Development of a Broad-spectrum Sunprotective Formulation for Indian Skin using Natural Ingredients

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During a search for my research area, sunscreen formulations caught my fancy, both as a user and as a pharmaceutical scientist. I noticed that many of the Indian cosmetic brandsare selling sunscreens with a variety of label claims which were technical and new to the Indian consumer, for e.g. SPF,UVA+, waterproof,broad –spectrum, etc. I studied and realized the significance of these terms and the importance of sun protection. When the ultraviolet rays of the sun fall on skin, they cause skin drying, tanning, and photoaging and on over-exposure even photocarcinogenesis (skin cancer).This compels one to use sunscreen products. The efficacy of sunscreen is gauged by Sun Protection Factor (SPF). SPF is calculated as the dose of UV radiation required to produce 1 minimal erythema dose (MED) on sunscreen-protected skin divided by the dose of UV radiation required to produce 1 MED on unprotected skin. Another criterion which is well adopted on the labels of sunscreens is PA system which is based on the persistent pigment darkening (PPD) reaction with UV-A rays of the sun. Accordingly, the sunscreen product is labelled as PA+, PA++, PA+++ or PA++++.

Then, I came across a very interesting research paper published in the Archives of Dermatology (1988) authored by T. Fitzpatricktitled, "The validity and practicality of sun-reactive skin types I through VI". This paper classifies skin into six categories depending upon their reaction on exposure to ultraviolet rays. Indians have either skin type IV (burns minimally and tans moderately) or V

* Ms. Kumud Madan, Ph.D. Scholar from Department of Pharmaceutical Sciences, Rohtak, is pursuing her research on "Development and Evaluation of a Broad Spectrum Sunprotective Topical formulation using Novel Delivery System of Safranal." Her popular science story entitled "Development of a Broadspectrum Sunprotective formulation for Indian Skin using Natural Ingredients" has been selected for AWSAR Award. The dream to prefix Dr in front of my name invoked a desire to doa Ph.D. I completed all formalities to get admission in the Department of Pharmaceutical Sciences, M. D. University, Rohtak, in August 2013.

(burns rarely but tans profusely). Besides, the Indian skin isblessed with melanin which itself has an SPF 4. It does not need sunscreens with very high SPF while the market is flooded with high SPF sunscreen products.

The more I was reading about sun protection, the more I got interested in this field. Observing my quest, Prof. Sanju Nanda, my research supervisor gave me a stimulus to define my aim and objective of research study. We decided to make a broad spectrum sunscreen formula which meets the need of the Indian skin which is devoid of any adverse effects of chemical sun screen agents.

We chose indigenous drug "*Safranal*" for development of broad spectrum sun protective formulation. Though the drug was a bit expensive but obviously less costly than the healthy skin. *Safranal* is a volatile compound present in Saffron "*Kesar*" which is responsible for its beautiful aroma and this treasure is grown in the state of Kashmir.

In the same year, we presented a poster in 65th IPC in December 2013on topic, "Growing Use of Sunscreen in India: Dearth of Quality and Regulatory Controls." Our poster won recognition from many intellectuals.

Further, I carried out a survey to make people aware of sunscreen using a questionnaire in the Delhi metro train. I was surprised to see the lack of consumer awareness regarding the use and knowledge about sunscreens.

In the initial phase of laboratory work, I started with an established porous delivery system, Microsponges. These are porous delivery systems that can imbibe or entrap a wide variety of substances. Working with a liquid drug, *safranal* and designing its novel delivery system was a challenging task. I made many trials batches by changing polymers and process parameters but could not obtain the desired results. The delivery system which boasted of encapsulating liquid drug actually did not work well in this case. I had to start afresh by going back to more literature survey. We decided to take up a lipidic based drug delivery approach this time.

Meanwhile, I presented a poster in the National Seminar organized by P.D. M. College of Pharmacy, Bahadurgarh, and Haryana on 7 April, 2015. The topic of my poster was, "Innovative technologies available in sunscreen: Decide one for yourself," and I got the Best Poster award. Such an event boosts the morale of a researcher and motivates further research.

Among the lipidic delivery system, I found Solid Lipid Nanoparticles (SLNs) as the most suitable one because of their light scattering properties. Using design expert software, I applied central composite design and made formulations to select the best. The experimental results came out to be positive this time. Taking the best as lead, other characterization techniques such as particle size analysis, electron microscopy, etc., were performed.

Then I tried natural colourant to make my final sunscreen without ill-effect of skin whitening. I used a herbal drug as colourant which also had additional properties of anti-aging and which is indigenous to my country. I coloured zinc oxide; a physical sunscreen agent with an extract of same and got a perfect shade of skin. The Indian land is full of vegetable resources which have been used since ages due to their established ethno pharmacological applications, but they are not patented, they are not a part of compositions or products used in modern society. So, the very idea of exploring our own natural resources was exhilarating.

Going through the literature of antioxidants, I came across a marine product with anti-aging properties. It is really a God gift that even shells of marine animals serve as useful products. I explored one such agent and incorporated into my sunscreen.

With an aim to use natural ingredients to boost sun screening activity, I also extracted oil from hen egg. It offered tremendous advantages and I used it in my formulation as well. I got the third prize in a poster presentation on the topic, "Exploring egg oil as a natural sunprotective agent: An initial study," in the National Conference in M.D. University on March 19,2015. While conducting my research, time flew by and the start of year 2017 was great. I got a review paper published titled, "Hen egg yolk oil: A potential source of bioavailable lutein and zeaxanthin for skin and sun protection," published in World Journal of Pharmaceutical Sciences; 5(1), Pg71-80, 2017.

I also tried anti- enzymatic activities of my drug to prove its antiphotoaging activity. For this, biochemical investigation was done. The establishment of the same with good results led to a research paper titled, "In-vitro evaluation of antioxidant, anti-elastase, anti-collagenase, anti-hyaluronidase activities of safranal and determination of its sun protection factor in skin photoaging," in Journal Bioorganic Chemistry volume 77 in 2018.

Citations of my article increased day by day and this brought a smile to my face. I started getting invites for various conferences and also got recognition. This secondary impact of my research brought positivity to my life as well. Meanwhile, I also got a review paper publishedtitled, "Nanotechnology Driven Cosmetic Products: Commercial and Regulatory Milestones," in Applied Clinical Research, Clinical Trials & Regulatory Affairs, 2018, 5, 112-121.

The positive results motivated me towards my goals. **Finally, I came up with a purely natural sunscreen with broad spectrum activity**. It was free from any chemical agents and also met the international standards of sunscreen. My product had a result of Boots Star Rating of ***. Boot star rating is a proprietary *in vitro* method used to describe the ratio of UVA to UVB protection offered by sunscreen with 1 as lowest value and 5 as highest. :My product also gave the value of PA++ which means the protection Grade of UVA between four and eight.

The formula of my sunscreen is purely novel and not been used or mentioned in literature. So, a thought of patenting came to our mind. Apatent to your name gives you a strong feeling of being an inventor. Currently, I am in the process of getting permission to get my formula patented. I am writing my thesis and shall be submitting it in a couple of months.

Research is the foundation of development of society. But it takes constant effort and faith in one's work to achieve success. Through this scientific deed, I would like to convey to society that the right quality, right quantity of sunscreen should be part of one's pouch if one has to remain longer in the sun. I am proud to contribute something novel and natural for the Indian skin which is made up of our own resources. I am grateful to almighty, my guide Prof. Sanju Nanda and my Department of Pharmaceutical Sciences, M.D. University, Rohtak, for providing support. I am also thankful to UGC for offering the BSR fellowship and my family members for their support.