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Increase in subjective well-being and psychological health after application of C8-silk lipoamino acid functionalized pigments included in a foundation

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Abstract

OBJECTIVE: The aim of this study was to evaluate the effects of two foundations before (D0) and after 5 days of application (D6) on psychophysiological parameters in order to compare C8-silk lipoamino acid functionalized pigments (FA) versus pure pigments (FP).

METHODS: Assessment of self-esteem, stress, mood and emotion using psychological tests and evaluation of salivary cortisol concentrations were realized on 40 healthy females using a crossover study design at D0 and D6. Four saliva samples were taken on the awakening (C1), 30 min after the awakening (during the foundation application (C2)), 1 h after the foundation application (C3) and at 1900 h (C4) at DO and D6. Area under the curve was calculated in order to obtain information about the total amount of a given substance excreted in a specific time period.

RESULTS: Five days of daily application of the foundation containing the pigments treated with the C8-silk lipoamino acids induced a significant increase ($P < 0.001$) in self-esteem and pleasant emotion ($P < 0.05$), and a significant decrease in general stress ($P < 0.05$). This was not the case after the FP application. Cortisol concentrations presented a pronounced diurnal rhythm whatever the foundation used. At DO, no significant differences were observed between the groups. At D6, cortisol concentrations measured 30 min and 1 h after the FA application were significantly lower ($P < 0.05$: C6.2, $P < 0.05$ C6.3, respectively) than those reported after FP application. AUC, a global stress response indicator, was significantly lower in FA group as compared to FP group after 5 days of application. Subjects found a decrease in tiredness signs and thought that FA has a good coverage.

CONCLUSION: Our results show that incorporation of C8-silk lipoamino acid as agent of pigment functionalization brings new benefits to a foundation. Adopting a psychophysiological approach, which is not invasive to the subjects, we show the measurement of cortisol at the same time that psychological indicators provide a scientific approach to examine the beneficial effects of a cosmetic product.

Résumé

OBJECTIF: Le but de cette étude randomisée croisée était d'évaluer les effets de deux fonds de teints (pigments traditionnels (FP) versus lipoaminoacides de C8 soie (FA)) avant (D0) et après 5 jours d'application (D6) sur des paramètres psychophysiologiques.

METHODES: L'évaluation de l'estime de soi, du stress, de l'humeur et des émotions conjointement à l'évaluation des concentrations de cortisol salivaire ont été réalisées sur 40 femmes. Quatre prélèvements salivaires ont été effectués le matin au réveil (C1), 30 min après (pendant l'application du fond de teint (C2)), 1h après l'application du fond de teint (C3) et à 19h00 (C4) au début (D0) et en fin d'expériementation (D6).

RÉSULTATS: Cinq jours d'application quotidienne du fond de teint contenant des pigments traités au lipoaminoacides de C8 soie ont induit une augmentation significative ($P < 0.001$) de l'estime de soi et des émotions plaisantes ($P < 0.05$), ainsi qu'une diminution significative du stress ($P < 0.05$). Ces résultats n'ont pas été observés après application du pigment traditionnel (FP). En début d'expérimentation (D0), aucune différence significative n'a été observée entre les groupes concernant les concentrations de cortisol salivaire, concentrations qui présentaient un rythme diurne prononcé. A D6, les concentrations de cortisol mesurées 30 minutes et 1 heure après l'application de FA étaient significativement inférieures ($P < 0.05$: C6.2, $P < 0.05$: C6.3, respectivement) à celles rapportées après l'application de FP.

Les sujets ont constaté une diminution des signes de fatigue.

CONCLUSION: Nos résultats montrent que l'incorporation du lipoaminoacide de C8 soie en tant qu'agent de fonctionnalisation des pigments apporte de nouveaux avantages à une base de fond de teint. L'approche psychophysiologique non invasive est une excellente approche permettant d'évaluer les effets bénéfiques d'un produit cosmétique.

Introduction

New shades, new textures, new formulae, new benefits and the market of foundations constitute one of the most dynamic make-up categories according to NPD Group analysis. In fact, new skincare properties and new textures still captivate consumers of cosmetic products [1]. In addition to make-up properties as colour-matching, long-lasting, coverage, soft-focus effect, claims for foundations about skincare focused on hydration, firmness, radiance and anti-pollution.

Depending on the analysis of foundations market by NPD Group, liquid foundation is the favourite format for the consumers, and

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long-lasting formulae still capture user's attention with a continued sales growth [1]. Generally speaking, cosmetic make-up consists of an oily and/or aqueous phases with pigments. The good dispersion of the pigments in one or the other of these phases is essential. The primary benefit of applying an organic compound to the surface of different minerals is that they will have comparable surface properties, and therefore, they will disperse homogeneously in the fatty or aqueous liquid phase. Other performance criteria can be associated such as skin affinity, better sensoriality and good spread on the skin [2].

