 10, purple plots) study populations with their respective blue and purple regression surfaces; black axis, constitutive L^*; purple axis, constitutive b^* values; and blue axis, constitutive a^* values

5 hours. Amount and exposure time of THERMOCREAM® were fixed via a pretest on 3 Caucasians volunteers followed by visual inspection of redness, whereas those of DIPROSONE® were based on previous studies.[25]

Four independent chromametric measurements were performed on each site before any application and after cream removal using a Minolta® Chromameter CR-400 driven by the software SpectraMagic™NX. For assessing skin color, chromameter was employed in the $L^*a^*b^*$ mode according to the three-dimensional color space of the *Commission Internationale de l'Eclairage*. During measurements, the instrument was gently placed vertically on the skin, with excess pressure strictly avoided.

After the skin irritation induction test, we have proceeded to a systematic evaluation of the clinical signs of irritation particularly visible redness, stinging, pruritus, burning, drying of skin, and edema. Each symptom was evaluated using a Visual Analog Scale according to a 0-5 numeric symptom intensity scoring of irritation where 0 = absence of the symptom, 1 = very light, 2 = mild, 3 = moderate, 4 = important/severe, and 5 = very severe/the worst possible. For each subject, the average of the three highest symptom scores found allowed us to give him a clinical irritation status.[12,26]

2.3 | Chromametric data calculation

For each participant, the constitutive values of the parameters L^*, a^* and b^* have been defined as the arithmetic means of the 12 measurements initially performed on the 3 sites (4 measurements per site) of the forearm prior to any application. Variations ΔL^*, Δa^*, and Δb^* at each site were defined as the difference between measured values after and before cream application (baseline value). For instance, concerning the parameter a^*:

$$\Delta a^* = a^*\,(\textit{after application}) - a^*\,(\textit{before application}).$$

The global variation of color ΔE at a site is defined as follow:

$$\Delta E = \sqrt{(\Delta a^{*2} + \Delta b^{*2} + \Delta L^{*2})}.$$

To assess color variations attributable to the cream, a parameter $d(\Delta)$ was defined as the difference between ΔL^*, Δa^*, or Δb recorded at the cream application site and ΔL^*, Δa^*, or Δb recorded at control site. For example, during irritation test, the following formula gave the value of a^* parameter variations attributable to irritant cream effect:

$$\mathrm{d}\,(\Delta a^*) = \Delta a^*_{(\text{THERMOCREAM application site})} - \Delta a^*_{(\text{Control site})}$$

In this study, global skin color saturation (Chroma C^*) mentioned is defined by the following formula:$C^* = \sqrt{(a^{*2} + b^{*2})}$.

Skin pigmentation was evaluated using the individual typology angle (ITA°):

$$\mathrm{ITA}^\circ = \left[\tan^{-1}\left(\frac{L^* - 50}{b^*}\right)\right] * \frac{180}{\pi}$$

where ITA° is given in degrees.[27]

2.4 | Statistical analysis

Normality assumption of distributions of quantitative variables was investigated using comparison of median versus mean, graphs (histogram and Q-Q plot) examination, and tested using Shapiro-Wilk normality test.[28] Based on this investigation, quantitative data were

summarized by means ± standard deviation and means plots in case of normal distributions and by median (P25-P75) and boxplots in case of skewed ones.

According to the data distribution, either parametric tests, ie, *t* test or welch test (in case of non-homogeneity of variances) or non-parametric tests such as Mann-Whitney U test (Wilcoxon test) were used for groups comparison. Fisher test was used to compare variances between groups. Inside each ethnic group, for comparison of control versus treated (irritated or blanched) sites, paired tests were used to assess the statistical significance of the observed mean (or median) difference. According to the data distribution, correlations between variables were assessed using either Pearson's correlation test or Spearman test.

Concerning qualitative variables, proportions were compared using exact test of Fisher.

