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Evaluation of the Protective Effect of Antipollution Lotion against Carbon Microparticles "Modeling" Atmospheric Pollution

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Abstract: ***Introduction: Skin is one of the prime targets of the harmful effects of environmental insults, with several studies highlighting Ozone (O_3), particulate matter (PM), and ultraviolet radiation (UV) as the major fore players of the foul act. However, very few studies have explored whether the harmful effects of these stressors can albeit be prevented with the use of anti - pollution cosmeceuticals. In the present work, we evaluated the protective effect of the 'anti - pollution lotion containing PhytoVie® Defense' against carbon microparticles (average particle size 1 µm) "modelling" atmospheric pollution. Methodology: An open - label, intra - individual study was conducted on female participants in France in July 2015. Anti - pollution lotion containing PhytoVie® Defense was compared against untreated site. Test product was applied as single standardised application on forearm with an area of 4 cm× 4 cm. The outcomes measured at the end of the study were the percent protection obtained with test product compared to untreated site and the number of carbon microparticles left adhered to skin after rinsing when compared to baseline value. Results: A total of 21 female participants; aged 32 ± 2 years were enrolled in the study. The 'PhytoVie® Defense containing anti - pollution lotion' removed 32% more carbon micro - particles compared to the untreated site, demonstrating a significant protective effect against pollution (p=0.0004) Conclusions: By harnessing advanced ingredients and technologies, PhytoVie® Defense lotion seeks to provide a protective barrier against pollutants, and enhance the skin's natural defences especially against particulate matter, ultimately contributing to healthier, more radiant skin in an increasingly polluted world; even after a single application.***

Keywords: Anti - pollution, micro particles, skin protection

1. Introduction

Air pollution has emerged as a significant global health concern, with far - reaching implications for human well - being.[1] Among the various health effects attributed to environmental pollutants, the impact on skin health is particularly alarming. The skin, serving as the body's first line of defence, is directly exposed to a myriad of airborne contaminants, including solar ultraviolet radiation, polycyclic aromatic hydrocarbons, volatile organic compounds (VOCs), nitrogen oxides, particulate matter (PM), ozone and cigarette smoke.[2, 3] To elucidate the effects of these pollutants on skin, carbon microparticles (average particle size 1 µm), which serve as a model for environmental pollution, have been analyzed. Studies have provided critical insights into their capacity to trigger oxidative damage and initiate inflammatory responses in the skin.[4]

Research has increasingly demonstrated that exposure to air pollution is linked to a range of adverse skin conditions, including premature aging, acne, eczema, and even skin cancer. The oxidative damage caused by pollutants accelerates the aging process, resulting in the formation of fine lines, wrinkles, and uneven skin tone.[5] Additionally, inflammatory responses triggered by these environmental stressors can exacerbate existing skin disorders, leading to increased discomfort and diminished quality of life for affected individuals.[6, 7]

As awareness of the detrimental effects of air pollution on skin health increases, there is an urgent need for effective protective measures. Anti - pollution skincare products have emerged as a vital solution, designed to shield the skin from environmental aggressors while promoting its resilience and overall health. These products aim to alleviate or prevent impact of environmental aggressors by controlling deposition and penetration of PM on skin and removing the deposited or penetrated pollutants. Several surfactants and barrier - forming polymeric materials have been used in different product forms, like cleansers, masks, exfoliators, moisturizers, and even wipes and mists.[8]

PhytoVie® Defense is one such patented formulation containing Copolymer of *Brassica campestris* and *Aleurites fordii* Oil. It forms a flexible and uniform film on the skin for even coverage and has the power to stay on skin longer, delivering superior protection from damage that is caused by environmental aggressors.[9]

Research has identified various phenolic compounds in *Aleurites fordii*, such as neolignan glycosides and phenolic glycosides, exhibit significant anti - inflammatory and antioxidant activities, thereby reducing skin inflammation and protecting against oxidative stress.[10] While these effects have been proven in *in - vitro* and *in - vivo* settings, their clinical evaluation is yet warranted.[11, 12]

This study explores the efficacy of an innovative anti - pollution PhytoVie® Defense skin lotion in humans, aimed at combating the harmful effects of air pollution on the skin.