Women are aware that they have wrinkles and that these will not go away, and like Millennials, they do not want any more over-promises [3]. Brousse *et al.* [4] relate that beauty then becomes more integrative, and it will globalize well-being, the silhouette, the lifestyle, the sleep or relaxing practices, resulting in a freer feminine look expecting new codes and expressions. Today, consumers expect their cosmetics to be more than a good tolerance and proven effectiveness, and in this quest for mindful beauty radiance, what women expect from cosmetics is emotional pleasure, sensoriality for improving well-being with new and smart cosmetic products [4]. In line with this evolution, more and more studies suggest the relationship between cosmetics use, self-esteem and self-perceived attractiveness [5]. Nash *et al.* [6] studied the correlation between make-up and women's mental health and reported that the use of cosmetics helped in the manifestation of emotional benefits such as having a good mood, reflecting a positive self-evaluation and showing a significant escalation in the confidence level. Moreover, even though skin defaults on the face do not directly affect the health of those who suffer from it, they certainly have a negative psychological impact on their daily lives and their social relationships. The perception of their own image is profoundly altered, not to mention their seductive abilities hindered. Recently, Gervason *et al.* [7] noted that daily application of a cosmetic cream during 56 days is followed by an increase in self-esteem and mood in 60-year-old women.

Even if these psychological parameters included in the wellness concepts currently have conquered cosmetic industry, and because wellness relates to subjective perception, it is difficult to prove that a product positioned in this way is not simply marketed as such, but actually shows a perceivable enhancement in the consumer's well-being. Besides subjective reports used in psychology area, objective non-invasive psychophysiological measurements can be used to record the effect of certain active ingredients on cognitive and emotional states in human. To account for this challenge, it is possible to use a psychophysiological approach [8] based on the measurement of psychophysiological parameters such as skin conductivity, blood circulation, or stress hormones such as cortisol. All of these physiological reactions are the result of unconscious mental processes that cannot be controlled. For example, it is well known that emotional states are capable of activating a neuroendocrine cascade involving salivary cortisol release and that psychosocial stress or threats to the social self (social value, status, worth, etc.) can generate a glucocorticoid response [9]. This steroid hormone plays a central role in the physiological and behavioural response to stress, with the activation of the hypothalamic–pituitary–adrenocortical axis (HPA) stimulating its release from the adrenal cortex [10]. Salivary cortisol represents a marker of circulating free cortisol and has been recommended to be an index of stress, saliva samples being a non-invasive and stress-free method [11]. The effect of emotions on the HPA is due to subcortical influences by the amygdale, a subcortical structure which is regarded as the central element for regulating emotions. Positive affective states seem to lower cortisol secretion [12].

Based on these data, the objective of this study was to evaluate the use of two foundations on psychophysiological parameters and their cosmetic benefits in order to highlight the interest of a C8-silk lipoamino acid silk as pigment functionalization agent versus untreated pigments. C8-silk lipoamino acid adds on the pigments of the foundation allows to get a more stable emulsion, long-lasting and high covering properties while staying fluid. Assessment of self-esteem, stress, mood and evaluation of cortisol concentrations was realized. Based on Pössel *et al.* [13], it can be proposed that application of foundation containing C8-silk lipoamino acid has positive effects on emotions and should influence cortisol release in a healthy way.

Material and methods

Fourty female participants were recruited with a mean age 35 ± 10 years. This study consisted in a randomized, simple-blind design, placebo-controlled, crossover study.

Participants tested the foundations on two periods separated by one week without experimentation. They were asked to rate the cosmetic benefits of two foundations on mood, self-esteem and stress, each being applied over a period of 5 consecutive days. The foundations were distributed to the participants, and they had to test them according to a randomization defined by the laboratory. The FP and the FA correspond, respectively, to the placebo and to the foundation with C8-silk functionalized pigments.

Assessments were made at D0 (baseline) and at D6 (after 5 days of daily use). As this study was conceived in a holistic perspective, we addressed psychological parameters (i.e. self-esteem, mood and stress) in addition to cortisol evaluation.

As we were investigating levels of cortisol, subjects with inflammatory disease or allergies were excluded. Moreover, participants with infectious diseases during 1 month before saliva sampling and active dental abscesses were excluded from the study. The responses to the questionnaire administered prior to the experiment indicated that none were pregnant or taking oral contraceptives. None of the participants smoked (or admitted to alcohol abuse or to the use of recreational drugs). In addition, the participants were not allowed to use any anti-histamines or anti-inflammatory medication during the testing for 24 h before testing. For participants who had colds or other infections on the day of testing, the assays were rescheduled for a day when they were no longer ill.

