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Use of natural pigments obtained from cyanobacteria and algae

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Abstract. The article reflects data on the use of cyanobacteria pigments in cosmetology. One of the sources of natural antioxidants are the pigments obtained from various algae and cyanobacteria. An essential source for extracting pigments and biologically active substances used in cosmetology, pharmaceuticals, etc. is represented by algae and cyanobacteria. Also, the extracts from cyanobacteria have an important role in the anti-wrinkle effect. Useful pigments include: carotenoids, xanthophylls, astaxanthin, fucoxanthin, chlorophyll, phycoerythrin.
Keywords: carotenoids, xanthophylls, astaxanthin, fucoxanthin, chlorophyll, phycoerythrin, cosmetology.

Utilizarea pigmenților naturali obținuți din cianobacterii și alge

Rezumat. Articolul reflectă date despre utilizarea pigmenților de cianobacteri în cosmetologie. Una dintre sursele de antioxidanți naturali sunt pigmenții obținuți din diverse alge și cianobacterii. O sursa esentiala pentru extragerea pigmentilor si substantele biologic active folosite in cosmetologie, farmaceutice, etc reprezinta algele si cianobacteriile. De asemenea, extractele din cianobacterii au un rol important in efectul antirid. Pigmenții utili includ: carotenoizii, xantofilele, astaxantina, fucoxantina, clorofila, ficoeritrina.
Cuvinte cheie: carotinoizi, xantofile, astaxantina, fucoxantina, clorofila, ficoeritrina, cosmetologie.

1. Introduction

Nowadays, consumers' desire for organic cosmetics has increased substantially, as synthetic products cause multiple adverse effects and possess a much lower absorption rate due to large molecules. Thus, algae and cyanobacteria such as Spirulina platensis have gained particular importance in the cosmetic industry. They have beneficial effects on the dermis, being a source of biologically active substances [1].

Carotenoid production by *Spirulina platensis* has often been experimentally stimulated under different stress conditions such as high salinity and nitrogen deficiency. Exposure of *S. platensis*. Carotenoid and B-carotene content has been shown to increase at high levels of saline and nitrogen deficiency. The increase in carotene content in cyanobacterial cells can be attributed to the excessive formation of free radicals under stress conditions, produced to protect the cells and to continue their growth [2].

From the multitude of substances extracted from cyanobacteria, Carotenoids are listed, which are yellow or orange pigments whose chain ends with ionic rings, being biosynthesized in increased quantities by a large part of photosynthesizing cyanobacteria [3].

Chemically, carotenoids are non-oxygenated organic compounds such as α-carotene, β-carotene and lycopene, or oxygenated hydrocarbons such as lutein and astaxanthin. Due to the keto or hydroxyl terminations at the ionone ring, carotenoids possess antioxidant properties [4].

This type of pigments are fat-soluble, which provide protection to the skin against UV rays, at the same time they inhibit the synthesis of melanin, being strong antioxidants. Marine microalgae also contain about 0.2% carotenoids. In cosmetology, β-carotene is the main ingredient of balms, shampoos, aftershave lotions, which are of biotechnological interest in extracting this compound [9].

2. Obtained results and discussion

The main sources of carotenoids are, in addition to cyanobacteria, microalgae from the Chlorophytaceae family. Species of the genus Dunaliella, for example, have a high content of β-carotene, and *Hematococcus pluvialis* contains a high level of xanthophylls (astaxanthin).

A promising biotechnological source are xanthophyte microalgae, which synthesize (violaxanthin, antheraxanthin, zeaxanthin, neoxanthin and lutein) and can also produce other biologically active substances, such as astaxanthin (figure 1), loroxanthin and caraxanthin. For example, brown algae and diatoms produce fucoxanthin, diatoxanthin [2].

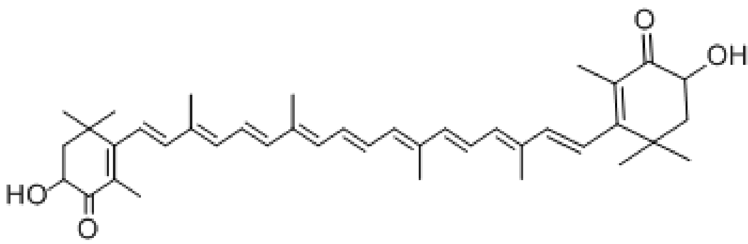

Figure 1. Structural formula of the astaxanthin compound

Astaxanthin (Figure 1) is a red carotenoid pigment that possesses both ketone and hydroxyl groups, it shows more intense antioxidant properties than vitamin E and β-carotene [3]. As an antioxidant it scavenges free radicals and protects the lipid bilayer from peroxidation and inhibits H_2O_2- mediated activation of the NF-jB transcription factor.

Astaxanthin extracted from Hematococcus pluvialis shows effective protection against UV rays, also shows some improvement against wrinkles as well as improves skin texture, blocks the production of pro-inflammatory cytokines. It is known that this pigment also possesses skin depigmentation properties, it inhibits melanin synthesis by 40% [9]. Based on biotechnological progress, Fujifilm Corporation has created a product based on the astaxanthin pigment ”Astalift Whitening Essence”, this product is effective in combating skin spots that appear during aging. Kose is another company that has marketed astaxanthin that fights both wrinkles and blemishes on the skin. The Swedish company AstaReal AB has marketed astaxanthin in the AstaReal cream, which helps to revitalize the skin, removes wrinkles and also gives skin elasticity. In 1996 Arad and Yaron developed eye shadow, lipstick in the form of powders or creams obtained from some emulsions of red microalgae [3].