2. Materials and Methods

This study was an open - label, intra - individual study conducted at a single study centre in France in July 2015, with a total enrolment of 21 female participants.

2.1 Eligibility criteria

The main inclusion criteria were healthy female participants of Caucasian ethnicity devoid of hairs on volar aspect of the forearms, aged between 20 and 45 years, and with a skin photo type ranging from I to IV. The subject willingly gave a written, duly signed informed consent form.

The exclusion criteria included pregnant or nursing women, the presence of cutaneous pathology on the forearm, tattoos on the inner forearm, and the use of dermopharmaceutical or cosmetic products other than cleansing products on the test site on the day of the study.

2.2 Investigational Product

The test product, containing a white anti - pollution lotion with PhytoVie® Defense, was compared to an untreated site. Test product was applied as single standardised application of 2 mg/cm^2; on forearm with an area of 4 cm× 4 cm.

2.3 Study Procedure

After careful evaluation, based on inclusion and exclusion criteria by the investigators, participants were enrolled in the study. A duly dated and signed informed consent document was obtained from participants. They were previously instructed to visit the laboratory without application of any care products to their forearms since the previous evening.

Forearm sites were defined based on a randomization list, with one site designated as treated and the other as untreated. The test product (2 mg/cm^2) was applied to the treated site. After a 20 - minute waiting period, images of both sites were acquired using a HIROX® videomicroscope; indicated as baseline value (**t_0**).

Microparticles (average particle size - 1 µm) were then applied to both sites, followed by another round of image acquisition before rinsing; indicated as carbon microparticles left adhered before rinsing (**t_1**). The sites were rinsed off with water and uniformly massaged with fingerstall for about 10 seconds per site followed by wiping with a dry woven cotton (about 23.7 cm^2). Final images after rinsing of both the treated and untreated sites were also recorded, indicated as carbon microparticles left adhered after rinsing (**t_2**), to complete the trial.

2.4 Outcome Measures

The test outcomes measured at the end of the study were the percent protection obtained with test product compared to untreated site and the number of carbon microparticles left adhered to skin after rinsing when compared to baseline value.

2.5 Statistical Analysis

In the study, data were analysed using a paired t - test to determine whether the mean difference between paired data samples was significantly different from the hypothetical mean (zero) under the null hypothesis (H_0). The alternative hypothesis (H_1) stated that the average difference was either greater or less than zero, corresponding to a two - tailed test. A type I error rate of 5% was selected, indicating the risk of incorrectly rejecting the true null hypothesis.

3. Results

3.1 Population analysis

A total of 21 participants were enrolled, and completed the study. The detailed population demographics is represented in the table below.

Table 1: Demographic data of study participants

Parameters		Demographic data
Age in years, mean (SD)		32 (2)
Gender*	Male	0
	Female	21
Skin type*	Normal skin	17
	Dry skin	3
Phototype*	I	0
	II	9
	III	10
	IV	2

* Data represented as Number of participants

3.2 Protective effect

The protective effect of the test product compared to untreated site was calculated based on the variations of the carbon micro - particles quantity (in pixel unit). Under the study conditions, the amount of carbon microparticles removed from the area treated with the 'Anti - pollution lotion containing PhytoVie® Defense' was 32% greater compared to the untreated area. The test product demonstrated a significant protective effect against pollution (p=0.0004). (Table 2)

Table 2: Comparison of the protective effect between the test group and no - treatment group

	Test group	No treatment group	Between - group difference	
			Percent protection [a]	p - value
Protective effect				
Before cleansing (t_1)	268506 ± 12012	317036 ± 18721	-	-
After cleansing (t_2)	83269 ± 8099[b]	202769 ± 16326[b]	32%	0.0004

[a] t_1 versus t_2 in both groups; [b] $p<0.001$ compared to t_0

3.3 Micro particles adhesion to skin

The data indicate that the quantity of carbon microparticles adhered to the skin after rinsing (t_2) is statistically significantly higher compared to baseline (t_0) for both the test group ($p<0.0001$) and no treatment group ($p<0.0001$). Furthermore, the difference in carbon microparticle quantity from baseline (t_0) to post - rinsing (t_2) is significantly smaller at the site treated with PhytoVie® Defense containing anti - pollution lotion compared to the untreated site ($p<0.0001$). (Table 3)

The Effect of PhytoVie® Defense on skin protection against particle deposition and cleansing efficacy is shown in figure 1.

