

PLANT STEM CELLS IN COSMETICS

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Stem cells have, undoubtedly, been a trendy topic in the recent years. The media keep serving new reports about innovative treatment methods applying these cells, their application in esthetic medicine and even in cosmetics. In shops we can find quite an extensive assortment of creams, masks, rejuvenating serums which – as the manufacturers assure us – owe their unique properties to these cells. What is the reason why stem cells are such an attractive research topic? What are their properties? And, most importantly, what differentiates them from other cells of our organism?

The majority of body cells specialize in fulfilling particular functions within the tissue they are a part of. This means that, for example, the cells of a muscle are not able to transform into skin cells and fulfil the same functions. Unlike other cells, stem cells are not specialized and they are the most primary cells. They have two features:

- potentially unlimited ability for division (self-renewal),
- differentiating into other types of cells.

In practice, this means that the task of stem cells is not to fulfil specialized functions, but to increase their pool, and after receiving the appropriate signal they are able to differentiate and to fulfill specific tasks. Because of their ability to differentiate, they are divided into:

- totipotent stem cells – they may transform into any cell of the organism and of the extra-embryonic structures, such as the placenta,
- multipotent stem cells – they may give origin to several different types of cells of similar properties and embryonic origin,
- unipotent stem cells – they may differentiate into only one type of cells (e.g. keratinocytes in the epidermis)¹,
- pluripotent stem cells – they may transform in every type of cells with the exception of extra-embryonic structure cells.

An organ which shows very good regenerative properties is the epidermis made of epithelial tissue. It is composed of several layers of cells containing keratinocytes at various stages of differentiation. They come from the stem cells of the epidermis which are located at its base, where they are present in the form of a single layer of cells (the base layer). As they differentiate, keratinocytes move towards upper layers of the epidermis until they reach the most external layer (stratum corneum), where they die and become exfoliated. Stem cells are also present in the dermis which is located deeper. It is made of connective tissue containing fibroblasts which produce collagen, i.e. a tensile resistant protein responsible for skin elasticity.

The dynamic renewal of the epidermis ensures the healthy look of the skin, protection against external factors and the proper course of wound healing. With age, regeneration mechanisms become less effective and cells slowly lose their abilities of quick self-renewal. The result of this are aging processes which are additionally affected by external factors such as excessive exposure to UV radiation, environmental pollution, or stress². In order to slow them down, science looks for ways of strengthening and protecting the stem cells of the skin.

The invaluable wealth of nature comes to the rescue! Scientists discovered that plants have their own stem cells present in apical meristems of the plant stem and lateral meristems of the root, i.e. these elements of the plant which undergo intense division and functional differentiation. Unlike human and animal cells, they demonstrate pluripotential properties throughout their whole life, which means that they can give origin to any plant tissue³.

Does this mean that cosmetic products which offer stem cells in their content actually include living cells? The answer is: no. It has to be underlined that in vitro cell cultures require special diligence in maintaining appropriate conditions such as temperature, pH, the composition of the growth medium, as well as sterility. Otherwise, the cells simply die. It is, therefore, impossible for creams to contain living stem cells. Moreover, due to species incompatibility, they have no possibility to regenerate human epidermal tissue⁴. We thus come to the question: what stands behind the pompous name “plant stem cells”? The answer is simple: actually cosmetics contain extracts of cells and to them they owe the beneficial effect on the skin, thanks to the content of valuable metabolic products: proteins, lipids, carbohydrates and polyphenols which have an antioxidant effect, as well as plant hormones. All these natural chemicals improve the processes which take place in the skin and induce the “anti-aging” effect, i.e. delaying the skin aging processes. These substances stimulate the human stem cells of the epidermis and of the dermis to divide, they improve their vitality and condition, and support the production of collagen in the dermis. Moreover, they regulate the activity of genes and the functions of epidermal cells. This is visible in the increase of skin elasticity, its improved tone, the smoothing and shallowing of wrinkles^{3,5}.

The plants from which stem cells are obtained are not chosen randomly. They demonstrate resistance to difficult environmental conditions, they frequently grow in extreme locations or demonstrate increased resistance to storage time. Such plants have developed the ability to synthesize valuable substances for defense purposes, which allow them to survive in unfavorable conditions. A good example is the argan tree which grows only in the south-western part of Morocco and is a rare and very resistant species. It is able to stand extreme droughts and very high temperatures (even above 50°C!). During long-term water deficiency this plant dries out and may remain in such a state of rest for several years, and when humidity increases, it immediately returns to life. The argan tree is best known for the valuable oil obtained from the seeds of its fruit.

Other examples of plants from which stem cell extracts are obtained include: *Echinacea angustifolia*, *Eryngium maritimum*, gardenia, *Leontopodium nivale*, grape, malus (apple tree), *Centella asiatica*, tomato.

