# Modification of Sunless Tanning Solution for UV Protection Purposes


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## Abstract

One of the largest aspects of the cosmetics industry is sunless tanning products which provide a tan without harmful UVA and UVB rays from the sun or sunless tanning booths. Unfortunately, these topical agents do not provide additional sun protection. In order to improve the sun protection factor of an existing commercial sunless tanning solution, titanium dioxide ($TiO_2$) and ascorbic acid (vitamin C) were used since they are common additives of cosmetic products. To test this idea, a model protein system was used by depositing a film of a gelatin, composed of peptides and proteins, onto a transparent glass slide. This model mimics the Maillard reaction, a browning effect, that occurs in the proteins within human skin. To evaluate the slow color development of the Maillard reaction absorbance measurements were taken at different time intervals.


## Introduction

Sunless tanning has been one of the longest-lived fads in beauty. Since Coco Chanel was photographed in the 1920's with a suntan, tan skin has been considered beautiful. In the 1950's a medical researcher, Eva Wittgenstein, noticed that a medication that she was using left a brown stain on her patients' skin. She painted her own skin with the solution, which contained dihydroxyacetone (DHA), and within hours these patches turned brown. DHA produced the color changes by what is called a Maillard reaction, browning the top layer of human skin much the same way a steak browns as it cooks. [1] During this chemical reaction, DHA reacts with amino acids in the skin, arginine, lysine, and histidine, to generate a browning process. Heyns products form melanoidins when in the presence of these amino acids as shown in Figure 1.[2]

Though sunless solutions are much safer than getting lots of ultraviolet damage while tanning in the sun, they do not provide any sun protection. Previous research has indicated that ascorbic acid can increase the solubility of sunscreen agents such as $TiO_2$ into the skin, allowing for sun protection for a significantly longer time.[3] The goal is to modify a sunless tanning solution using the synergistic properties of these two components.

## Methods

For the skin model, glass slides were prepared by depositing colorless, flavorless gelatin in a thin, uniform fashion in consistent amounts. Aliquots containing constant concentrations (0.1352 M) of each $TiO_2$, ascorbic acid (Vitamin C), and one with both compounds in a 1:1 ratio were created. 30 uL of each of these aliquots were combined with 270 uL of the preexisting sunless tanning solution (TAN), Norvell COSMO solution. Absorbance measurements were taken using a Shimadzu UV -3600 Ultraviolet-Visible Spectrophotometer. , 30 uL of TAN, TAN/$TiO_2$, TAN/Vitamin C, and TAN/$TiO_2$/Vitamin C solutions were deposited onto gel-coated slides. Each slide was dried in a oven at body temperature (37.5°C) for 25 minutes.

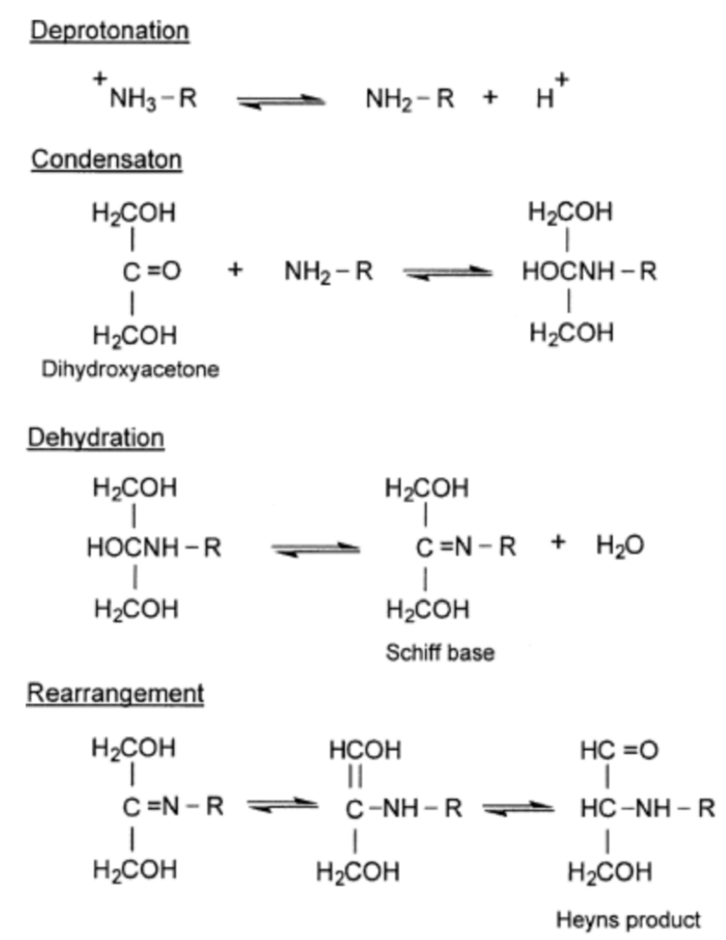


Figure 1. Mechanism of DHA with amino groups leading to pigment molecules.