Foundation composition

The foundation developed is a water in silicone emulsion. It is composed of:

- 25.9% of aqueous phase (water, glycols, preservatives, salt, active ingredient (with skin radiance efficiency))
- 54.1% of oily phase (silicones, preservatives, sun filters, fragrance)
- 20% of pigments.

Containing 20% of pigments charges, this foundation has a high coverage to ensure an even complexion and to correct colour defaults, whereas the presence of volatile emollients and film-forming polymer bring long-lasting properties. Its silicone-derived elastomers provide softness and velvet finish, and the powder derived

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from a silicon resin gives a creamy touch. A specific agent of pigment functionalization C8-silk lipoamino acid, with proved anti-microbial properties, was applied on the pigments (iron oxides and dioxide titanium) for technically stabilizing the emulsion by making the pigments more hydrophobic. The placebo foundation has exactly the same composition but with pure pigments instead of functionalized ones.

Psychological parameters

At D0, D6, D9 and D16, participants were asked to complete a range of questionnaires and were informed that there were no right or wrong answers, and that they should answer as honestly as possible. These tests included Stress Analogue Scale (EVA), self-esteem [14] and emotion according to the Bried Mood Scale Introspection Scale (BMIS) [15]. The perceived benefits of the subjects were also explored.

Rosenberg self-esteem scale
This is a 10-item unidimensional scale that measures both positive and negative feelings about the self to evaluate self-worth [14]. The answers were rated as follows: 1 (strongly agree), 2 (agree), 3 (disagree) and 4 (strongly disagree). Five questions (3, 5, 8, 9 and 10) were reversed while doing the score calculation. Higher scores indicated higher self-esteem. In our study, the Cronbach alpha was 0.802.

Brief Mood Introspection Scale
The BMIS scale is an open-source mood scale consisting of 16 mood adjectives to which a person responds (e.g., Are you 'happy'?) [15]. The scale can yield measures of overall pleasant-unpleasant mood and arousal–calm mood, and it also can be scored according to positive–tired and negative–relaxed mood. Each score is computed from a different scale (set of items) containing a different number of items. Pleasant–unpleasant uses all 16 items, arousal–calm, 12 items, positive–tired, 7-items, and negative–relaxed, 6 items.

Stress Analogue Scale: EVA
The EVA consists of a horizontal line of 10 centimetres limited and not graduated. The lowest possible level is at the left end and the highest level possible at the right end.

The question was the following: 'How is my state of stress in my life in general'. The subject is considered stressed if the score at the EVA is strictly greater than 60 mm [16].

Satisfaction test
The subjects had to answer questions about their satisfaction given by the use of tested products. Concerning 12 cosmetic benefits, they had to tick their satisfaction level, using a likert scale 'totally agree', 'agree', 'not really agree' and 'disagree'. Then, they had to indicate how long the foundation lasts on the face during the day by ticking a number of hours among the proposed choices on a table.

Saliva sampling
The participants received the saliva sampling materials along with both spoken and written instructions. In accordance with the Declaration of Helsinki, the purpose of this study was thoroughly explained to each individual prior to data.

Saliva samples were collected in an adapted tube (Cryovial, SalivaBio, distributed by Salimetrics, Inc., State College, PA, USA) using a passive drool system thanks to the Saliva Collection Aid (Salimetrics State College USA). At D0, D6, D9 and D16, four saliva samples were taken:

- on the awakening (C1),
- 30 min after the awakening (just after the foundation application (C2)),
- 1 h after the foundation application (C3)
- and at 1900 h (C4).

To avoid contamination of saliva with blood, participants were instructed not to brush their teeth 30 min before doing each saliva sample. In addition, smoking, eating and drinking beverages containing alcohol, caffeine or fruit juice were not allowed for 30 min before sampling. Apart from these restrictions, participants were free to follow their normal daily routines on the sampling days. Saliva samples were stored at –18 °C until biochemical analysis.

Saliva assays
Participants were asked to deliver in the specific tube at least 1 mL of saliva for each sample. The saliva volume was estimated by weighing to the nearest milligram, and the saliva density was assumed to be 1.0 g mL^{-1} [17]. The saliva flow rate (mL min^{-1}) was determined by dividing the volume of saliva by the collection time. The saliva flow rate of valid samples should not be <0.1 mL min^{-1}. Under basal conditions, the rate of saliva production is 0.5 mL min^{-1}.

Salivary cortisol was assayed using kits (cortisol EIA kit assay kit, Salimetrics, Inc., State College, PA, USA). The intraassay maximum coefficient of variation was 6.3%, and the inter-assay maximum coefficient of variation was 6.41%. Cortisol activity was expressed as nmol L^{-1}.

