EVALUATION OF THE EFFICACY OF A COSMETIC TREATMENT CONTAINING ÑANDÚ OIL USING SENSORY AND INSTRUMENTAL METHODS

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Summary

The aim of the present work was to evaluate the efficacy of a cosmetic treatment composed of a day cream and a night cream containing Ñandú oil, using sensory and instrumental methods. Twenty six female volunteers in good health used the developed cosmetic products for 28 days. Sensory (clinical evaluation and selfevaluation) and instrumental (hydration, sebum and pH) measurements were performed at the beginning and after 14 and 28 days of application of the treatment. Sensory and instrumental methods indicated that the objectives of the cosmetic treatment were achieved. After 14 days a significant increase in hydration, lightness, smoothness and general state was achieved, suggesting an improvement in the state of the epidermis. After 28 days, treatment also caused an increase in wrinkles and elasticity quality scores in old women, which suggests an improvement in the state of the dermis.

Both clinical evaluation and selfevaluation methods provided similar and complementary information and were able to detect changes in the state of the skin of the volunteers with treatment. Instrumental measurements showed that, despite being acid and formulated with Ñandú oil, the evaluated cosmetic products did not caused an excessive increase in pH and sebum of the skin of the volunteers.

Riassunto

Scopo del presente lavoro è di valutare l’efficacia di un trattamento cosmetico basato sull’uso di una crema da giorno ed una crema da notte contenente olio di Ñandú. A tale scopo sono stati utilizzati metodi sensoriali e strumentali su un gruppo di 26 donne sane volontarie per un periodo di 28 giorni.
Le valutazioni sensoriali (valutazione chimica e autovalutazione) e strumentali (controllo idratazione, sebo e pH) sono state effettuate dopo 14 e 28 giorni dall’applicazione bi/giornaliera dei prodotti. Con entrambi i metodi si è potuto verificare il raggiungimento dell’obiettivo prefissato. Dopo 14 giorni è stato verificato un incremento dell’idratazione cutanea, della luminosità e levigatezza generale della cute trattata.

Dopo 28 giorni è stato anche verificato un incremento della elasticità cutanea accompagnato da un miglioramento delle rughe, dovuto, probabilmente, ad un riassestamento generale del derma.

Questi dati sono stati confermati sia dai metodi strumentali che dall’autovalutazione dei soggetti. D’altra parte l’utilizzo dell’olio di ſandu non provoca incrementi nei lipidi di superficie, né del pH cutaneo.
INTRODUCTION

Fats and oils, both from animal and vegetal origin, have been included in cosmetic products for a very long time. However, demand for these products has augmented in the last decade due to the increasing interest in incorporating natural ingredients in cosmetic products (1).

Ratites are flightless birds which include ostrich (Struthio camelus), emú (Dromaeus novaehollandiae), ñandú común (Rhea americana) and choique (Pterocnemia pennata). Oils from these birds are commonly incorporated in products for both therapeutic and cosmetic use (2,3). These oils are rich in triacylglycerides with unsaturated fatty acids as palmitoleic, oleic, linoleic and linolenic acid (4), which make their inclusion in cosmetics an interesting possibility. These products might act as lipophilic emollients in cosmetic emulsions.

Ñandú oil contains 62.5% unsaturated fatty acids, which includes 37.0% monounsaturated fatty oils (mainly oleic acid -34.7%-) and 24.7% polyunsaturated fatty acids (5). Besides, ñandú oil contains high concentrations of linoleic acid (22.2%) and linolenic acid (2.5%), both essential fatty acids (5). Essential fatty acids deficit has been reported to cause an abnormal increase in transepidermal water loss, leading to the development of dry and scaly skin (6). Moreover, linoleic acid or emollients containing it have been reported to increase barrier function of the skin, favoring water retention of the stratum corneum (1,7). Therefore, ñandú oil appears as an interesting active emollient.