Table 3: comparison between the carbon microparticles quantity left adhered to skin post rinsing with baseline value

	Test group	No treatment group	Between - group difference	
			Reduction in micro particles adhered [b]	p - value
Return to initial state				
Comparison between micro - particles quantity after rinsing (t_2) with baseline value (t_0)	**74684 ± 8234** [a]	**194357 ± 16825** [a]	- 119637 ± 15935	0.0001

[a] $t_2 - t_0$ in both groups; [b] $p<0.001$ compared to T_0

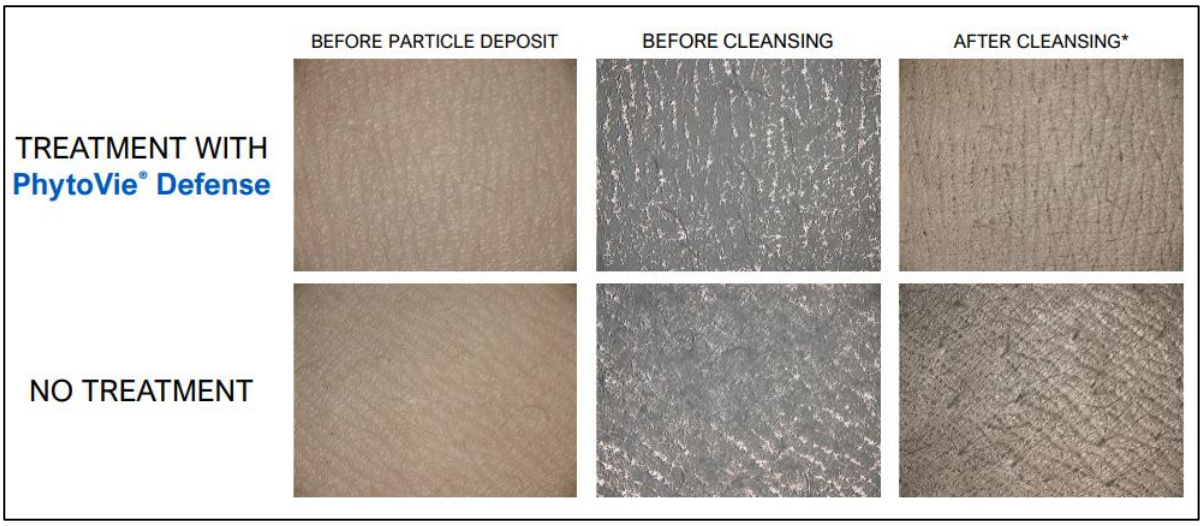

Figure 1: Comparative imaging showing reduced carbon micro - particle retention and improved post - cleansing skin texture in treated versus untreated sites

2.0% Usage Level
* $p< 0.0005$ statistically significant vs untreated

4. Discussion

The ability of PM to enter skin cells in vitro has been well documented, which results in localization to the mitochondria, thereby inducing damage and ROS production.[13, 14] Therefore, it is possible that, PM penetrates skin either through hair follicles or transdermally, and exerts its detrimental effects through the generation of oxidative stress, which contributes to extrinsic skin aging, characterized particularly by pigment spots on the face and nasolabial folds, and less so by coarse wrinkles, solar elastosis and telangiectasia.[15]

Our study found that after a single application of the 'anti - pollution lotion containing PhytoVie® Defense', the number of carbon microparticles removed from treated site were significantly higher when compared with untreated site indicating better protection from pollution. These biological activities can be attributed to phenolic compounds and diterpene esters in *Aleurites fordii* that contribute to maintaining skin integrity and preventing damage from environmental factors.[10]

5. Conclusion

Anti - pollution lotion containing PhytoVie® Defense is effective in protecting the skin against carbon micro - particles 'modelling' atmospheric pollution, even after a single application.

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