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Freshness evaluation of refreshing creams: Influence of two types of peppermint oil and emulsion formulation

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Synopsis

The aim of the present work was to study the influence of emulsion composition and two types of peppermint oil (common and dementholated) on freshness perception (skin feel) of refreshing creams, as evaluated by trained assessors and two consumer panels. Both common peppermint oil (PO) and dementholated peppermint oil (DPO) were added in a 1% concentration to two base emulsions formulated with high (emulsion A) and low (emulsion B) concentration of apolar components. The samples' freshness was evaluated by a panel of trained assessors and by consumers. Results showed that the freshness sensation was higher when formulation B was considered, which indicates that its low proportion of apolar components might have enhanced peppermint oil liberation and penetration into the skin, increasing freshness perception. On the other hand, no significant differences in freshness intensity after 5 min of application were found between creams formulated containing DPO or PO, suggesting that other components different from menthol might have contributed to the immediate perception of freshness. Results from the present work showed that emulsion formulation has a great effect on freshness perception, suggesting that different formulations should be considered and tested when developing refreshing cosmetics.

INTRODUCTION

Peppermint or *Mentha piperita* is a common herb, grown in Europe and North America, that is frequently used in cosmetic products as an odorant and refreshing agent (1,2). The plant contains about 1.5% essential oil. Menthol is the main component of the essential oil of peppermint (29% to 48%) and has been claimed to be mostly responsible for the oil's refreshing properties (3,4). Menthol has been used as an odorant, as a flavoring, and as a cooling agent (5).

Menthol causes a fresh sensation some time after application and usually can lead to burning sensations when applied to the skin (6). The sensations perceived when

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applying a refreshing agent to the skin or the mucous membranes depend on the concentration of the agent. At low concentrations menthol might cause a fresh sensation, whereas at higher concentrations (2–5%) it might lead to irritation or local anesthesia, and at concentrations between 5% and 10% it could cause burning sensations (6). For this reason, dementholated peppermint oil (which has a lower concentration of menthol) could be an alternative to generate immediate freshness without uncomfortable sensations. The use of dementholated peppermint oil has been also claimed to be cheaper. Despite the fact that dementholation is an extra processing step, this oil is usually sold at a lower price in Buenos Aires because of added value of the extracted pure menthol.

In general terms, the freshness sensation on the skin depends on the refreshing agent, its concentration, and its ability to migrate from the product to the skin and to penetrate the stratum corneum (7). Therefore, the freshness sensation of a cosmetic cream depends both on the refreshing agent and the composition of the medium in which it is included. Peppermint oil is a lypophylic component and therefore is soluble in the oil phase of emulsions. When used in cosmetic emulsions, peppermint oil needs to be liberated from it in order to penetrate the skin. For this reason, a low solubility of peppermint oil in the oily phase or a low proportion of apolar components in the emulsion could enhance this process (6,8) and increase the freshness perception.

In the last decade, sensory evaluation has become one of the most important tools in the substantiation of claims related to human perception of the characteristics of cosmetic products when applied to the skin. Sensory profiling of cosmetic products is a powerful tool for the cosmetic industry as it provides relevant information for the development and marketing of new products, the reformulation of existing products, and the optimization of manufacturing processes (9,10). Traditionally, this methodology has been performed with a group of trained assessors who objectively provide a quantitative description of the sensory characteristics of products (9). In particular, Quantitative Descriptive Analysis with trained assessors has been widely used to study the sensory characteristics of cosmetics and cosmetic ingredients (11–15).

On the other hand, consumer studies provide information about the consumers' needs, expectations, and perceptions of product (11,16–21). For decades, consumers have been considered capable only of hedonic judgments (9,10). However, in order to assure the success of their products in the market, cosmetic companies also need information on how consumers perceive the sensory characteristics of their products. For this reason, descriptive analysis with consumers, i.e., asking consumers to rate the intensity of different sensory attributes, has received increasing attention in recent years and has been reported to be a good alternative to classical sensory profiles provided by trained assessors (22,23).

Consumers' perception is influenced by cultural and sociodemographic variables. Thus, cross-cultural studies could be extremely important and useful when devoloping cosmetic products for different international markets.

The aims of the present work were to study: (a) the influence of emulsion composition and two types of peppermint oil (common and dementholated) on the freshness perception of refreshing creams as evaluated by trained assessors (n=6) and two separate consumer panels (n = 50+50), and (b) the influence of freshness on consumers' liking of refreshing creams.