The sensory characteristics of ñandú oil were studied in previous work (8). When applied on the skin, this product showed similar sensory characteristics to those of dimethicone. In this work, ñandú oil was classified as a protective fatty emollient due to the fact that it left an oily film on the skin that lasted several times (8).

However, the efficacy of cosmetic treatments containing ñandú oil has not been studied.

The efficacy of cosmetic products could be regarded as the achievement of the main goals proposed during their development. Efficacy is an important factor for the sales potential of any cosmetic product. If the clinical activity of a certain cosmetic product can be supported by sensorial perception, this product is more likely to be successful in the market place (9).

The state of the skin during the study of the efficacy of cosmetic treatments could be evaluated using both instrumental and sensory methods. Sensory methods include clinical evaluation and selfevaluation. Clinical evaluation is a sensory method for skin state evaluation performed by experts (Dermatologists or Cosmetologists), who objectively evaluate the state of a patient's skin by using their senses and adequate methodologies (10). In this case, experts evaluate the efficacy of cosmetic products and decide which product they consider as better. On the other hand, selfevaluation consists in a subjective method to evaluate the state of the skin performed by cosmetic users (11-19).

Several authors have used clinical evaluation and instrumental methods to evaluate the efficacy of cosmetic products (12, 13, 20, 21), or selfevaluation and instrumental methods (11-15, 16, 19). In previous work (22) sensory methods for skin diagnosis were developed, applying clinical evaluation and selfevaluation, and concluded that they provided complimentary information. While clinical evaluation provided information regarding the objective state of the skin, selfevaluation provided a measure of the perception that each volunteer has of her skin.

The aim of the present work was to use sensory and instrumental methods to study the efficacy of a cosmetic treatment composed of a day cream and a night cream contain containing ñandú oil.
MATERIALS AND METHODS

Subjects

Twenty six female volunteers in good health, of Caucasian origin, were recruited for the present study. Subjects had different types of skin (dry, normal, mixed, and greasy). Their ages ranged between 35 and 66 years old and they had not had any dermatological conditions and were not consuming any anti-inflammatory, or steroid pharmaceuticals, and were not applying any pharmaceutical on their facial skin. Volunteers were sorted into two groups considering their age: fourteen young women (between 35 and 45 years old) and twelve old women (46 years old and more).

All subjects were informed of the aims of the study and gave their written consent in conformity with the ethics of cosmetic experimentation (23, 24). Instructions of how to apply the cosmetic products under evaluation were given to the volunteers.

Cosmetic treatment

A cosmetic treatment for skin face care was designed, composed of two creams containing ñandú oil.

Ñandú oil was obtained by extraction from ñandú (Rhea americana) greasy tissue in hot water followed by centrifugation (5). This product was subject to clinical and bioengineering comedogenic and hypoallergenic studies. According to these studies, the use of ñandú oil as cosmetics’ raw material was safe and non-comedogenic.

The formulation of the creams was the following:

**Night cream:** Aqua, BHT, Ceteareth 20, Cetearyl alcohol, Glycerin, Gliceryl stearate SE, EDTA, Isopropyl myristate, Perfume, Phenoxy etanol (and) DMDM, hidantoin (and) methylparaben (and) propylparaben, α-hydroxiacids -AHA- (Pyrus malus (and) Vitis vinifera (and) Citrus limonum (and) propilenglycol (and) water (and) imidazolidinylurea (and) methyl paraben), ñandú oil, Tocopheril acetate and Xantan Gum.

**Day cream:** Aqua, BHT, *Camellia sinensis* extract, Carbomer, Ceteareth 20, Cetearyl alcohol, EDTA, Gliceryl stearate SE, Glycerin, Mineral oil, Perfume, Phenoxy etanol (and) DMDM, hidantoin (and) methylparaben (and) propylparaben, ñandú oil, Sodium ascorbil phosphate, Tocopheril acetate, Triethanolamine and Urea.

Participants were instructed to use the products in the following way: day cream should be applied after morning skin hygiene and could be reapplied if considered necessary; whereas night cream should be applied at night, after corresponding hygiene.

