The Natural Moisturising Factor: A Key Component of Skin Barrier Function

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Abstract

Life on earth in a dry atmosphere requires the presence of a barrier against water loss to prevent desiccation. Our skin represents the largest organ of the human body and provides this barrier that is essential for terrestrial life. The uppermost layer of the skin is the epidermis, mainly constituted by keratinocyte cells. It is a highly organised multilayered epithelium. In the basal layer, keratinocytes proliferate and undergo a tightly controlled differentiation programme upon movement into the suprabasal layers. Finally, when these cells reach the outermost layer of the epidermis, they are subjected to a real programmed cell death, resulting in the formation of corneocytes. These anucleated and flattened cells, filled with keratin, form the most superficial layer of the epidermis, the *stratum corneum*, also known as the horny layer. The *stratum corneum* enables the epidermis to fulfil one of its main functions: the barrier function. More than a water barrier, it also helps to protect against UV radiation, pathogens and mechanical stress.

Abnormalities in *stratum corneum* moisturisation induce dry skin, which can lead to uncomfortable skin irritation. To ensure an efficient barrier function, the skin has to be properly moisturised. Thus, the skin has its own natural hydration, controlled by the natural moisturising factor or 'NMF', a complex mixture of small hygroscopic molecules.

Introduction

Keratinocytes correspond to the predominant cell type in the epidermis. Epidermal stem cells residing in the basal layer of the epidermis are able to proliferate and, thus, are responsible for epidermal renewal. The newly formed cells gradually move towards the surface of the skin and finally undergo the late stages of terminal differentiation. This tightly controlled programme leads to the formation of dead *stratum corneum* cells called corneocytes. These dead cells lack a plasma membrane and instead are encased in a structure known as the cornified envelope (CE). The CE is highly resistant and consists of insoluble, cross-linked proteins and lipids. Both lipids and the CE of the *stratum corneum* are responsible for the mechanical integrity and water impermeability of the epidermis. They regulate the water loss from the body and limit the transepidermal water loss or 'TEWL' (Figure 1 see page 2). The most superficial corneocytes of the *stratum corneum* are permanently eliminated by the phenomenon of desquamation or exfoliation. Indeed, the corneocytes are held together by corneodesmosomes and the breakdown of these adhesive structures by various proteases allows desquamation.

The *stratum corneum* has to be properly moisturised to ensure a correct barrier function, a normal desquamation and to keep flexible. For that, the epidermis produces its own natural moisturising factor or 'NMF'[1].

The Natural Moisturising Factor or NMF

The NMF plays an important role in maintaining the physical properties of the *stratum corneum*. The NMF is found within the corneocytes and represents up to 20%-30% of the dry weight of the *stratum corneum*.

The NMF helps the *stratum corneum* to remain moisturised and facilitates critical biochemical events such as the regulation of several proteases essential for desquamation. Indeed, normal water content of the skin is about 20%, whilst dry skin can contain less that 10% water content. The NMF consists of several small molecules. Some of them have hygroscopic properties, explaining the water-binding capacity of NMF (Table 1 see page 3)[2]. Furthermore, NMF contains trans-urocanic acid synthetised from histidine. Upon exposure to UV radiation, trans-urocanic acid undergoes an isomerisation reaction, converting it to cis-urocanic acid, known as immunosuppressive factor[3].

In the 1990s, Rawlings et al. were using the tape-stripping procedure to measure the NMF components[2,4]. More recently,