MATERIAL AND METHODS

REFRESHING AGENTS

Commercial samples of peppermint oil were used in the study (Aromática S.A., Buenos Aires, Argentina). Two types of peppermint oil were considered: common peppermint oil (PO) and dementholated peppermint oil (DPO). The menthol content was determined by GC. Common peppermint oil had 50% menthol, whereas dementholated peppermint oil had 30%.

SAMPLES

Both agents were added to base emulsions in a concentration of 1%. This concentration was selected after considering the supplier's recommendations and previous studies. Two emulsions were formulated with high (emulsion A) and low (emulsion B) concentration of apolar components. Emulsion A was formulated with a high concentration of mineral oil and triethanolamine stearate as an emulsifier, whereas emulsion B was formulated with a low proportion of apolar components. The formulation of the emulsions is shown in Table I. Both refreshing agents were incorporated in the two base emulsions, giving as a result four samples of refreshing creams: APO (base A with common peppermint oil), ADPO (base A with dementholated peppermint oil), BPO (base B with common peppermint oil), and BDPO (base B with dementholated peppermint oil).

Emulsions were prepared in 5-kg batches, following different manufacturing procedures depending on their formulation. In the case of emulsion A, water was first heated to 70°C. Then the components of the oily phase (stearic acid, glycerol monostearate, and mineral oil) were mixed, heated to 70°C, and added to the water with mechanical agitation at 200 rpm with a helix agitator. The emulsion was agitated for 5 min and then triethanolamine was added. After cooling the emulsion to 40°C, peppermint oil was incorporated.

For emulsion B, the manufacturing procedure was the following: polyacrylamide, isoparaffin, and laureth-7 were dispersed in water with gentle agitation at room temperature,

Table I
Formulation of the Emulsions Used in the Study

Formulation	Emulsion			
	APO	ADPO	BPO	BDPO
Stearic acid	3.00	3.00	—	—
Triethanolamine	0.06	0.60	—	—
Glycerol monostearate	0.40	0.40	—	—
Mineral oil	30.0	30.0	—	—
Polyacrylamide, isoparaffin, laureth-7	—	—	3.00	3.00
Peppermint oil (PO)	1.00	—	1.00	—
Peppermint dementholated (DPO)	—	1.00	—	1.00
Aqua c.s.p.	100	100	100	100

APO: Base A with common peppermint oil; ADPO: Base A with dementholated peppermint oil; BPO: Base B with common peppermint oil; BDPO: Base B with dementholated peppermint oil.

heated to 40°C, and agitated for 5 min at 200 rpm with a helix agitator. Then, peppermint oil was added to the emulsions.

In order to study the emulsions' stability, centrifugation was used. After being centrifuged at 3000 rpm for 15 min, no phase separation was observed in the emulsions, even after 6 months of storage at 25°C.

SENSORY PANEL

A sensory panel consisting of six trained assessors with previous experience in the evaluation of cosmetic products evaluated the freshness of the refreshing creams. Before the test, a mixture of isopropyl alcohol and water (45:55) was applied to the forearms of the assessors in order to clean the zone, and it was allowed to dry for 5 min. Then, 4-cm-diameter circles were drawn on the internal side of the non-dominant forearms of the assessors. Assessors were asked to place a controlled preweighted amount of the emulsion (0.05 g) in the center of one of the circles. The assessors rubbed the sample with their fingers within the circle in a circular way 30 times at a rate of two times per second. Freshness was evaluated 5 and 10 min after application using a structured 11-point scale anchored by 0 (no freshness) and 10 (burning sensation). In this scale, a rating of 8 corresponded to the description "very fresh."

Samples were presented using white polyethylene containers labeled with three-digit random numbers. Two sessions were held over two consecutive days for duplicate evaluation of the samples. In the two sessions, the four samples were presented following a randomized balanced rotation (multiple orthogonal Latin square) in monadic sequence. The tests were carried out in a sensory laboratory designed in accordance with ISO 8589 (24). The evaluations were performed under artificial daylight-type illumination, temperature control (between 22° and 24°C), and air circulation.

CONSUMER STUDIES

Two studies were carried out in two different cities: one in Buenos Aires (Argentina), and the other in Montevideo (Uruguay). In each city fifty female consumers of refreshing creams, ages ranging from 20 to 60, evaluated the four samples. A preweighted amount of each emulsion (0.3 g) was presented to consumers in plastic containers. Samples were presented following a randomized balanced rotation in monadic sequence, as in the trained assessors' panel evaluations. In this case, consumers evaluated each sample only once.