The treatment was design to achieve two objectives:

- Short and medium term (few days to 1 week): Improve properties that depend on the superficial skin layers; such as hydration, smoothness, lightness and therefore general state. To achieve this objective moisturizing agents (urea, glycerin and AHA), emollients (ñandú oil and isopropyl myristate), antioxidants (*Camellia sinensis* extract, sodium ascorbil phosphate and tocopheril acetate) and lightening agents (sodium ascorbil phosphate) were included in the formulation (25-32).

- Long term (more than a month): to improve properties related to the deep layers of the skin; such as reduce wrinkles and increase elasticity. To achieve this objective antiaging agents (*Camellia sinensis* extract, AHA, sodium ascorbil phosphate and tocopheril acetate) were included in the formulation to favor the generation of collagen fibers, giving as a result softer skins.

- Besides, the designed treatment presents aging
prevention effects due to the presence of antioxidants.

**Efficacy evaluation**

Evaluation of the state of the facial skin of the volunteers was carried out using clinical evaluation and self-evaluation, as developed in previous work (22). Instrumental measurements (hydration, pH and sebum) were also performed. Three evaluation instances were considered: before they start the treatment, after fourteen days of treatment and after 28 days.

Evaluations were carried out under controlled temperature and humidity (20°C and 60% relative humidity). Volunteers were asked to stay under those conditions for 15 minutes before the evaluation (33, 34).

**Clinical evaluation**

A Cosmetologist observed the facial skin of the volunteers and scored different attributes using a structured 9-point quality scale (Table I). The evaluated attributes were: wrinkles (amount and depth), hydration, smoothness, elasticity, lightness and general state. After the evaluation, the Cosmetologist defined the type of skin of each volunteer (dry, normal, mixed, and greasy) and an interview about skin care and hygiene was performed.

**Self-evaluation**

Volunteers were asked to evaluate the state of their facial skin by scoring the same attributes than the Cosmetologist, using the same quality scale.

**Instrumental measurements**

Three instrumental measurements were performed on the facial skin of the volunteers: hydration, pH and sebum.

Hydration was measured by electrical capacitance using a Corneometer CM825® (Courage + Khazaka electronic GmbH, Köln, Germany). The skin of the volunteers was classified as very dry when the reading was lower than 50, dry when the reading was between 50 and 60, and sufficiently moistured when the reading was higher than 60 (34).

<table>
<thead>
<tr>
<th>Description</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>9</td>
</tr>
<tr>
<td>Very good</td>
<td>8</td>
</tr>
<tr>
<td>Good</td>
<td>7</td>
</tr>
<tr>
<td>Satisfactory</td>
<td>6</td>
</tr>
<tr>
<td>Fair</td>
<td>5</td>
</tr>
<tr>
<td>Enough</td>
<td>4</td>
</tr>
<tr>
<td>Defective</td>
<td>3</td>
</tr>
<tr>
<td>Poor</td>
<td>2</td>
</tr>
<tr>
<td>Very poor</td>
<td>1</td>
</tr>
</tbody>
</table>

**TABLE I**

Quality scale used to evaluate the state of the skin during clinical evaluation and self-evaluation.
Evaluation of the Efficacy of a Cosmetic Treatment Containing Ñandú oil

Sebum was determined using a Sebumeter SM810® (Courage + Khazaka electronic GmbH, Köln, Germany) and expressed in mg/cm². Sebum was only determined before the start of the treatment and at the end. When sebum reading was lower than 70 skins were classified as dry, when it was between 70 and 180 as normal, and as greasy if sebum reading was higher than 180.

pH was measured using a plane electrode 5Skin pH meter PH 900® (Courage + Khazaka electronic GmbH, Köln, Germany). Skin was classified according to its pH in acid skin (pH between 3.5 and 4.4), normal skin (pH between 4.5 and 5.5) and basic skin (pH between 5.6 and 6.5).