Statistical analysis

SPSS for Windows version 19.0 was used to analyse the data. Psychological characteristics are expressed as means and standard deviations (SD). Cortisol results are expressed as means and standard errors (SEM). To test for normality of distribution and homogeneity of variance, Kolmogorov–Smirnov and Levene's test were applied prior to statistical analyses.

For each foundation used, an analysis of variance (ANOVA) for repeated measures on both factors, 2 (Week) x 4 (time of sampling) was computed for cortisol to analyse differences in the daily secretion patterns of cortisol between the week. A foundation x time of sampling repeated measures ANOVA was also evaluated to analyse differences in the daily secretion of cortisol between foundation application at D0 and after 6 days of foundation application. Post-hoc Bonferroni test was used to assess any significant differences shown. Where appropriate (violation of sphericity assumption), Greenhouse–Geisser corrections were applied for repeated measures ANOVAs.

Area under the curve was calculated according to the formula described by Pruessner *et al.* [18] in order to obtain information about the total amount of a given substance excreted in a specific time period. Student's *t*-test for paired test was used for comparison concerning AUC.

Concerning psychological parameters, non-parametric tests were used to determine differences according to foundation application and time. P value < 0.05 was considered statistically significant.

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Results

Salivary parameters

Salivary flow rates did not change significantly overtime. Values were between 0.53 ± 1.7 and 0.54 ± 0.5 mL min^{-1}.

The mean cortisol (C) concentrations are presented in Table I. The C levels measured were in the standards of those found in the literature [19]. They presented a pronounced diurnal rhythm in accordance with the results of Seeman and Robbins [20]. Indeed, saliva cortisol concentrations increased after awakening and then progressively decreased towards the evening. However, at DO, no significant differences were observed between the foundations.

At D6, a mean effect of foundation ($P < 0.05$) was noted, indicating that cortisol concentrations between the foundations emerged. Indeed, cortisol concentrations measured 30 min and 1 h after the FA application were significantly lower ($P < 0.05$: C6.2, $P < 0.05$ C6.3, respectively) than those reported after FP application (Table I).

A lower overall cortisol output (AUC) was noted after FA applications. In fact, area under the curve with respect to the ground (AUC), a global stress response indicator, revealed a significant effect of the foundation AUC being significantly lower in FA group as compared to FP group after 5 days of applications (AUC FA: 0.64 ± 0.1 versus 1.93 ± 0.3; ($P < 0.005$).

Psychological parameters

Self-esteem

At D0, we noted that placebo or pigments group had the same self-esteem measure. Five days of daily application of the foundation containing the pigments treated with the C8-silk lipoamino acids (FA) induced a significant increase ($P < 0.001$) in self-esteem. This was not the case for the placebo application (FP) (Fig. 1).

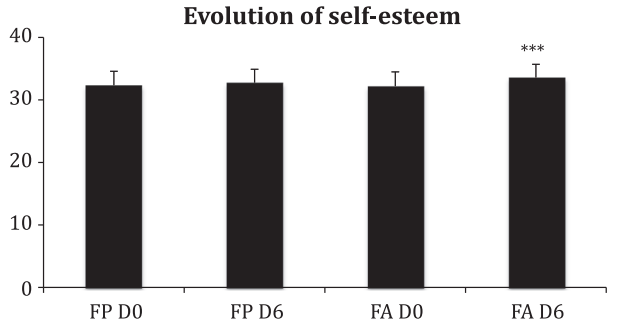

Figure 1 Evolution of self-esteem (Mean ± SD). Foundation placebo: FP. Foundation active (FA) ***: $P < 0.001$ D0 versus D6.

Stress response

At D0, general stress did not differ between groups. This stress was low. This parameter significantly decreased after 5 days of FA applications ($P < 0.05$). This was not the case after FP application (Table II).

Brief Mood Introspection Scale (BMIS)

This scale is based on eight dimensions: happiness, affection, calm, energy, fear, anger, fatigue and sadness, and specifically measures the mood changes of the subjects. Four subscores can be computed from the BMIS: pleasant–unpleasant, arousal–calm, positive–tired and negative–relaxed Mood. We only focused on the subscores pleasant–unpleasant. We noted that the application of FA during 5 days induced a significant increase in the pleasant score ($P < 0.05$). This was not the case after the FP application (Table II).

Satisfaction test

Non-skin intolerance reaction had been noticed during the study.

Figure 2 presents the percentage of positive responses depending on the applied foundation. According to the Federation of Beauty Companies (FEBEA), and recognized in the cosmetic industry, if the percentage of favourable responses ('agree' + 'totally agree') is superior of 70%, the claim is considered as proved.