First, consumers were asked to smell the samples and to score the freshness sensation of each and their odor liking, using a structured ten-point scale (1–10). Then, consumers applied the samples on their forearms, and 5 min after application they were asked to evaluate their freshness sensation and their liking using a structured ten-point scale.

DATA ANALYSIS

In order to establish differences between the freshness sensation of the evaluated creams, an analysis of variance (ANOVA) was carried out on trained assessors' data, considering type of peppermint oil, emulsion formulation, time, assessor, repetition, and the

first-order interactions "type of peppermint oil × emulsion formulation," "time × type of peppermint oil," and "time × emulsion formulation" as fixed sources of variation. Differences were considered significant at $p < 0.05$. When differences were significant, honestly significant differences were calculated using Tukey's test.

An ANOVA was also carried out on consumers' data, considering type of peppermint oil, emulsion formulation, city, and the interaction "type of peppermint oil × emulsion formulation" as fixed sources of variation. Differences were considered significant at $p < 0.05$. When differences were significant, honestly significant differences were calculated using Tukey's test.

RESULTS AND DISCUSSION

TRAINED ASSESSORS' PANEL

According to ANOVA, assessor and repetition did not have a significant effect on freshness scores (Table II), suggesting homogeneity and reproducibility of the trained assessors' panel.

Moreover, as shown in Table II, according to the trained assessors' panel, type of peppermint oil, emulsion formulation, and time significantly affected freshness sensation ($p < 0.05$). Moreover, the interactions "time × emulsion formulation" and "time × type of peppermint oil" were significant ($p < 0.05$), indicating that the evolution of the freshness sensation with time depended on the refreshing agent and the formulation of the emulsion that contained the refreshing agent.

As shown in Table III, 5 min after application freshness sensation was significantly higher when formulation B was considered. This could be explained by considering that penetration of peppermint oil into the skin is necessary in order to reach the nerve terminals associated with freshness sensation (8). Thus, the low proportion of apolar components in formulation B could have enhanced peppermint oil liberation and penetration into the skin, increasing freshness perception.

On the other hand, the type of peppermint oil did not significantly affect freshness perception after 5 min of application (Table III). Thus, menthol removal did not affect freshness sensation at this evaluation instance, suggesting that other components different from

Table II
Results of the ANOVA Performed on Data from the Trained Assessors' Panel

Source of variation	ANOVA results	
	F	*p*-value
Assessor	1.40	0.2312
Repetition	0.02	0.8820
Emulsion formulation	272.92	<0.001
Type of peppermint oil	8.00	0.0059
Time	20.35	<0.001
Type of peppermint oil × emulsion formulation	67.01	<0.001
Time × type of peppermint oil	30.32	<0.001
Time × emulsion formulation	17.32	<0.001

Table III
Freshness Sensation Evaluated by a Trained Assessors' Panel (n = 6), 5 and 10 Min after Application of the Four Refreshing Creams Considered

Sample	Freshness sensation	
	5 min	10 min
APO	$4.0^{a\,A}$	$6.0^{b\,B}$
ADPO	$4.0^{a\,B}$	$3.0^{a\,A}$
BPO	$6.0^{b\,A}$	$6.0^{b\,A}$
BDPO	$7.0^{b\,A}$	$7.0^{b\,A}$

Rows with different lowercase superscripts are significantly ($p \leq 0.05$) different according to Tukey's test. Columns with different capital superscripts are significantly ($p \leq 0.05$) different according to Turkey's test.

menthol could have contributed to immediate and long-term freshness of peppermint oil (6,25).

Freshness sensation of creams formulated with emulsion B did not significantly change when evaluated 5 or 10 min after application (Table III). Meanwhile, freshness sensation of emulsion A containing common peppermint oil significantly increased, whereas freshness sensation of emulsion A containing dementholated peppermint oil decreased with time. This indicates that the evolution of freshness sensation with time depended on both the refreshing agent and the emulsion that contained it. The fact that freshness sensation changed with time only for creams formulated with emulsion A could be attributed to its slower liberation of apolar compounds due to its high proportion of apolar components. After 10 min, emulsions A and B formulated with common peppermint oil showed a similar freshness intensity. However, when these emulsions were formulated with dementholated peppermint oil, the high proportion of apolar components did not permit the penetration to the skin of menthol and other components responsible for freshness sensation. Therefore, results from the present work suggested that freshness sensation and its evolution with time depended on both the refreshing agent and emulsion formulation.