For each volunteer 5 measurements of hydration and pH were performed on each cheek, whereas 3 measurements of sebum were performed.

Data analysis

Analysis of variance (ANOVA) was performed on the instrumental and sensory data obtained considering volunteer and time as variation factors. When differences were significant (p<0.05) means and Fisher’s least significant differences were calculated.

Principal component analysis (PCA) was performed on the clinical evaluation and selfevaluation data, to illustrate the relationship between variables, and between variables and volunteers.

At each evaluation time, volunteers were sorted in groups according to instrumental data for hydration, pH and sebum. The existence of differences in the volunteers frequency distributions with time was evaluated using \( \chi^2 \) statistical test. An analysis of variance (ANOVA) was performed on clinical evaluation, selfevaluation and instrumental measurements data, considering group as variation factor. When the effects were significant, mean ratings for each sample and Fisher’s least significant differences were calculated. Differences were considered significant when p < 0.05.

All statistical analyses were performed using Genstat Discovery Edition (VSN International, UK).

RESULTS AND DISCUSSION

Clinical evaluation

Analysis of variance performed on clinical evaluation data showed that all the evaluated attributes varied with time of application of the evaluated cosmetic treatment (p<0.001).

As shown in Table II, after 14 days of treatment, a significant (p<0.001) improvement was found in softness, lightness, hydration and general state. This improvement continued until the end of the study. Scores increased from 3-4 (defective to enough) to 6 (satisfactory) after 28 days, which shows the efficacy of the developed cosmetic treatment. Softness, lightness and hydration correspond to skin characteristics that depend on the state of the superficial layers of the skin and therefore easily and quickly respond to treatment. Considering that the main objective of the proposed treatment was to improve these skin attributes, results suggest that it was achieved.

On the other hand, wrinkles and elasticity were not significantly affected after 28 days of treatment. These attributes depend on the state of the dermis and need long treatments (of more than 28 days) to achieve significant improvements.

Results according to age group

As previously mentioned, volunteers were sorted into two groups considering their age in young and old women. Clinical evaluation data was analyzed separately for each of these age groups.

As shown in Table III, similar results were found for young and old women. A significant improvement in smoothness, lightness, hydration and general state was registered after 14 days of treatment.
for both age groups. Therefore, these results suggest that the efficacy of the developed cosmetic treatment on the epidermis did not depend on the age of the volunteers. Thus, it could be used by both age groups for improving this aspect of the state of the skin.

On the other hand, an increase in elasticity was observed for both age groups after 28 days of treatment. Moreover, an improvement in wrinkles was achieved after 28 days only for old women. The fact that young women did not show an improvement in wrinkles quality scores could be attributed to the fact that they show high scores at the beginning of treatment.

**TABLE II**

Average scores for clinical evaluation of the state of the facial skin of the volunteers throughout treatment.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Time of application of the treatment (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Wrinkles</td>
<td>5.3 a</td>
</tr>
<tr>
<td>Smoothness</td>
<td>3.6 c</td>
</tr>
<tr>
<td>Lightness</td>
<td>5.3 c</td>
</tr>
<tr>
<td>Hydration</td>
<td>5.0 a</td>
</tr>
<tr>
<td>Elasticity</td>
<td>3.7 c</td>
</tr>
</tbody>
</table>

Values within a row with different superscript are significantly different according to Fishers’ Least Significant Difference Test (p<0.05)

**TABLE III**

Average scores for clinical evaluation of the state of the facial skin of the volunteers throughout treatment by age group.