For all the tests performed, the significance level was set at 0.05. The 95% confidence intervals were used to indicate the precision of groups estimated differences. All statistical analyses were performed using GraphPad Prism 5 for Windows version 5.03 and R for windows version 3.5.3.

3 | RESULTS

3.1 | Skin color differences between both ethnic studied groups

The mean values of constitutive color parameters in both ethnic groups were calculated and compared. Regarding the skin brightness, constitutive L^* values were lower ($P < .0001$) in Africans (40.82 ± 4.93) than in Caucasians (66.72 ± 1.44) with a 95 percent confidence interval (95% CI) of difference at −29.5 to −22.3 which confirmed that Africans have a darker skin. Concerning skin chromaticity, whereas no significant difference was found in b^* values between both ethnic groups (16.15 ± 3.42 for Africans vs 15.29 ± 1.39 for Caucasians, $P = .5$), Africans exhibited a higher (11.13 ± 0.96 vs 7.93 ± 1.14 for Caucasians; $P < .0001$) value of a^* (95% CI of difference with Caucasians = +2.2 to + 4.2), which confirmed that Africans had a redder skin. A strong positive correlation ($r = .95$, $P < .0001$) was detected in Africans group between b^* parameter and L^* parameter. A lower but still relevant positive correlation ($r = .65$, $P = .04$) was also found in that group between a^* and b^* parameters. However, no significant correlation was detected between L^* and a^* in that group which suggested that, in Africans, when brightness increased, skin saturation in yellow increased and when redness increased yellowness increased too. At the same time, among Caucasians, a strong negative correlation ($r = -.75$, $P = 1.1 \times 10^{-2}$) was observed between L^* and a^*. According to skin pigmentation, Caucasian group had an ITA° value of 47.6° ± 3.6° (corresponding to light skin) whereas African group had an ITA° value of −30° ± 17.7° (brown to dark skin) as expected. The skin color three-dimensional scatterplot showing relationships between parameters and regression surfaces is presented at Figure 1C.

3.2 | Skin irritation induction test

The numeric symptom intensity scale was used to compare skin irritation between subjects following THERMOCREAM® application. As