CONSUMER PANEL

According to ANOVA, consumers' freshness perception after smelling and after application was significantly affected by emulsion formulation (Table IV). Samples with formulation B were perceived by consumers as fresher, which is in agreement with data from the trained assessor's panel. However, type of peppermint oil did not significantly affect consumers' freshness perception both after smelling and applying the samples (Table IV). Despite the fact that consumers were not trained, they provided results similar to those of a trained assessors' panel. This suggests that consumer profiling techniques could be an interesting alternative for evaluating cosmetic products when there is not enough time or resources to train a sensory panel.

Consumers in Buenos Aires and Montevideo scored freshness sensation of the creams in significantly different ways, as shown in Table IV. This suggests that consumers from different countries could perceive the sensory characteristics of a cosmetic product in a significantly different way. However, the main differences between both samples were in the scores, and not in their relative intensity, which could be explained by considering

Table IV
Results of the ANOVA Performed on Data from Consumers

Variable	Source of variation	ANOVA results	
		F	*p*-value
Freshness after smelling	Type of peppermint oil	0.30	0.5817
	Emulsion formulation	17.87	<0.001
	Type of peppermint oil × emulsion formulation	2.44	0.1190
	City	9.15	<0.001
Liking after smelling	Type of peppermint oil	0.24	0.6252
	Emulsion formulation	10.94	<0.001
	Type of peppermint oil × emulsion formulation	0.11	0.7426
	City	15.83	<0.001
Freshness after application	Type of peppermint oil	0.36	0.7406
	Emulsion formulation	66.61	<0.001
	Type of peppermint oil × emulsion formulation	0.11	0.9973
	City	16.68	<0.001
Liking after application	Type of peppermint oil	0.26	0.6137
	Emulsion formulation	50.02	<0.001
	Type of peppermint oil × emulsion formulation	0.03	0.8607
	City	15.43	<0.001

that consumers had not had training previous to the evaluations and therefore did not have a clear representation of what a "very fresh" cream was. These differences in consumers' scores could be attributed to cultural differences in freshness perception and could be also related to the fact that consumers had no training prior to their evaluations.

However, both consumer samples perceived creams formulated with emulsion B as significantly fresher, not detecting differences due to the type of peppermint oil (Table V), which suggests the validity of using consumers to gather information about the sensory characteristics of cosmetic products.

Table V
Average Consumers' Freshness Sensation and Liking after Smelling and Applying the Four Evaluated Refershing Creams in Montevideo and Buenos Aires

City	Sample	After smelling		After application	
		Freshness	Liking	Freshness	Liking
Buenos Aires (n=50)	APO	6.3^{b}	6.5^{b}	6.4^{b}	6.5^{b}
	ADPO	6.2^{b}	5.8^{a}	6.2^{b}	5.9^{a}
	BPO	6.8^{c}	6.6^{b}	6.0^{c}	6.7^{b}
	BDPO	7.4^{c}	7.2^{b}	7.4^{c}	7.2^{b}
Montevideo (n=50)	APO	5.0^{a}	5.1^{a}	5.0^{a}	5.0^{a}
	ADPO	4.7^{a}	4.7^{a}	4.7^{a}	4.7^{a}
	BPO	7.3^{c}	6.5^{b}	7.2^{c}	6.5^{b}
	BDPO	7.2^{c}	6.5^{b}	7.2^{c}	5.5^{b}

Rows with different superscripts within the same column are significantly ($p \leq 0.05$) different according to Tukey's test.

As shown in Table IV, consumers' liking scores were also significantly affected by emulsion formulation. Consumers showed a higher liking for samples formulated with emulsion B (Table V), which indicates that consumers' liking of refreshing creams increased as the freshness sensation increased.

Consumers in Buenos Aires and Montevideo showed highly significant differences in the degree of preference for the evaluated refreshing creams, which could be related to the fact that they perceived their freshness differently. This stresses the importance of performing cross-cultural studies when developing cosmetics for different markets.

CONCLUSIONS

Results from the present work showed that emulsion formulation has a great effect on freshness perception. This suggests that when evaluating refreshing agents or developing refreshing products, different formulations should be considered in order to obtain accurate results and assure the products' success in the market. Although dementholated peppermint oil had a lower concentration of menthol than common peppermint oil, it contained several other components that cause the freshness sensation in the first minutes after application. This oil could be used to formulate cheaper refreshing creams with respect to common peppermint oil because of the lower price of the former product.

Consumers' freshness evaluation was similar to that of trained assessors, indicating the validity of gathering information about the sensory characteristics of cosmetic products from consumers. Consumers from different cities evaluated their preference of refreshing creams in significantly different ways, showing the importance of performing cross-cultural studies when developing cosmetic products aimed at different markets.

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