<table>
<thead>
<tr>
<th>Young (35-45 years old)</th>
<th>Old (&gt;45 years old)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Wrinkles</td>
<td>4.4 b</td>
</tr>
<tr>
<td>Smoothness</td>
<td>4.0 c</td>
</tr>
<tr>
<td>Lightness</td>
<td>4.0 c</td>
</tr>
<tr>
<td>Hydration</td>
<td>4.0 b</td>
</tr>
<tr>
<td>Elasticity</td>
<td>4.0 b</td>
</tr>
<tr>
<td>General state</td>
<td>3.9 c</td>
</tr>
</tbody>
</table>

Values within a row with different superscript are significantly different according to Fishers’ Least Significant Difference Test (p<0.05)
Regarding wrinkles and elasticity, no significant increase in their scores were found after 28 days of treatment. These results suggest that volunteers observed an improvement in the state of their skin after 14 days of application of the evaluated cosmetic treatment. This improvement in smoothness, lightness and hydration after 14 days of treatment might encourage volunteers to continue the treatment for a longer period, making the treatment possible to improve wrinkles and elasticity, characteristics that are more difficult and take more time to improve.

Results for selfevaluation were in agreement with those for clinical evaluation data, suggesting that both methods provided similar information and were able to detect changes in the state of the skin of the volunteers with treatment.

**Results according to age group**

As shown in Table V, similar results were found for young and old women. A significant improvement in smoothness, lightness, hydration and general state was registered after 14 days of treatment for both age groups, improvement that continued between days 14 and 28 days. These results suggest that volunteers in both age groups perceived the efficacy of the developed cosmetic treatment. Differences in the effect of cosmetic treatment in wrinkles were observed between young and old women. While young women noticed an improvement in wrinkles after 28 days, old women did not notice an improvement in this attribute with treatment. However, clinical evaluation data showed an improvement in wrinkles for both age groups after 28 days of treatment. Thus, these results suggest a difference in the perception of the efficacy of the cosmetic treatment between old women and the Cosmetologist. Old women seemed stricter than the Cosmetologist while evaluating changes in their wrinkles.

**Principal component analysis**

A principal component analysis was performed on selfevaluation data before and after 28 days of treatment. The first and second principal components accounted for 45.7 and 45.4 % of the variance of the clinical evaluation data respectively.
TABLE V
Average scores for selfevaluation of the state of the facial skin of the volunteers throughout treatment by age group.

<table>
<thead>
<tr>
<th>Young (35-45 years old)</th>
<th>Old (&gt;45 years old)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Wrinkles</td>
<td>6.4 b</td>
</tr>
<tr>
<td>Smoothness</td>
<td>5.5 c</td>
</tr>
<tr>
<td>Lightness</td>
<td>5.0 c</td>
</tr>
<tr>
<td>Hydrationness</td>
<td>4.8 c</td>
</tr>
<tr>
<td>Elasticity</td>
<td>4.9 c</td>
</tr>
<tr>
<td>General state</td>
<td>5.3 b</td>
</tr>
</tbody>
</table>

Values within a row with different superscript are significantly different according to Fishers’ Least Significant Difference Test (p<0.05)

As shown in Figure 3, the first principal component (PC1) contrasted positively with lightness, smoothness, hydration and general state; whereas the second principal component (PC2) was positively correlated with wrinkles and elasticity. These results are in agreement with previous work (22) and with results for clinical evaluation data.

A similar trend was observed when evaluating the relative position of the volunteers before and after 28 days of treatment in the PCA of selfevaluation data than that of clinical evaluation data. As shown in Figure 4, 73% of the volunteers were initially located to the left of PC1, showing low values for smoothness, lightness, hydration, general state. Nonetheless, this percentage was inverse at the end of the treatment (after 28 days) as 73% of the volunteers were located to the right of PC1, suggesting a good level of care of their skin. Moreover, all the volunteers moved to the right of PC1, showing an improvement in their perception of the state of their skin after applying the treatment for 28 days. Some volunteers also moved up in PC2, showing an improvement in wrinkles and elasticity, suggesting an improvement in the state of their dermis. Nevertheless, these displacements were fewer than those on PC1 and were shown by a smaller amount of volunteers, in agreement with clinical evaluation data. Therefore, these results show that volunteers perceived the efficacy of the evaluated cosmetic treatment.