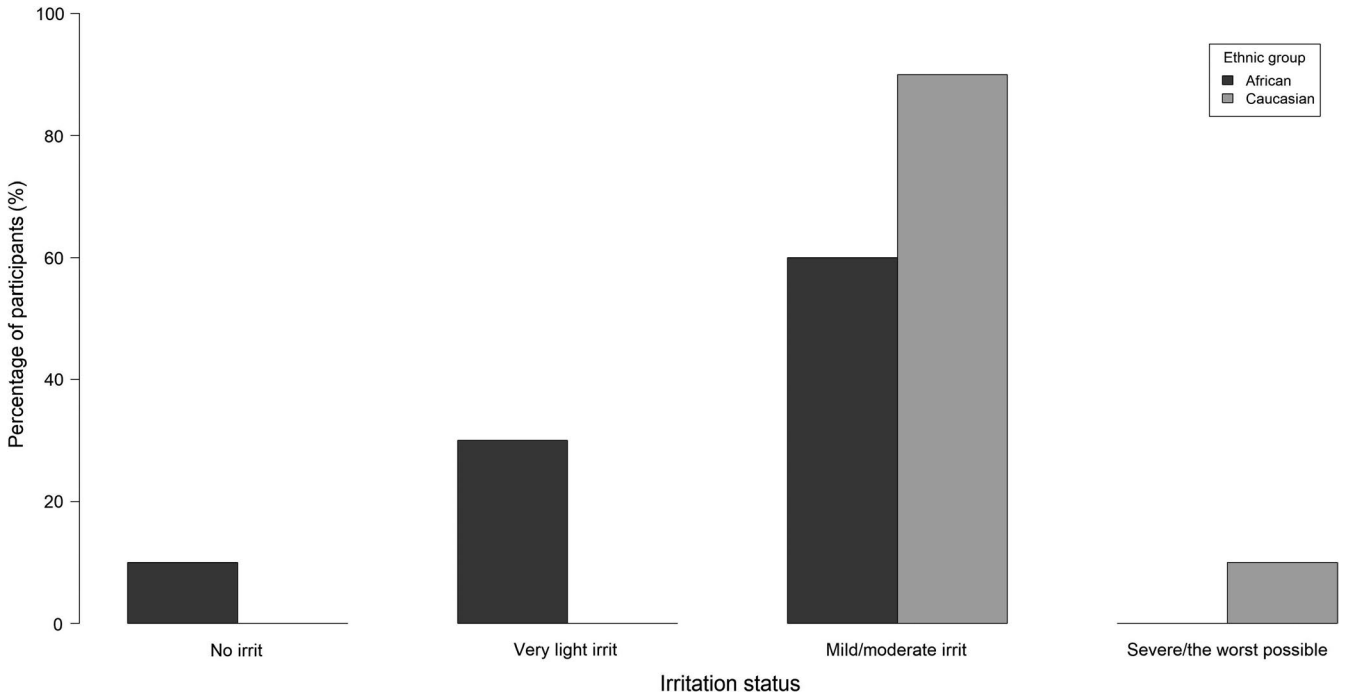

FIGURE 2 Barplot of clinical irritation status found in both ethnic groups during skin irritation inducing test using the numeric symptom intensity scale. N (Africans) = 10 and N (Caucasians) = 10

shown at Figure 2, the individual susceptibility to irritant cream was different between Africans and Caucasians. One African participant showed no irritation symptoms and others were moderately irritated whereas all Caucasians were irritated. Those results, however, did not allow us to conclude some differences of susceptibility to THERMOCREAM® between Africans and Caucasians. Indeed, exact test of Fisher performed, showed no significant difference ($P = .09$) between proportions of subjects of both populations at least moderately irritated which represented 60% in Africans and 100% in Caucasians.

Variations in color parameters of irritated sites were compared with those observed at control sites by adequate paired statistical tests (Figure 3A-D). Table 1 summarized ΔL, Δa, Δb, and ΔE values at control and irritated sites in both populations. Considering all irritated subjects of African group (score ≥ 1; N = 9), while no significant difference was observed for parameter L^*, a significant increase in parameter a^* was observed at irritated site. At the same time, global skin color variation (ΔE) was significantly more important at African irritated sites. Unlike for Δa^* and ΔE, Δb^* was significantly lower at irritated sites versus control ones.

All irritated Caucasians (N = 10) showed significant differences in color parameters variations between irritated sites and control sites. At irritated sites, while Δa^* and ΔE had higher values, L^* decreased. The b^* parameter, unlike the observations made in Africans, lightly increased.

Color variations due to irritating cream effect d(Δ) were further calculated into both ethnic groups taking into account the irritation status. It was observed that in both group, $d(\Delta a^*)$ and d(ΔE) increased with irritation severity. For subjects with slight irritation symptoms, $d(\Delta a^*)$ mean value was very insignificant (0.2 ± 0.16) but the global color variation, d(ΔE) was close to the calculated mean value in the mild-moderately irritated group (1.02 ± 0.2 compared with 1.37 ± 0.24).

For comparisons between Africans and Caucasians, to avoid any bias, statistical tests were performed only on mild to moderately irritated subjects of both groups (Figure 3E-H). Except for $d(\Delta L^*)$ whose difference was not significant between the two populations, African exhibited lower d(Δ) values.

A strong positive correlation was found between $d(\Delta a^*)$ and d(ΔE) in both Caucasian ($r = .99$, $P < .0001$) and African ($r = .86$, $P = .001$) ethnic groups.