By taking in account this threshold of 70%, 7 claims have been proved for the foundation with C8-silk lipomino acid: as 'decreases tiredness signs', 'good coverage', 'evens complexion', 'homogenizes complexion', 'easy to apply', 'doesn't dry face skin (no tightness)' and 'skin is soft after application'. On the contrary, only 4 claims can be associated to the placebo: 'easy to apply', 'homogenizes complexion', 'good coverage' and 'evens complexion'.

Discussion

Cosmetics usage, as an alterable aspect of physical attractiveness and individual appearance, has the potential to have considerable impact on an individual's body image, self-perceived attractiveness

Table I Means ± (SE) of cortisol concentrations noted in the subjects at D0 and after 5 days of foundation application: (FP: placebo; FA: active)

	D0				After 5 days of foundation application			
(nmol L^{-1})	C1	C2	C3	C4	C6.1	C6.2	C6.3	C6.4
FP	7.99 (1.36)	12.9 (2.34)	6.17 (1.05)	2.09 (0.35)	7.14 (1.3)	10.73 (1.51)	6.25 (0.86)	1.99 (0.22)
FA	7.33 (1.0)	12.80 (1.96)	5.69 (1.16)	2.88 (0.26)	5.57 (0.8)	6.3[a] (0.27)	3.51[a] (0.73)	1.38 (0.29)

At D0; C1: upon wakening (0700 h); C2: 30 min after the awakening (during the foundation application (0730 h); C3: 1 h after the foundation application (0900 h); and C4: in the evening (1900 h). After 5 days of application; C6.1: upon wakening (0700 h); C6.2: 30 min after the awakening (during the foundation application (0730 h); C6.3: 1 h after the foundation application (0900 h); and C6.4: in the evening (1900 h).
[a] $P < 0.05$ (foundation active versus foundation placebo).

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Table II Pleasant score before (D0) and after the application of foundation (D6) (FP: placebo; FA: active) (Mean ± SD)

	General stress (D0)	General stress (D6)	BMIS-pleasant (D0)	BMIS-pleasant (D0 + 6 days)
FP	4.3 ± 1.5	3.9 ± 1.5	23.1 ± 0.49	23.9 ± 0.51
FA	4.3 ± 1.4	3.7 ± 1.4[a]	22.6 ± 0.51	24.6 ± 0.55[a]

[a]$P < 0.05$ (D0 versus D6).

and self-esteem. The objective of this study was to evaluate the effects of two foundations applied during 5 days on psychophysiological parameters and their cosmetic benefits in order to evaluate the interest of C8-treated pigments lipoamino acids (FA) versus pure pigments (FP). Our study was original because – to our knowledge – study to consider the link between applications of cosmetics products such as foundation, HPA response and psychological parameters is scarce.

For the daily rhythm of cortisol, we found subjects having a low overall output of salivary cortisol ($P < 0.005$) after 5 days of FA applications when compared to FC applications (Table II). At the same time, we noted a significant decrease in self-esteem and stress (Table II) and an increase in pleasant emotions through the BMIS score (Table II).

It is known that emotional states are capable of activating a neuroendocrine cascade involving salivary cortisol release [12], and common thinking associates the hormone cortisol with negative mood states. Watanabe *et al.* [21] noted that during emotional improvement after relaxation, cortisol levels are also reduced. Because cortisol levels rise during stress, this hormone is sometimes found to be associated with negative affect [22]. Hence, the hypothalamic–pituitary–adrenal (HPA) axis responds to a variety of physiological and psychological challenges that may or may not give rise to negative affect, such as waking up in the morning and physical exercise [23]. However, the link between cortisol and negative affect is not straightforward and in debate [24], and little attention has been paid to link salivary cortisol released, emotion and cosmetics. Recently, Watanabe *et al.* [21] reported a link between essential oil aromatherapy, mood states and salivary cortisol concentration in 41 healthy females. In a current research project on 35 female subjects inhaling the odour of saffron volatile oil for 20 min led to a decrease in both cortisol and anxiety level [25]. Our results are in line with these studies.

Some studies were also able to show the positive influence of cosmetics on well-being and self-esteem, which are resulting in positive emotions [26]. For example, an increase in positive and a decrease in negative emotions after hairdressing by professional hairdressers were found [27]. In a recent study, Gervason [7] noted a relationship between cosmetic application, mood and self-esteem in a population of women aged 60 and over. Scientific approach such as the neuroscience approach or the psychophysiological approach, as we used in this study, is now available to study this link between emotions and cosmetic, and to prove cosmetic efficacy on this topic [28]. Because emotional benefits obtained by cosmetic product become a major issue to remain competitive, it seems very important that cosmetic industry uses a holistic and systemic approach when it wants to show the effectiveness of a product.