INSTRUMENTAL MEASUREMENTS

Hydration

As shown in Table VI, ANOVA showed a highly significant increase in hydration with time of application of treatment, which could be attributed to the presence of emollients (níandú oil and isopropyl miristate) and moisturizing agents (glicerine and urea) in the cosmetic products included in the treatment. These results are in agreement with the increase in hydration scores during clinical evaluation and selfevaluation.
As shown in Table VI, young women showed higher hydration values than old women throughout treatment, as expected due to aging effects on skin. Both age groups showed a significant increase in hydration due to treatment. Volunteers were sorted in three categories according to hydration measurements: very dry, dry and sufficiently moisturized.

Table VII shows type of skin frequency distribution, considering hydration scores, throughout treatment.

$\chi^2$ test showed highly significant differences were found in volunteers' frequency distribution with time of application ($p=0.0016$), suggesting that treatment changed skin hydration scores, changing the category in which volunteers were sorted.

As shown in Table VII, treatment caused a mar-
ked increase in the percentage of women with hydrated skin and a concomitant decrease of those with very dry and dry skin. While only 27% of the those showed sufficiently moistured skins at the beginning of the treatment, this percentage increase to 77% after 28 days of treatment. These results show an increase in skin hydration with treatment, suggesting the efficacy of the evaluated treatment.

**Sebum**

Sebum was measured at the beginning and the end of the treatment. ANOVA showed that volunteers showed higher sebum scores (p<0.05) at the end of the treatment, which could be attributed to the presence of emollients and waxy substances (glyceryl stearate and cetaryl alcohol) in the cosmetic products included in the treatment.

As shown in Table VIII, old women showed lower sebum scores than young women throughout treatment. This difference could be explained considering a decrease in the secretion of the sebaceous glandules with aging.

### TABLE VI

Average scores for instrumental hydration scores of the volunteers throughout treatment, for the whole population and by age group.

<table>
<thead>
<tr>
<th>Time of application of the treatment (days)</th>
<th>0</th>
<th>14</th>
<th>28</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole population</td>
<td>51.8</td>
<td>62.6</td>
<td>64.8</td>
</tr>
<tr>
<td>Young women (35-45 years old)</td>
<td>52.8</td>
<td>63.0</td>
<td>66.2</td>
</tr>
<tr>
<td>Old women (&gt;45 years old)</td>
<td>50.6</td>
<td>62.2</td>
<td>63.3</td>
</tr>
</tbody>
</table>

Values within a row with different superscript are significantly different according to Fishers’ Least Significant Difference Test (p<0.05)

### TABLE VII

Type of skin frequency distribution considering hydration scores throughout treatment.

<table>
<thead>
<tr>
<th>Time of application of treatment (days)</th>
<th>Very dry</th>
<th>Dry</th>
<th>Sufficiently moisturized</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>42</td>
<td>31</td>
<td>27</td>
</tr>
<tr>
<td>14</td>
<td>15</td>
<td>35</td>
<td>50</td>
</tr>
<tr>
<td>28</td>
<td>4</td>
<td>19</td>
<td>77</td>
</tr>
</tbody>
</table>
Treatment significantly increased (p<0.05) sebum in women for both age groups, as shown in Table VIII.

The skin of the volunteers was sorted into three categories according to their sebum scores: dry, normal and greasy. Table IX presents type of skin frequency distribution of the volunteers, according to their sebum scores, at the beginning and the end of treatment.

As shown in Table IX, a slight decrease in percentage of volunteers with dry skin and a parallel increase in women with normal skin were observed after 28 days of treatment.

On the other hand, as the evaluated cosmetic products contained ņandú oil an excessive increase in sebum could be expected. However, it is important to indicate that after 28 days of treatment no increase was registered in percentage of women with greasy skin. These results suggest that the increase in sebum due to treatment was restricted to women with very low levels of sebum.

**pH**

As shown in Table X, the evaluated treatment caused a significant decrease in pH after 28 days, for both young and old women. This could be attributed to the low pH of the cosmetic products that composed the treatment.