3.3 | Skin blanching induction test

After blanching induction test using DIPROSONE® cream, variations in color parameters of treated sites were compared with control sites (Figure 4A-D). Table 1 summarized ΔL^*, Δa^*, Δb^*, and ΔE values at control and blanched sites in both populations. In Africans, a significant

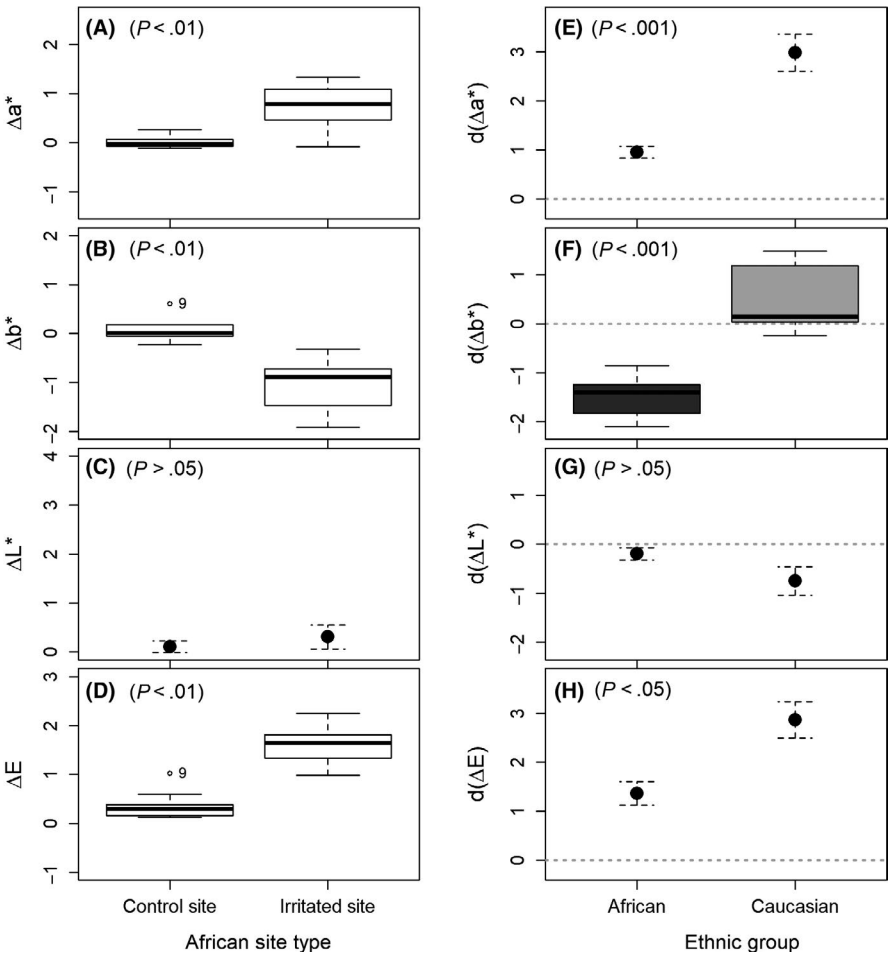

FIGURE 3 (A-D) Compared variations of color parameters in African subjects presenting irritation symptoms (at least score 1; N = 9) at control and irritated sites during skin irritation test with p value of comparison calculated using Wilcoxon signed-rank test for A, B and D and paired t test for C. (E-H) Color parameters variations attributable to irritant cream effect compared between mild/moderately irritated subjects of both Africans (N = 6) and Caucasians (N = 9) ethnic groups using independent tests, ie, Welch t test for E and G, Wilcoxon rank-sum test for F and t test for H. Error bars in means plots are standard errors

TABLE 1 Color parameters[a] variations compared between treated (T) and control (C) sites during irritation and blanching induction tests using appropriate paired tests