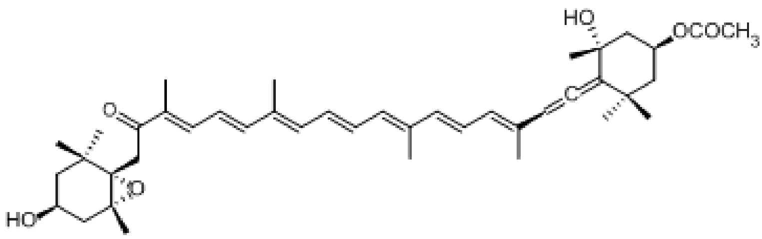

Figure 2. Structural formula of the compound fucoxanthin

Fucoxanthin (Figure 2) is a pigment that contains the hydroxyl group in the ionic ring, it is brown or olive-green in color. It contributes to the photosynthesis process in brown algae such as Sargassum saliquastrum by absorbing red light[4], acquired from them which exhibits antioxidant properties against cell damage induced by hydrogen peroxide.

It has been observed that fucoxanthin obtained from Laminaria japonica inhibits the activity of tyrosinase and melanogenesis, which is a method of skin whitening, because it limits the speed of pigmentation [3,15]. Likewise, this pigment hydrates the skin and maintains the functionality of the skin cells, the softness of skin, anti-wrinkle effect, as well as anti-inflammatory effect [6]. The main bioactivities of fucoxanthin are: antimalarial, antitumor, anti-obesity, anti-inflammatory and antidiabetic [15, 16]. From a pharmaceutical point of view, this pigment has protective effects on the brain, liver, blood vessels, bones and eyes; in creams it has revitalizing effects on the dermis [6]. The companies Unilever, L'Oreal, Henkel and Beiersdorf will improve the growth of the carotenoid market value in the European market due to the properties they possess [14].

Laminaria digitata Isochrysis spp., *Postelsiapa maeformis* and species of the genus Nostoc are algae species widely used in cosmetology due to the pigments: a-chlorophyll and b-chlorophyll [4].

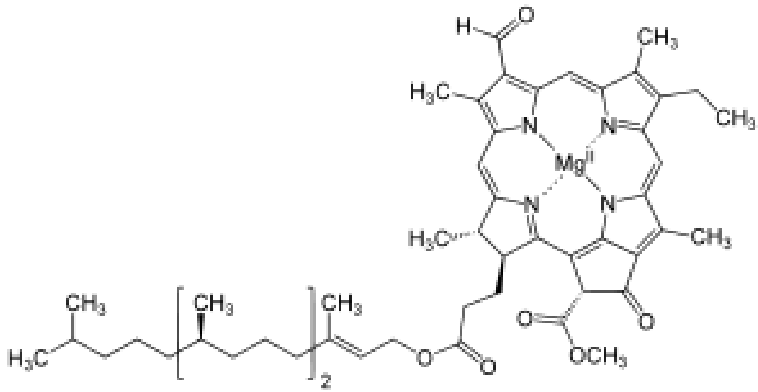

Figure 3. Structural formula of the chlorophyll compound

b-Chlorophyll (Figure 3) is structurally similar to a-chlorophyll, just as a-chlorophyll participates in the process of photosynthesis. b-Chlorophyll absorbs energy while a-chlorophyll does not. Chlorophyll is found in Spirulina spp. which, in addition to pigments and fatty acids, also contains vitamins and minerals that are widely used in cosmetology [8]. It has antioxidant, anti-inflammatory, anti-wrinkle effects, gives elasticity to the skin as well as participates in collagen synthesis and moisturizing [5, 6]. Due to its ability to inhibit odors, chlorophyll is used in the production of deodorants and toothpaste [10].

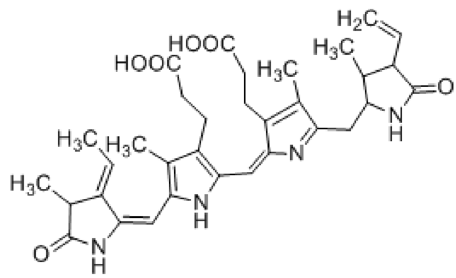

Figure 4. Structural formula of the phycoerythrin compound

Phycoerythrin (Figure 4), the red pigment responsible for the photosynthesis process, reflects red light and absorbs the blue one [4]. It is responsible for capturing light from the red to green spectrum of light. According to its absorption spectrum, phycoerythrin can be divided into three classes: β-phycoerythrin (545–565nm), R-phycoerythrin (499–565nm) and C-phycoerythrin (565nm) [13]. From a structural point of view, it is composed of the chromatophores contained in phycobilins. Phycoerythrin pigment possesses anti-inflammatory, moisturizing, nourishing and soothing properties on the skin as well as an emollient [5, 6]. This pigment is found in the algae from the species of the Porphyridium genus, as well as in cyanobacteria [8, 11] which, in addition to their biologically active properties, are considered to be an alternative to artificial dyes. Following the biotechnological process, this pigment serves as a base for lipsticks and eye pencils. [8] Obtaining cosmetic products based on phycobiliproteins (PBPs) is very expensive due to a low extraction yield and chemical instability. Also, these compounds tend to suffer denaturation in light and heat. Due to the fact that the production of PBP from natural sources requires a large investment in the cultivation of cyanobacteria, cultivators for the mass production of cyanobacteria and algae on a large scale are now being created.[10]

3. Conclusions

According to the previously described review and the subsequent development of cosmetology, pharmacists rely on the development of new biological technologies for obtaining useful pigments for various branches. Synthetic compounds in cosmetology often produce adverse effects, while the natural ones, extracted from algae or cyanobacteria, are hypoallergenic, antioxidant, anti-melanogenic, anti-cancer, anti-aging, antimicrobial and anti-inflammatory. So the development of biotechnology is promising both for cosmetology and for other branches of the industry.

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