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From a Plant to a Valuable Extract

The first stage in the process of obtaining an extract from stem cells is the selection of the appropriate plant material and propagating the plant using the micropropagation method. The next, very important step is sterilizing the tissue in order to get rid of microorganisms which can infect the cell culture. The material prepared this way is processed mechanically, which causes its fragmentation. As a result of fragmentation, specialized cells which build plant tissues undergo dedifferentiation, entering into a state of pluripotency and thus gaining the nature of stem cells. A cell culture is set up using them, with delivering to it all the necessary nutrients. The next step is the selection and choosing the cell line of the most desired biochemical and metabolic characteristics. The last stage is the optimization of the process for production at an industrial scale by adjusting the cells to growth in liquid. This results in a significant increase of biomass. In the beginning, cell cultures are suspended in glass vessels of small volume (a conical flask) and after some time they are transferred to bioreactors (a volume of up to 100 l), in which the cultivation of stem cells takes place on an industrial scale. In the end, the biomass is subjected to the effect of high pressure and enzymatic digestion in order to damage the cell wall of the cultured cells. This way, a suspension is obtained which contains cytoplasm, cellular organelles and cell debris with torn walls. The whole of it is extracted and the homogenates are closed in liposomes and in this form they are placed in cosmetics. Such a form facilitates the penetration of valuable ingredients through the skin.

How Did it All Start?

The first extracts from plant stem cells were introduced into the cosmetic industry in 2008 (PhytoCellTec Malus Domestica technology). For this purpose, a cultivar of Swiss malus (apple tree) named Utt wiler Spätlauber (Malus Domestica) was used. Why was this apple tree chosen? Its fruit may be stored in warehouses for a long time without drying out or becoming rotten. These unique properties intrigued scientists. A range of studies were carried out, which confirmed the suspicions about the beneficial effect of the extracts from the cells of this plant on skin. The company Mibelle Biochemistry conducted a clinical trial on a group of 20 women aged 37-64. For four subsequent weeks these women were requested to rub the cream containing the extract from the swiss apple tree cells. The depth of wrinkles was measured using an optical device which provided 3D imaging of the skin surface. After the lapse of the analyzed time it was demonstrated that wrinkles shallowed by 15% in reference to the control group. In vitro studies carried out on cell cultures of the skin also confirmed the vitalizing effect of that extract^{3,7}.

Debunking Myths

The term “stem cells” frequently generated negative feelings and associations in the recipient. A lot of different myths have been created in relation to this topic. These myths are very frequently the result of the informational chaos present on the Internet. It is, therefore, worth to have a look at this issue and to dispel the doubts which may emerge.

1. In Poland the law prohibits using human cells and tissues in the production of cosmetics, as determined by the Act on Cosmetics of 30 March 2001.
2. There are no literature reports stating that stem cells from the umbilical cord blood are used in cosmetic products. There is, therefore, no question of procedures that raise ethical doubt.
3. Cosmetics containing “stem cells” actually contain only their extracts, and not living cells, therefore they do not change the proper functioning of human cells. The action of compounds contained in these extracts is based on supporting natural processes of division and renewal of the cells of our organism.
4. Even if stem cells survived in a cosmetic, due to species incompatibility, it is not possible for them to become part of the human tissue.

Conclusion

The extracts from plant stem cells are the source of valuable active substances which do not induce immunological response, so they are completely safe. Obtaining them is environmentally friendly and possible even from hardly accessible or endangered cultivars, without interfering into and disrupting their natural ecosystem.

Research proves that they result in many beneficial effects such as:

- the increase of skin density and firmness,
- shallowing wrinkles,
- smoothing of the epidermis,
- stimulating the skin to renewal,
- increase of the production of collagen and elastin fibers,
- protection of epidermal stem cells,
- strengthening of hair follicles.

There are also voices indicating that preparations based on stem cells cannot be effective due to the low penetration of the skin layers. It should be remembered that the process of epidermis renewal is influenced by many factors, including age. The older the organism, the more difficult it will be to observe a spectacular change of the condition of its skin. We should not expect cosmetics to do miracles. Time cannot be cheated, therefore aging cannot be reversed completely. It is, however, possible to support natural processes of renewal. Cosmetic products based on plant stem cells are a relatively new solution, therefore research is constantly being carried out in this area^{3,7}.

Stem cells, both the plant ones and the animal ones (including human ones), carry a lot of hope for medicine and cosmetology. Will they cure us from many diseases which, until now, have remained incurable? Are they the key to maintaining the desired long-term youth? The answers to these questions will certainly be soon delivered to us by scientists.

Polish Contribution to Studies on Stem Cells

Polish scientists have been first in the world to discover the presence of stem cells in... deer antlers. The antlers are the only organ present in mammals which undergoes complete regeneration, i.e. self-renewal. The pace of its growth may even be up to 2 cm per day! These properties raise high interest of researchers all around the world, but Wrocław was the place where it was possible to, for the first time, derive a stable line of stem cells of the antlers, named MIC-1. Experiments carried out on rabbits referring to, among others, the influence of the discovered cells on the healing process of post-operative damages of the mandible bone demonstrated that they induce bone tissue to regeneration. The effect of another experiment, consisting in the intradermal administration of the stem cells of the antlers, was the increase of the number of hair follicles and accelerated growth of hair. Both experiments on rabbits demonstrated that the stem cells of the antlers do not allergize, they are not rejected and immunogenic, and their action consists in stimulating other cells to division and to the production of their own proteins, which leads to the reconstruction of destroyed tissues. The resulting conclusions give great hope of the broad application of the stem cells of the antlers in regenerative medicine and in cosmetology. In 2012, the first cosmetic products of an anti-aging nature, based on extracts from deer antlers stem cells, were introduced to the market^{8,9}.

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The article has been reviewed by dr hab. Magdalena Rost-Roszkowska from the Department of Animal Histology and Embryology of the University of Silesia.

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Publication implemented within the scope of the National Scientific Leadership Center KNOW



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