		Irritation induction test[b]				Blanching induction test			
		ΔL^*	Δa^*	Δb^*	ΔE	ΔL^*	Δa^*	Δb^*	ΔE
Africans	T	0.3 ± 0.7	0.8 (0.5; 1.1)	−0.9 (−1.5;-0.7)	1.6 (1.3;1.8)	0.9 ± 0.6	−0.4 (−0.8;-0.2)	−0.9 ± 0.4	1.5 ± 0.6
	C	0.1 ± 0.36	-0.03 (−0.08;0.06)	0.01 (−0.05;0.2)	0.3 (0.2;0.4)	-0.08 ± 0.5	-0.01 (−0.1;0.4)	-0.24 ± 0.7	0.86 ± 0.6
	p	.4	.005	.002	.002	.001	.01	.04	.05
Caucasians	T	-1.3 ± 1.1	3.2 (2.7;4.8)	0.5 ± 0.6	3.9 ± 1.8	1.3 ± 1.4	-1.3 ± 1.2	-0.32 ± 0.6	2.07 ± 1.7
	C	-0.4 ± 0.75	0.02 (−0.2;0.08)	-0.08 ± 0.5	0.9 ± 0.8	-0.93 ± 1.3	1.2 ± 0.9	-0.1 ± 0.9	1.9 ± 1.4
	p	.03	.001	.014	.001	.0007	.0004	.4	.8

[a]Parameters were summarized by Mean ± SD in case of normal distributions and by Median (P25; P75) in case of skewed ones; p = *P* value of comparison paired test between treated site and control site.
[b]Only irritated subjects (N = 9 for Africans and N = 10 for Caucasians) color parameters variations were considered for irritation induction test.
For blanching induction test N (Africans) = 10 et N (Caucasians) = 10.

difference was detected for all parameters. Indeed, a decrease in a^* parameter was detected at treated sites. A significant decrease in b^* parameter was also detected. In contrast to previous parameters, ΔL^* and ΔE showed higher values at treated sites. In Caucasians, an important decrease in a^*, which was higher ($P = .004$) than in African subjects, was also detected at treated sites. Caucasians showed a not significant decrease in b^* parameter at treated sites which was, however, not significantly different to the decrease observed in Africans ($P = .28$). A significant increase in L^* parameter was recorded at treated sites; this was slightly more important than in Africans. In contrast, no significant difference was observed in ΔE at blanched sites, which did not reveal a significant difference in global color change between Caucasians and Africans ($P = .3$). Some intercorrelations (summarized results in Table 2) were detected between the color variations attributable to cream effect in both groups. Indeed, in Africans, two strong positive correlations were detected between $d(\Delta L^*)$ and $d(\Delta E)$ variations and between $d(\Delta a^*)$ and $d(\Delta b^*)$. In Caucasians, however, a strong negative correlation was detected between $d(\Delta L^*)$ and $d(\Delta a^*)$.

4 | DISCUSSION

Human skin color is governed by its melanin content, its oxy-and deoxy-hemoglobin content and the amount of endogenous or exogenous pigments such as bilirubin and carotene.[1] The constitutive skin color parameters differences and intercorrelations highlighted during this study can be substantially explained by the ethnic variation in melanin content and composition. A study led in different ethnic groups showed that the most lightly pigmented (European, Chinese, and Mexican) skin types have approximately half as much epidermal melanin as the most darkly pigmented (African and Indian) skin types.[29] It has been well demonstrated by several studies that L^* values displayed a negative exponential relationship with epidermal total melanin content.[15,30] We have confirmed this behavior with lower L^* values observed in Africans. The higher constitutive a^* values in Africans can also be explained by the epidermal melanin content since there exists no evidence in literature that cutaneous blood flow varies with ethnicity.[15] In fact, it is obvious that melanin predominantly brown in color reflects large amounts of red incident light.[8,15] Furthermore, it is evidence-based that melanin is not a pure substance but is a mixture in various proportions of three pigments in both Africans and Caucasians.[31,32] Melanin is composed of a reddish yellow subtype called pheomelanin, a light brown DHICA-enriched eumelanin and a dark brown or black DHI-enriched eumelanin. In African studied group, increasing levels of pheomelanin can explain the positive correlation between a^* and b^*, and decreasing levels of eumelanin can explain the negative correlation between L^* and b^*. It is obvious that the negative correlation between constitutive values of L^* and a^* observed in the Caucasian population may result from a decrease in the total amount of melanin. This negative correlation between L^* and a^* in lower pigmented people had already been recorded by some authors in the range of $L^* < 60$.[30]

