Use of enzymes in cosmetics: proposed enzymatic peel procedure

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ABSTRACT

Exfoliation is a procedure that helps in skin cell renewal, as it consists of removing non-vital cells from the skin's surface. In addition to eliminating impurities and facilitating the penetration of cosmetically active ingredients, removing this layer restores the skin to its natural appearance, improving its texture and uniformity, and resulting in an improved skin appearance. Such cosmetic products are also referred to as enzymocosmetics. The main plant proteolytic enzymes used in skin exfoliation are papain from papaya, bromelain from pineapple and ficain from fig tree. This review aims to present the most common enzymes used in cosmetic products and to present an enzymatic peel procedure.

Keywords: cosmetic procedure, enzymatic peel, enzymes, exfoliation, peels

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INTRODUCTION

The cosmetic industry constantly attempts to develop **innovations and alternatives** to existing cosmetic products. A strong trend has been observed in modern-day cosmetics towards safe cosmetic ingredients of natural origin, particularly to avoid a negative ecological impact on the environment (1). A study performed by the Danish Council THINK Chemicals identified 65 chemicals of concern in 39 products. The chemicals identified included iodopropynyl butylcarbamate, which is an allergenic; butylparaben, resorcinol and ethylhexyl methoxycinnamate, all of which are classified as endocrine disruptors; glyoxal, which is mutagenic; and zinc pyrithione, a CRM Category 1B substance, which is a presumed human carcinogenic, mutagen, or reproductive toxicant, based on animal studies (2, 3).

As such, consumers are exposed to these chemicals, perhaps daily. An intense investigation into the benefits of what plants and fruits can bring to consumers is therefore required, since it is clear that dermal treatment with active cosmetics can help improve skin rejuvenation (4). This article presents the most common **plant enzymes** used in cosmetic products and presents an enzymatic peel procedure.

EPIDERMIS AND DERMIS

The **skin** covers an area of about 2 m^2 and accounts for around 15% of the body's weight, meaning it weighs between three to four kilos and is thus the largest and heaviest organ in the human body (5). The skin covers the entire human organism and is essential for life. It has a variable appearance, functions and structure, depending on the body region. The skin is a multifunctional organ that performs vital functions, such as providing an external coating, thermoregulation, a healthy microbiological environment and defence against external aggressions (cold, heat, pressure, pain, etc.). It is divided into three layers: the epidermis, dermis and subcutaneous tissue (6).

The **epidermis** is the most superficial layer of the skin and is in direct contact with the external environment. It is stratified and avascularised epithelial tissue and forms the first line of defence against external factors. It subdivides itself into five layers: the stratum corneum, stratum lucidum, stratum granolosum, stratum spinosum and stratum basale. The **stratum corneum** has dead keratin cells that reduce the skin's permeability, preventing water loss. Keratinised cells help retain water and form a protective layer that protects against biological, physical and chemical agents (7). The epidermis also protects against ultraviolet rays. Sunlight initially triggers the production of melanin in the stratum basale. Melanin acts as a natural sunscreen for the skin and protects against harmful ultraviolet rays, which is why people get tan when exposed to the sun. However, excessive exposure to the sun can disrupt this process, leading to hyperpigmentation.

The **dermis** is a thick, elastic but firm intermediate layer located below the epidermis. It subdivides itself into two layers: the reticular layer and the papillary layer (8). It is composed of connective tissue (mainly fibroblast cells and collagen and elastin fibres) and blood vessels, lymphatics vessels and nerves (7). It plays an essential role in protecting the body against external and irritating influences, but it also nourishes the upper layers of the skin from the inside. Its thick, firm texture helps to alleviate external pressures and, when damage occurs, it contains connecting tissues, such as fibroblasts and mast cells that heal wounds.

The **subcutaneous tissue**, which envelops the overall musculature except for cutaneous muscles, provides for the passage of cutaneous nerves, blood vessels and lymph vessels, and plays a role in connecting the dermis and fascia of the muscles (9).

EXFOLIATION

Exfoliation is the process of **removing impurities and keratinised cells** from the skin's surface, and thinning and making the stratum corneum uniform, to facilitate the penetration/permeation of cosmetically active ingredients, resulting in healthier-looking skin with an improved aesthetic appearance (10). An exfoliation can have different depths: superficial, which reaches from the stratum corneum to the papillary dermis (60 µm); medium, which reaches from the papillary dermis to the reticular dermis (450 µm); and deep, which reaches from the mid-reticular dermis to 600 µm (11, 12).

Skin exfoliation can be chemical, mechanical or enzymatic (13). **Chemical exfoliation** includes the use of acids in the form of, for example, creams, lotions, gels or solutions. It is a type of aesthetic treatment that is performed by applying products with acidic formulas of pH<5 to remove the damaged or old layers, and to promote the growth of a new, smooth layer. It is a process that accelerates the cell renewal process from the deepest layers of the skin, while the most superficial and older layers are eliminated (11). It acts non-specifically by reducing the cohesion between corneocytes, known as a keratolytic effect (14).

Mechanical exfoliation involves the physical scrubbing of the skin with a mild abrasive, such as micro-fibres, adhesive exfoliation sheets, micro-bead facial scrubs, crushed apricot kernels or almond shells, sugar or salt crystals, or using abrasive sponges, brushes, cloths and crepe paper (10).

Enzymatic peels use proteolytic enzymes (proteases) that break down proteins. Enzymes are macromolecules that accelerate chemical reactions with considerable advantages over chemical catalysts, mainly because of their specific action and ecological qualities. Enzymes for dermal application can be used for cosmetic and therapeutic purposes, and should have a high degree of purity, high specificity, low antigenicity and stability under physiological conditions (15). Enzymes generally have numerous industrial applications, while new applications of these biological catalysts are discovered every day, particularly in the area of cosmetics. The enzymes used most frequently in cosmetics are presented in Table 1.