Pigments are colouring agents used in all make-up products for colouring, ornamenting or unifying the skin. They are insoluble in oil and in water and can be of synthetic or natural origin. Mostly it is mineral oxides (iron, chromium, titanium or zinc). Some are coloured such as black, red and yellow iron oxides. Some are white, as titanium or zinc oxides. The good dispersion of the pigments in one or the other of these phases is essential. One of the primary benefits of these pigments is that they will

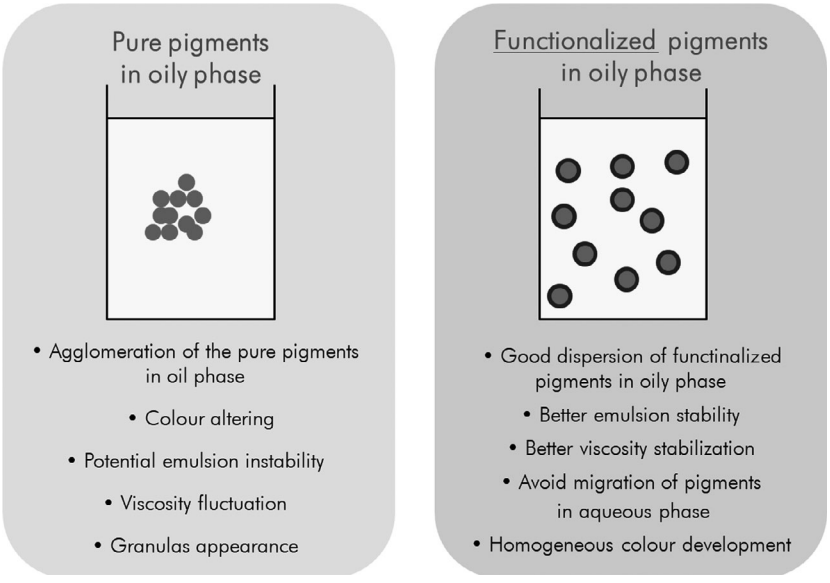

Figure 2 Percentages of positive responses ('totally agree' or 'agree') by applied foundation (foundation with C8-silk lipoamino acid in blue, placebo in green). The solid black line corresponds to the 70% threshold.

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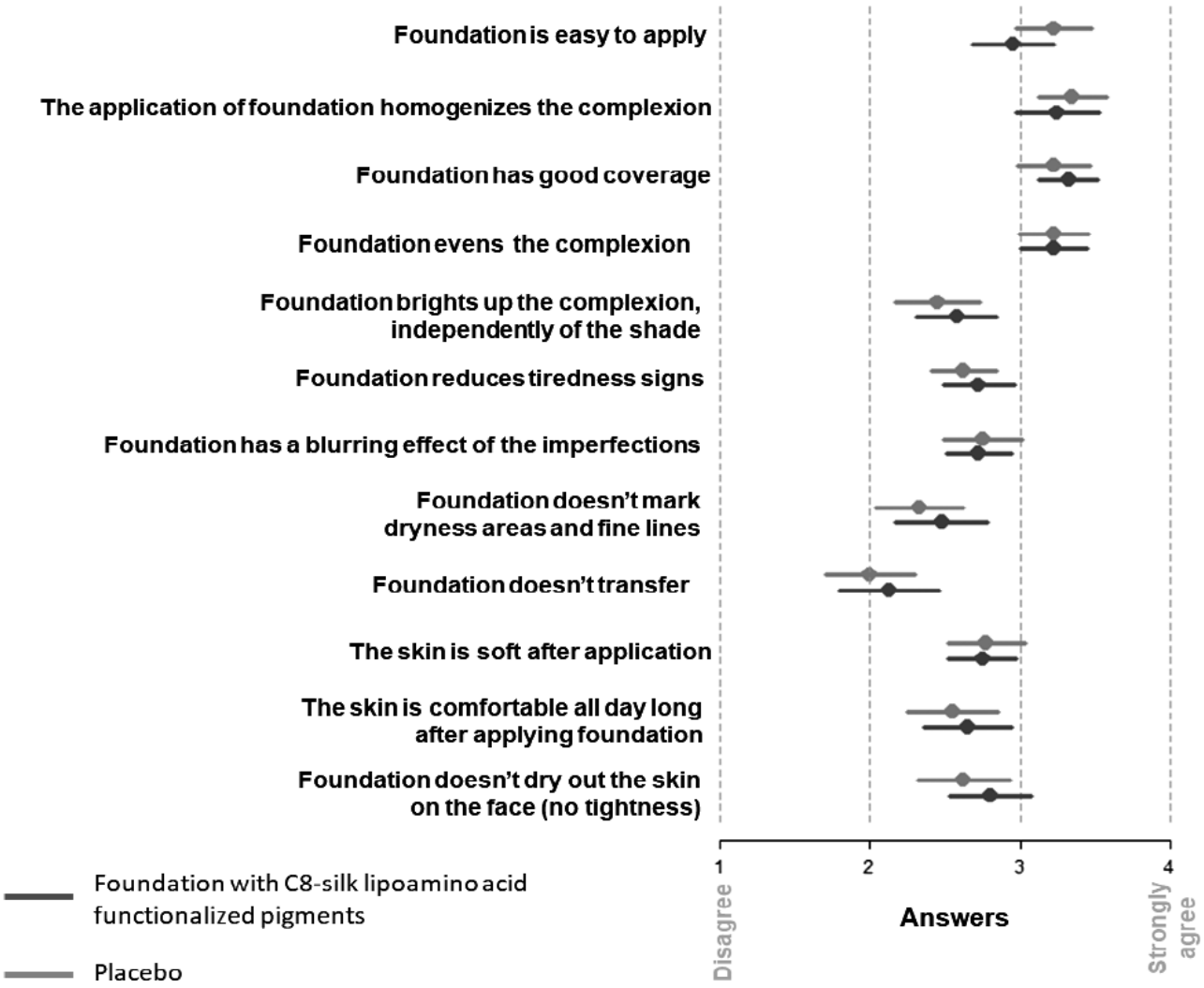