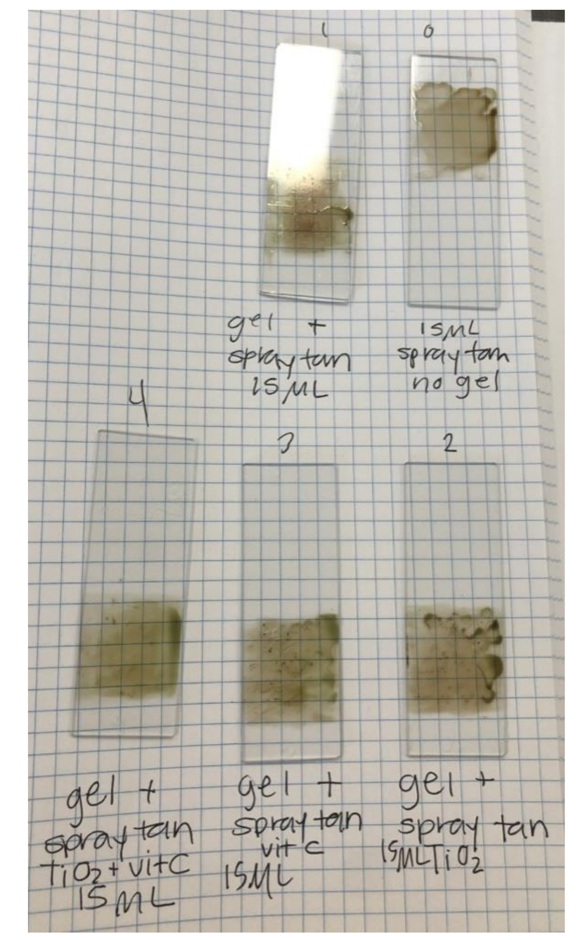

Figure 2. A set up of glass slides used for absorbance measurements.

## Results

The absorbance of diluted aqueous solutions of sunless tanning solution (TAN), Vitamin C, and $TiO_2$ are shown in Figure 3. The TAN solution has several peaks and a broad absorption in the visible range. $TiO_2$ shows as good at due to the broad range of wavelengths shown in the spectra and could add some protection against damaging rays. The absorbance measurements of glass slides with and without self-tanning solution are shown in Figure 4. The gel/glass slide with TAN showed matching absorbance peaks at around 410 and 636 nm to the TAN on only glass slide but it shows a new broad band around 485nm. No increase in absorbance was seen at around 380 nm where Maillard products absorb. To compare signal, spectra were normalized at the 636 nm peak. TAN solutions were prepared with added $TiO_2$ and Vitamin C and deposited on gelatin covered glass slides. The initial absorbance for slides with mixed solutions are shown in Figure 5 and were also monitored over time. For these slides, there are changes corresponding to the generation of Maillard products at around 485 nm. The slides with solutions containing TAN mixed with $TiO_2$ had an increase in absorbance seen at 400 nm. To compare signal, spectra were normalized at the 636 nm peak.

## Conclusion

In order to produce long lasting sun protection, ascorbic acid and titanium dioxide solutions are added to a sunless tanning liquid. A model using gelatin as a source of protein material for the tanning solution seems to react and produce a browning in the film as indicated in an increase in absorbance in the films at around 485 nm. More experiments are necessary to conclude sun protective properties for the modified solution.