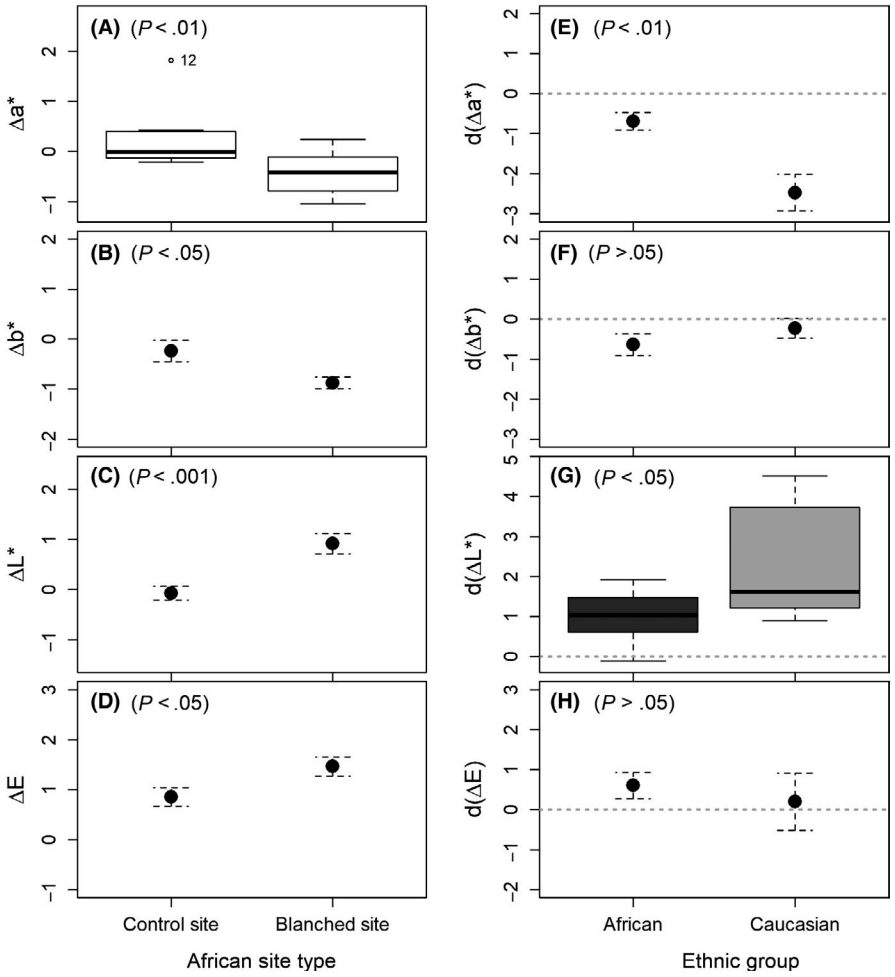

FIGURE 4 (A-D) Compared variations of color parameters in African population (N = 10) at control and blanched sites during blanching test with *P* value of comparison calculated using Wilcoxon signed-rank test for A and paired *t* test for B, C, and D. (E-H) Color parameters variations attributable to blanching cream effect compared between Africans (N = 10) and Caucasians (N = 10) with *P* value calculated using independent comparison tests, respectively, Welch *t* test for E and H, *t* test for F and Wilcoxon rank-sum test for G. Error bars in means plots are standard errors

