The Impact of Polymers In Sunless Tanning Delivery Systems

Olga V. Dueva-Koganov[1], Ph.D., Colleen Rocafort[2], B. Scott Jaynes[1], Ph.D., Joseph Lupia[1], Ph.D., Bernice Ridley[3], XianZhi Joe Zhou[1], Ph.D. and Shaun Barker[1]

Ciba Specialty Chemicals, Inc.
[1]Tarrytown, NY, [2]High Point, NC and [3]Bradford, UK

Introduction

A sun-tanned appearance is considered to be a symbol of a healthy and active life, and sunless tanners provide such appearance to the skin without the need for UV exposure. Sunless tan is generated by the Maillard reaction of dihydroacetone (DHA) and/or erythrulose with the amino acids, peptides and proteins in the stratum corneum. Some sunless tanners have the disadvantage of not providing the desired control over color development with tans being uneven, too light or dark, or too orange or yellow. Also, it is known that some individuals do not develop a noticeable tan with DHA. Thus, a need exists to develop sunless tanning compositions that provide improved color and help to develop a tan for inadequately reacting individuals. It is known that various chemicals can modify or enhance the tanning reaction obtained with DHA on skin. Examples of such ingredients include amino acids [1], amino-substituted silicone compounds [2], polyacrylamide [3], amphoglycinate derivatives [4], thickeners, humectants, UV-filters, vitamins and emollients [5]; however, the data regarding the impact of polymers on the development of a sunless tan are rather limited.

Our objective was to evaluate the ability of several polymers to influence the color development induced by sunless tanning formulations.

Method Description

We have utilized VITRO-SKIN® N-19 (IMS, Inc.) [6] as a substrate and an *in vitro* efficacy testing methodology for sunless tanners described by R. Jermann et al. with minor modifications. This *in vitro* methodology is a reliable tool to estimate the efficacy of self-tanning formulations on human skin [5]. Substrate was pre-cut into 4x4 cm pieces and hydrated according to the protocol described in [6]. Application dose was 2 mg/sq.cm; temperature: 76 -78 °F. Color of the samples was measured every 24 h for 4 days with COLORTEC PSM™; Color Mode: L*a*b*; Observer 10°; Primary Illuminant D65 (Color-Tec, Clinton – NJ).

Test Articles

The following commercial and experimental polymers were evaluated:

A - Dimethylacrylamide/Ethyltrimonium Chloride Methacrylate Copolymer;
B - Hydroxypropyl Starch Phosphate;
C - Experimental Polymer Derivative.
DHA-compatible polymers **A** and **B** were evaluated in a simple base containing: Water, 3% DHA, 4% Pentylene Glycol, Preservatives and pH adjustors. Polymer **A** was tested at **1.5% (active)** and **B** at **5% (active)** levels. These levels were recommended by the manufacturers as sufficient to create a gel-lotion with **A** or a gel with **B**.

Experimental polymer **C** was tested in 2% aqueous solution, pH adjusted. It was applied on the substrate as a second coat immediately after application of DHA-containing product.

A commercially available sunless tanner/daily moisturizer (D) designed for medium/tan skin tones was tested as a benchmark. Ingredients in **D** included: Water, Glycerin, Cetearyl Alcohol, Petrolatum, Mineral Oil, Dimethicone, Ceteareth-20, Glyceryl Stearate, Persea Gratissima (Avocado) Fruit Extract, Avena Sativa (Oat Meal) Extract, Simmondsia Chinensis (Jojoba) Seed Extract, Calendula Officinalis Flower Extract, Olea Europaea (Olive) Fruit Oil, Tocopherol, Cyclopentasiloxane, Stearic Acid, Hydroxyethyl Acrylate/Sodium Acryloyldimethyltaurate Copolymer , Aluminum Starch Octenylsuccinate, PEG-100 Stearate, Methylparaben, Propylparaben, Xanthan Gum, DMDM Hydantoin, BHT, Fragrance, Dihydroacetone, Caramel, Titanium Oxide, Mica, Erythrulose.

Experimental Results

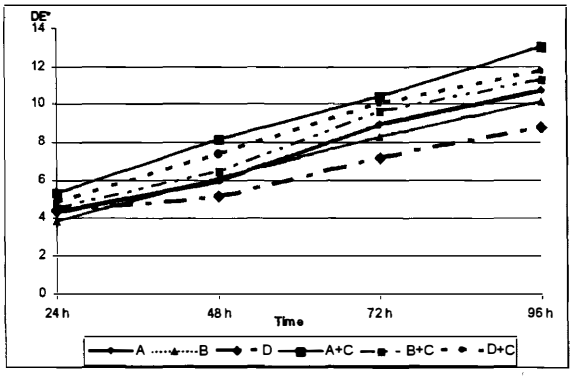

Figure 1. Color development after application of the test articles

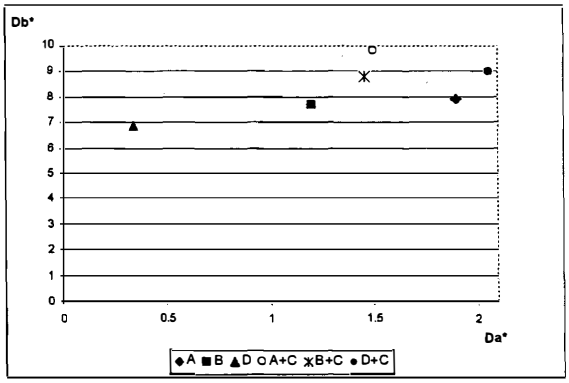

Figure 2. Color induced by the test articles after 72 h

Conclusions

Commercially available polymers - Dimethylacrylamide/Ethyltrimonium Chloride Methacrylate Copolymer (**A**) at **1.5% (active)** and Hydroxypropyl Starch Phosphate (**B**) at **5% (active)** levels were evaluated in DHA (3%) containing systems. Both **A** and **B** generated a good intensity of the resulting color with **A** being superior. These systems (**A** and **B**) also outperformed a commercial sunless tanner (**D**). Experimental polymer **C** accelerated the color development when used in conjunction with test articles (**A**, **B** and **D**). Further *in vitro* and *in vivo* studies of the polymers are underway.

The sunless tanner market continues to grow rapidly and our findings can help to develop new products with superior performance to fulfill consumers' expectations.

References

1. Robinson; Larry R. and Tanner; Paul R., **US 5,603,923** *(1997)*, Artificial tanning compositions having improved color development
2. Lentini; Peter, Muizzuddin; Neelam, Pelle; Edward and Punto; Louis, **US 5,503,824** *(1996)* Skin tanning compositions
3. Ziegler; Philip D. and Crotty; Brian A., **US 5,232,688** *(1993)*, Self-tanner cosmetic compositions
4. Dueva-Koganov; Olga, Russo; Thomas and Sanogueira; James P., **US 2007/0003496** *(2007)*, Sunless tanning composition and method of sunless tanning
5. R. Jermann, M. Tourniat and D. Imfeld *International Journal of Cosmetic Science*, **24**, 1-8 (*2002*)
6. http://www.ims-usa.com/ittrium/visit?path=A1x66x1y1xa0x1x65y1xc6x1x65y1xccx1x65

Acknowledgements

We are grateful for the support of our colleagues at Ciba, especially **Dr. Mervin Wood**. We would like to thank **Dr. John Sottery and Peter Sottery** of IMS, Inc. for valuable discussions.