The skin of the volunteers was sorted in three categories according to pH measurements: acid, normal and basic. Table XI shows type of skin frequency distribution, considering pH, throughout treatment.

As shown in Table XI, no significant differences were found with time application of treatment in the type of skin distribution of volunteers.

Thus, although the evaluated night cream was acid (pH=4) it only caused an slight acidification of the skin of the volunteers.

**CONCLUSIONS**

Both sensory and instrumental methods provided useful information to evaluate the efficacy of the developed cosmetic treatment. Both clinical evaluation and selfevaluation methods provided similar and complementary information and were able to detect changes in the state of the skin of the volunteers with treatment.

<table>
<thead>
<tr>
<th>TABLE VIII</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average scores for sebum scores of the volunteers throughout treatment, for the whole population and by age group.</strong></td>
</tr>
<tr>
<td>Time of application of the treatment (days)</td>
</tr>
<tr>
<td>Whole population</td>
</tr>
<tr>
<td>Young women (35-45 years old)</td>
</tr>
<tr>
<td>Old women (&gt;45 years old)</td>
</tr>
</tbody>
</table>

Values within a row with different superscript are significantly different according to Fishers' Least Significant Difference Test (p<0.05)
Clinical evaluation provided objective information about the efficacy of the treatment and might be useful to support efficacy claims. On the other hand, self-evaluation could be regarded as a measure of how satisfied consumers are with the evaluated cosmetic treatment and with its effects on their skin. Sensory and instrumental methods indicated that the objectives of the cosmetic treatment were achieved. After 14 days a significant increase in hydration, lightness, smoothness and general state was registered, suggesting an improvement in the state of the epidermis. After 28 days, treatment also caused an increase in wrinkles and elasticity scores in old women, which suggests an improvement in the state of the dermis.

Instrumental measurements showed that, despite being acid and formulated with ñandú oil, the evaluated cosmetic products did not caused an excessive increase in pH and sebum of the skin of the volunteers.

### TABLE IX

*Type of skin frequency distribution considering hydration scores throughout treatment.*

<table>
<thead>
<tr>
<th>Time of application of treatment (days)</th>
<th>Type of skin</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Acid</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>14</td>
<td>0</td>
</tr>
<tr>
<td>28</td>
<td>4</td>
</tr>
</tbody>
</table>

### TABLE X

*Average scores for pH scores of the volunteers throughout treatment, for the whole population and by age group.*

<table>
<thead>
<tr>
<th>Time of application of the treatment (days)</th>
<th>Whole population</th>
<th>Young women (35-45 years old)</th>
<th>Old women (&gt;45 years old)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>5.4 b</td>
<td>5.4 b</td>
<td>5.4 b</td>
</tr>
<tr>
<td>14</td>
<td>5.5 b</td>
<td>5.5 b</td>
<td>5.5 c,b</td>
</tr>
<tr>
<td>28</td>
<td>5.2 a</td>
<td>5.2 a</td>
<td>5.3 a</td>
</tr>
</tbody>
</table>

Values within a row with different superscript are significantly different according to Fishers’ Least Significant Difference Test (p<0.05)
TABLE XI

Type of skin frequency distribution considering pH measurements throughout treatment.

<table>
<thead>
<tr>
<th>Time of application of treatment (days)</th>
<th>Acid</th>
<th>Normal</th>
<th>Basic</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>73</td>
<td>27</td>
</tr>
<tr>
<td>14</td>
<td>0</td>
<td>54</td>
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</tr>
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Fig. 4 Volunteers loadings in the principal component analysis of selfevaluation data at the beginning and end of treatment.
References


24) Declaration of Helsinki, Recommendations guiding physicians in biomedical research involving human subjects. Adopted by the 18th World Medical Assembly, Helsinki, Finland (June 1964), amended by 29th World Medical Assembly. Tokyo, Japan (Oct 1975); the 35th World Medical Assembly, Venice, Italy (Oct 1983); and the 41st World Medical Assembly, Hong Kong (Sep 1989).


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