Table 1: Enzymes used in cosmetic products.

Enzyme	Source	Cosmetic use	References
Protease	Fungi	Antioxidant Facilitates the penetration of active substances Stimulates or inhibits desquamation, skin scaling and dryness Removes death cells Peeling Anti-aging	(16–18)
Superoxide dismutase	Yeast (recombinant)	Anti-aging Neutralises reactive oxygen species (ROS) Antioxidant Increases longevity	(19, 20)
Catalase	Aerobic organisms	Counterbalances ROS	(21)
Lipase	Bacteria	Deep cleansing of the skin Acne Anti-cellulite	(22, 23)
Hyaluronidase	Bacteria	Anti-cellulite Moisturising agent	(23, 24)
Alkaline phosphatase	Yeast and fungi (recombinant)	Increases cellular metabolism Anti-wrinkle	(23, 25)

ENZYMATIC PEEL

Enzymatic peels, also referred to as enzymocosmetics, are cosmetic products with **proteolytic enzymes** that specifically hydrolyse the peptide bonds of proteins in the stratum corneum (14, 26). They promote biological exfoliation, faster skin regeneration, provide deep cleansing and facilitate the penetration of cosmetically active substances (27). The thickness of the stratum corneum is decreased, giving the skin more texture and plasticity. The main plant enzymes used in skin exfoliation are papain from papaya, bromelain from pineapple and ficain from fig trees (10).

Papain is a proteolytic enzyme, endopeptidase, found in a concentration of about 8% in papaya fruits (*Carica papaya*). In dermal use, its main application is in the medical field for the debridement of devitalised tissues, accelerating the healing process of wounds and burns (28). Papain has a molecular weight of 23,406 Da, an isoelectric point of 8.75 and an ideal temperature for enzymatic activity of 65 °C (29). The major amino acids are glycine, valine and tyrosine (30).

Bromelain is a protease derived from the stem and fruit of pineapples (*Ananas comosus*). Stem bromelain is a mixture of different thiol endopeptidases and other components isolated from *Ananas comosus* stem, bark and leaves. Its molecular weight, isoelectric point and ideal temperature for enzymatic activity are 35 kDa, 10 and 37°C, respectively (31–33). In terms of amino acids, the major ones are alanine, glycine and aspartic acid (34). Bromelain has applications in the cosmetic industry, and is used to treat acne, wrinkles and dry skin. It digests the proteins of dead cells in the upper layer of the skin, resulting in their replacement by younger skin cells from the lower layers. It also helps to reduce post-injection bruising and swelling (35, 36).

Ficain, also known as ficin, is derived from the stems of the fig tree (*Ficus carica*) and has an enzymatic activity as an excellent exfoliant. It is also said to have antioxidant benefits (37). Its molecular weight is 24,294 Da and its isoelectric point is 9.0, while the ideal temperature for enzymatic activity is 50 °C (38). A recent study showed that ficin has an antioxidant and whitening effect in skin cells, and that it has the potential to be developed as a new bio-cosmetic material (39).

USE OF ENZYMATIC PEELS

Purpose of use

The use of enzymatic peels is recommended in skin (hyper)pigmentation, acne spots, for oily or rough skin, and in general skincare, regardless of its phototype.

Precautions

Enzymatic peels are generally more comfortable and safer than chemical peels. It is a good alternative for individuals with sensitive skin and high skin phototypes that may react to irritation by generating post-inflammatory hyperchromia, and for people with allergies to glycolic acid, and can be used as a summer peel.

Side effects

Even though side effects from enzymatic peels occur less frequently compared with chemical peels, they can occur and include skin irritation or an allergic reaction.

Limitations

The main limitations are enzyme stabilisation to ensure enzyme activity and technological challenges in producing an active formulation (14, 23).

PROCEDURE

Given that the cells in the stratum corneum are held together by proteins, these can be enzymatically hydrolysed, and the dead cells loosened and superficially removed about 10 to 20 minutes after the application of an enzymatic peel. To achieve this effect, masks are frequently applied, consisting of dry extracts of enzyme-containing vegetable juices (latex) mixed with water. Enzymatic peels are generally considered to have a gentle effect on the skin, which is typically limited to the skin surface when used according to instructions.

Because there is a lack of information regarding the correct application of enzymatic peels, a procedure was designed using a powder formulation (Anubis Cosmetics, SL, Barcelona, Spain) with the following ingredients: rice (*Oryza sativa*) starch, lactose, kaolin, titanium dioxide, 1% papain, silica and sodium methylparaben. The manufacturer indicates that this percentage of papain is effective on the skin without sensitising. According to the manufacturer, the product is suitable for all skin types, including sensitive, atopic or oily.

- A correct facial analysis should be performed first to evaluate possible contraindications (40).
- Liquid facial cleanser is applied by massaging it with the fingers and removing it with a gauze soaked in water.
- Three measures of the enzymatic peel are mixed with two measures of water (the mixture should have a cream-like texture).
- The mixture is applied to the area to be treated using a brush.
- The peel should be left on the skin for a maximum of 15 minutes and then removed with warm water.

CONCLUSION

Proteolytic enzymes, such as bromelain, papain or ficain, have been used in personal care products for skin peels and smoothing for many years. However, the general problem associated with such use is the irritation of the skin due to their proteolytic activities. Nevertheless, their activity is still milder than in chemical exfoliation. The use of enzymes in cosmetics has not yet been thoroughly investigated. Technical difficulties in analysing enzyme activities on human skin and the inherent instability of enzymes, which makes them hard to formulate and stabilise in finished cosmetics, may be why there is a lack of studies in this area.

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