## Acknowledgements

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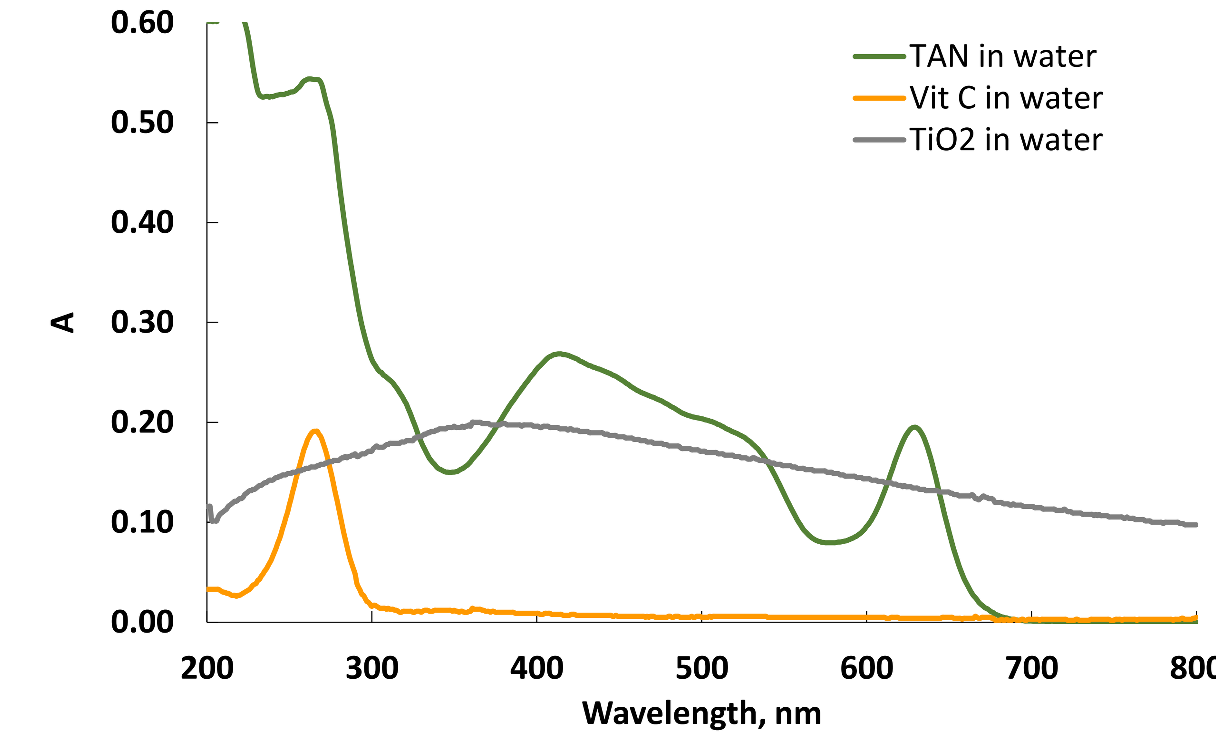


Figure 3. Absorbance measurements of diluted aqueous solutions of TAN, Vitamin C and $TiO_2$.