Figure 3 Illustration of interest of functionalized pigments in oily phase.

disperse homogeneously in the fatty or aqueous liquid phase. Other performance criteria can be associated with skin affinity, better sensoriality and good spread on the skin [2]. C8-silk lipoamino acid adds on the pigments of the foundation allows potentially to get a more stable emulsion, long-lasting and high covering properties while bringing a rich touch at application for a higher comfort to the skin [29]. C8-silk are located in the continuous oily phase where they will disperse better and make less agglomerates, as represented in the Fig. 3. It appears that this better dispersion of the pigment in the foundation would contribute to a better diffusion in the light of the colouring charges applied to the skin, for a brighter make-up result and a more illuminated complexion than that obtained with the placebo, as noted by the panel of this study (Fig. 3). On the other hand, this pigment isolation phenomenon also makes them less absorbent of the oily phase and captures less fat. One can put forward the hypothesis that this oily phase would then be more available to bring more comfort and softness to the skin. The skin is then better nourished, explaining the participants' findings that the foundation less dries skin and less marks dryness areas than with the placebo. Finally, a better nourished skin and brighter make-up result could explain the perception of reduced signs of fatigue noted by the panellists. All of the cosmetic benefits provided by the functionalization of pigments with the C8-silk would indirectly contribute to improve self-esteem and mood.

Summary

Our results show that incorporation of C8-silk lipoamino acid as agent of pigment functionalization brings new benefits to the foundation tested. In addition to its functional properties on emulsion stability and cosmetics quality, it decreases tiredness signs, has a good coverage, evens complexion and gives soft skin, without drying face skin, according to the panel. The main results of this study showed that this type of foundation used during 5 days can increase subjective well-being as well as physiological health by

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decreasing the concentration of the stress-related hormone cortisol. Adopting a psychophysiological approach, which is not invasive to the subjects, we show the measurement of cortisol at the same time that psychological indicators provide a scientific approach to examine the benefit of a cosmetic product.