Individual susceptibility to irritants is extremely variable.[16] That was confirmed by our findings. Furthermore, during the irritation induction test, differences were observed in skin irritability profiles of both populations. In irritated Africans (9/10), significant variations were recorded for a^* and b^* and also for the global color E. In Africans as well as in Caucasians, Δa^* values strictly matched with clinical status. The positive correlation observed with ΔE allowed us to conclude that in Africans as well as in Caucasians, Δa^* and Δ*E* may be associated to describe skin effect of exposure to an irritant cream. However, 2/3 of very lightly irritated Africans showed practically no variation of a^*. Therefore, it seems that the chromametric method is not sensitive enough to detect their symptoms. The significant increase in a^* parameter in both populations was the consequence of hemoglobin accumulation under the irritated area since oxyhemoglobin (oxy-Hb) absorbance displays a characteristic maximum in green region and a sharp decrease in red region of the visible light spectrum.[33] This hemoglobin accumulation (erythema) is due to the known vasodilating effect of API in THERMOCREAM®.[34,35] In Caucasians, the observed decrease of L^* parameter had already been reported in case of increases in hemoglobin concentration in the absence of any change in melanin pigmentation which proved the skin darkening effect

TABLE 2 Correlations matrix of variations of color parameters due to blanching cream effect

	Africans (N = 10)			Caucasians (N = 10)		
	$d(\Delta a^*)$	$d(\Delta b^*)$	$d(\Delta L^*)$	$d(\Delta a^*)$	$d(\Delta b^*)$	$d(\Delta L^*)$
$d(\Delta a^*)$	1	0.86_{**}	0.16_{ns}	1	-0.55_{ns}	-0.94_{***}
$d(\Delta b^*)$	0.86_{**}	1	-0.11_{ns}	-0.55_{ns}	1	0.30_{ns}
$d(\Delta L^*)$	0.16_{ns}	-0.11_{ns}	1	-0.94_{***}	0.30_{ns}	1
$d(\Delta E)$	0.12_{ns}	-0.17_{ns}	0.82_{**}	-0.16_{ns}	-0.46_{ns}	0.10_{ns}

Note: Statistical significance is written in subscript after *r* values where.

**Significant at *P* < .01 and ns, not significant (*P* > .05).

***Means significant at *P* < .001.

of hemoglobin.[36,37] In Africans, however, the darkening effect of hemoglobin increase is probably not significantly perceived because melanin darkening effect on constitutive L^* values is already so pronounced.

During this study, chromametric measurements after skin blanching induction (through vasoconstriction) may be perceived as a negative control to confirm color parameters variations observed in case of erythema induction. The local vasoconstriction effect of betamethasone propionate is obviously responsible for the significant decrease of a^* value observed in both ethnic groups after exposure to DIPROSONE® cream.[38] Queille-Roussel et al reported the correlation existing between the a^* parameter decrease and the increase of L^* parameter during skin blanching, as we noticed in both studied populations.[39] The parameters a^* and L^* were the most discriminating to assess blanching effect in both groups. However, while a strong negative correlation was found between variations of these two parameters in Caucasians, no significant correlation was detected in the African group. Moreover, in Africans, the increase of the parameter L^* was significantly higher than the decrease of a^*, which suggest an additional cause to L^* variation, probably an hypopigmentation which is a frequent side effect of corticosteroids application particularly in sub-saharan African ancestry's people.[40] Whatever, in Africans the blanching cream effect was well appreciated using L^* variation. That is comforted by the strong positive correlation existing between L^* parameter variation and global color variation ΔE in Africans.

Although chromameter showed a lower sensitivity in Africans compared to Caucasians, it is important to note that the chromametric measurements recorded during this study were extremely consistent with the physiological disturbances due to both creams application in Africans, as well as in Caucasians. In the present study, through the utilization of a tristimulus chromameter, we have demonstrated the feasibility to highlight color variations and to rationalize them in order to detect creams side effects in Africans as well as in Caucasians. Erythema reactions due to drug application on dark-skinned people can thus be detected. Therefore, the evaluation of cutaneous tolerance of cosmetic and dermatological pharmaceutical forms in development can be performed using this rapid and easy method on Caucasians as well as on Africans population.

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CONFLICT OF INTERESTS

The authors state no conflict of interest.

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