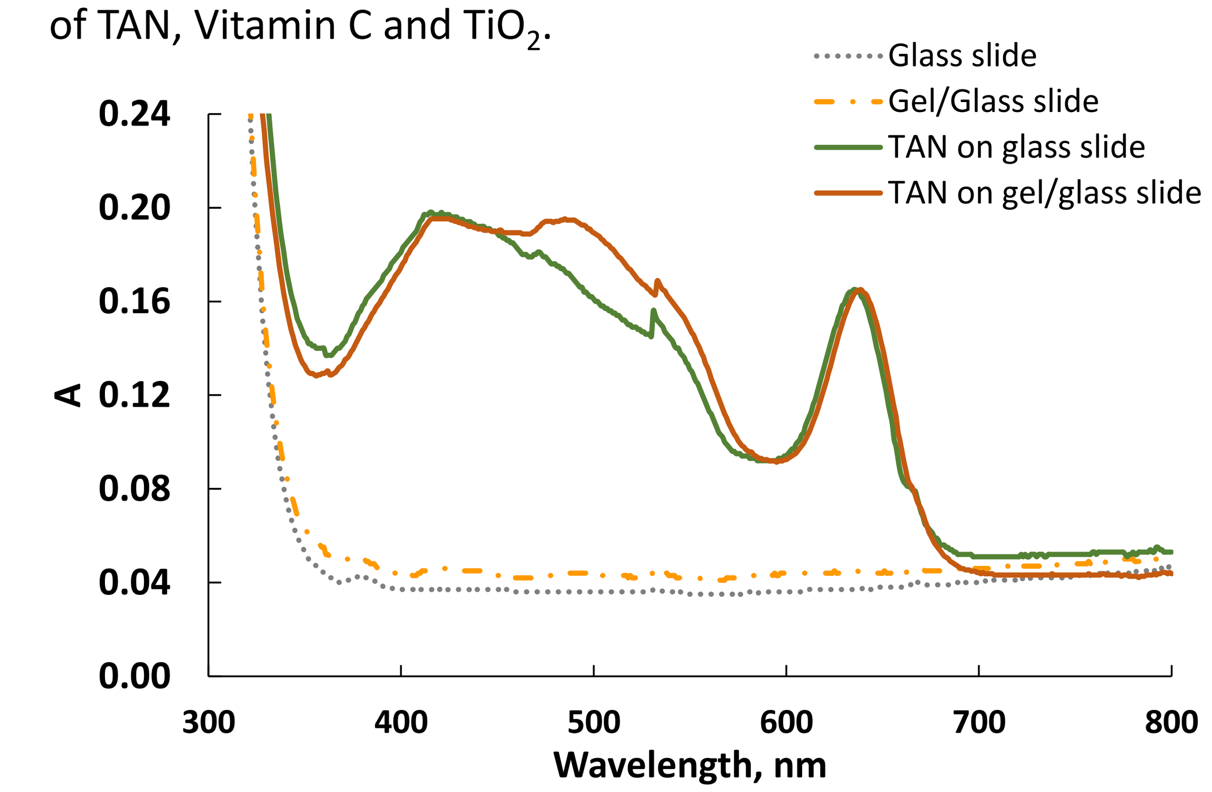


Figure 4. Absorbance measurements of glass slides with and without sunless tanning solution (TAN). Absorbance was normalized at 636 nm peak.

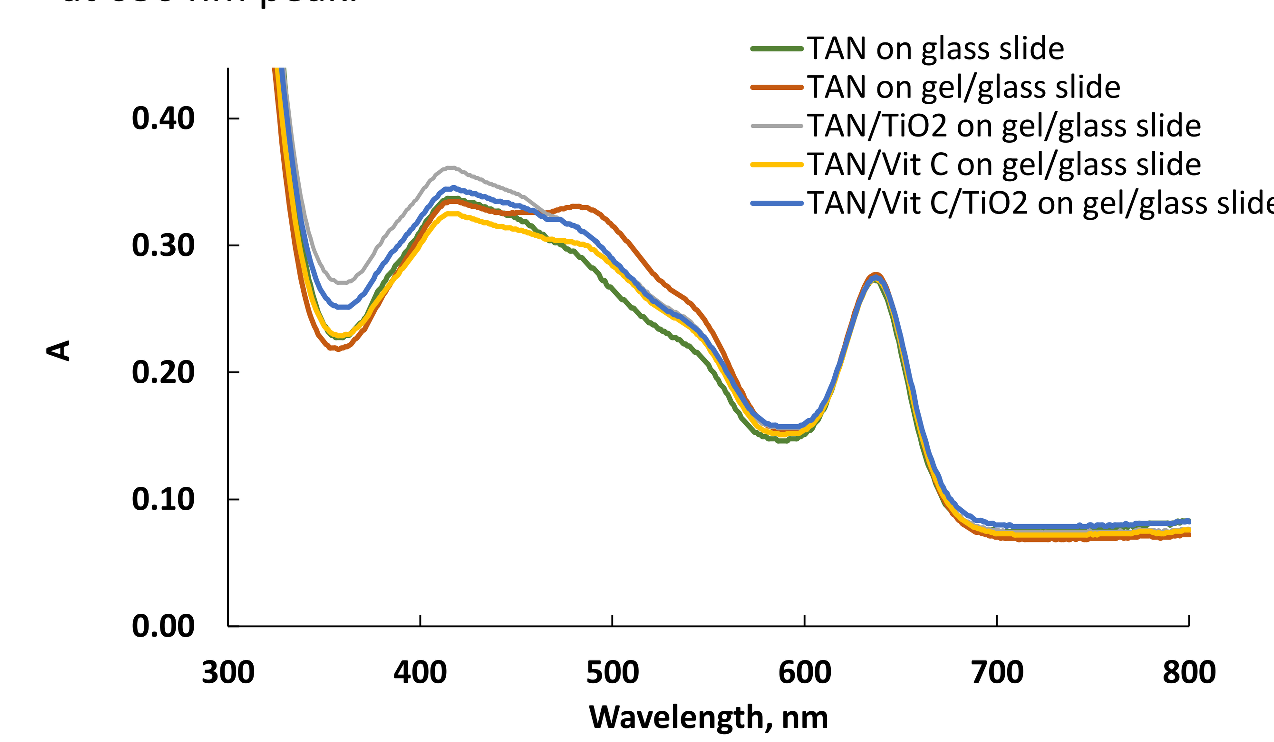


Figure 5. Absorbance measurements of glass slides with added Vitamin C and $TiO_2$ to TAN solutions as prepared accordingly to Figure 2. Absorbance was normalized at 636 nm peak.


## References

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