Acknowledgements

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References

1. Le, V.G. marché du fond de teint boosté par les innovations. *Premium Beauty News*, https://www.premiumbeautynews.com/fr/le-marche-du-fond-de-teint-booste,14222. (2018).
2. Takumi, T. Les pigments traités ou les techniques dites du "coating" ou de l'enrobage, L'observatoire des cosmétiques, https://cosmeticobs.com/fr/articles/ingredients-50/les-pigments-traites-ou-les-techniques-dites-du-coating-ou-de-lenrobage-3335. (2016).
3. Zouboulis, C.C., Makrantonaki, E. and Nikolakis, G. When the skin is in the center of interest: An aging issue. *Clin. Dermatol.* **37**, 296–305 (2019).
4. Brousse, P. and Milet, K. Pro-âge: "Laissez-moi être moi». *Premium Beauty News*, https://www.premiumbeautynews.com/fr/pro-age-laissez-moi-etre-moi,13260. (2018).
5. Fares, K., Hallit, S., Haddad, C. *et al*. Relationship between cosmeticsuse, self-esteem, and self-perceived attractiveness among Lebanese women. *J. Cosmetic Sci.* **70**, 47–56 (2019).
6. Nash, R., Fieldman, G., Hussey, T. *et al*. Cosmetics: they influence more than Caucasian female facial attractiveness. *J. Appl. Soc. Psychol.* **2**, 493–504 (2006).
7. Gervason, S., Napoli, M., Dreux-Zhiga, A. *et al*. Attenuation of negative effects of senescence in human skin using an extract from *Sphingomonas hydrophobicum*: development of new skin care solution. *Int. J. Cosmetic Sci.* (2019). https://doi.org/10.1111/ics.12534.
8. Kawasaki, K., Muroyama, K. and Murosaki, S. Effect of a water extract of *Curcuma longa* on emotional states in healthy participants. *Biosci. Microbiota Food Health.* **37**, 25–29 (2018).
9. Dickerson, S.S. and Kemeny, M.E. Acute stressors and cortisol responses: a theoretical integration and synthesis of laboratory research. *Psychol. Bull.* **130**, 355–391 (2004).
10. McEwen, B.S. Physiology and neurobiology of stress and adaptation: central role of the brain. *Physiol. Rev.* **87**, 873–904 (2007).
11. Lac, G., Lac, N. and Robert, A. Steroid assays in saliva: a method to detect plasmatic contaminations. *Arch. Physiol, Biochem. Biophysiq.* **101**, 257–262 (1993).
12. Frankenhaeuser, M. Psychoneuroendocrine approaches to the study of emotion as related to stress and coping. *Nebr. Symp. Motiv.* **26**, 123–161 (1978).
13. Pössel, P., Ahrens, S. and Hautzinger, M. Influence of cosmetics on emotional, autonomous, endocrinological, and immune reactions. *Int. J. Cosm. Sci.* **27**, 343–349 (2005).
14. Rosenberg, M. *Society and the Adolescent Self-Image*. Princeton University Press, Princeton (1965).
15. Mayer, J. D. and Gaschke, Y. N. The experience and meta-experience of mood. *J. Pers. Soc. Psych.* **55**, 102–111 (1988).
16. Chamoux, A., Boudet, G., Biat, I. *et al*. Exemple d'une démarche reporting de veille en santé mentale par le service santé travail environnement du C.H.R.U. de Clermont-Ferrand (63). *Arch Mal Prof.* **69**, 224 (2008).
17. Cole, A.S. and Eastao, J.E. *Biochemistry and Oral Biology*, 2nd edn, pp. 476–477. Wright, London (1988).
18. Pruessner, J.C., Kirschbaum, C., Meinlschmid, G. *et al*. Two formulas for computation of the area under the curve represent measures of total hormone concentration versus timedependent change. *Psychoneuroendocrinology* **28**, 916–931 (2003).
19. Fiet, J., Passat, P., Guechot, J. *et al*. Interet du dosage du cortisol dans la salive. *Nouvelle Presse Medicale* **10**, 2664 (1981).
20. Seeman, T.E. and Robbins, R.J. Aging and hypothalamic-pituitary- 919 adrenal response to challenge in humans. *Endocr. Rev.* **15**, 233–260 (1994).
21. Watanabe, E., Kuchta, K., Kimura, M. *et al*. Effects of bergamot (Citrus bergamia (Risso) Wright & Arn.) essential oil aromatherapy on mood states, parasympathetic nervous system activity, and salivary cortisol levels in 41 healthy females. *Forsch Komplementmed.* **22**, 43–49 (2015).
22. Wirth, M.M., Scherer, S.M., Hoks, R.M. *et al*. The effect of cortisol on emotional responses depends on order of cortisol and placebo administration in a within-subjects design. *Psychoneuroendocrinology* **36**, 945–954 (2011).
23. Filaire, E., Ferreira, J.P., Oliveira, M. *et al*. Diurnal patterns of salivary alpha-amylase and cortisol secretion in female adolescent tennis players after 16 weeks of training. *Psychoneuroendocrinology* **38**, 1122–1132 (2013).
24. Abelson, J.L., Khan, S., Liberzon, I. *et al*. HPA axis activity in patients with panic disorder: Review and synthesis of four studies. *Depression Anxiety.* **24**, 66–76 (2007).
25. Fukui, H., Toyoshima, K. and Komaki, R. Psychological and neuroendocrinological effects of odour of saffron (*Crocus sativus*). *Phytomed.* **18**, 726–730 (2011).
26. Graham, J.A. and Jouhar, A.J. Cosmetics considered in the context of physical attractiveness: a review. *Int. J. Cosmet. Sci.* **2**, 77–101 (1980).
27. Picot-Lemasson, A., Decocq, G., Aghassian, F. *et al*. Influence of hairdressing on the psycho- logical mood of women. *Int. J. Cosmet. Sci.* **23**, 161–164 (2001).
28. Carrasco-Douroux, C. and Bellon, P. How to evaluate emotional benefit of a warming cosmetic active? *SOFW J.* **145**, 30–35 (2019).
29. Hubbard, B., Delrieu, P. and Tabakman, T. Pearlecent pigments and illumination trend in makeup preparations. *SOFW J.* **144**, 12–18 (2018).

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