



Polyunsaturated Fatty Acids in Diet for General Health and Skin Care



Halina Bojarowicz^{1*}, Kinga Makowska² and Jerzy Krysiński¹

¹Department of Pharmaceutical Technology, Nicolaus Copernicus University, Collegium Medicum in Bydgoszcz, Poland

²Student at the Faculty of Pharmacy, Nicolaus Copernicus University, Collegium Medicum in Bydgoszcz, Poland

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*Corresponding author: Halina Bojarowicz, Laboratory of Technology and Cosmetic Form, Department of Pharmaceutical Technology, Nicolaus Copernicus University, Collegium Medicum in Bydgoszcz, Poland

Abstract

Polyunsaturated fatty acids (PUFA) are recognized as very potent and promising ingredients of both diet and skin care. They present numerous health promoting properties mainly due to modulating cells' response and inhibiting inflammation which plays a major role in many disorders. In recent years their impact on various skin conditions has been studied and consequently their positive activity can be applied in treatment of skin barrier impairments or *Acne vulgaris*.

Keywords: Polyunsaturated fatty acids; Omega-3; Omega-6; Inflammation; Skin barrier; *Acne vulgaris*

Opinion

Since the early years of 20th century the role of dietary fats has been extensively studied. As a result, polyunsaturated fatty acids (PUFA) and essential fatty acids (EFA) in particular have been proven to be indispensable for health maintenance without any doubts. Linoleic acid (LA, C18:2n-6) and α -linolenic acid (ALA, C18:3n-3) are parent fatty acids of two major groups of PUFA, omega-6 and omega-3 respectively [1]. LA is a parent compound for α -linolenic acid (GLA, C18:3n-6) and arachidonic acid (AA, C20:4n-6), while ALA is a precursor for eicosapentaenoic acid (EPA, C20:5n-3) and docosahexaenoic acid (DHA, C22:6n-3).

Proper PUFA dietary intake plays a significant role because of their broad spectrum of action. First of all, they influence regulation processes within cells, which further affect tissues and human organism as a whole. The most interesting aspect is a signaling function of PUFA metabolites, especially in inflammation process, which is a major part of many illnesses [2]. Nowadays, metabolic pathways of fatty acids, as well as their disorder's impact on various diseases are well-studied. Both omega-3 and omega-6 fatty acids undergo numerous enzymatic reactions that lead to forming of eicosanoids, prostaglandins, prostacyclin's, thromboxane's and leukotrienes, which modulate the immune function of tissues [3]. Differentiating those two groups is pivotal because of their generally opposing roles: final metabolites of omega-6 display pro-inflammatory activity, while omega-3 derivatives

are known to be anti-inflammatory. The fact that both groups are metabolized by the same enzymes and compete for the access is worth noting [4].

Moreover, PUFAs affect fluidity of the phospholipid bilayer what further determines functioning of tissues, organs and systems of human body. Number of receptors as well as their affinity for hormones, growth factors, proteins etc. depends on cell membrane's fluidity. This is especially important in path mechanism of disorders like insulin resistance – deficiency of PUFA causes increased stiffness of cell membrane and as a result both expression of receptors and affinity for insulin decrease. Therefore, PUFAs are crucial as they ensure optimal cell response to signal molecules [5,6].

Unfortunately, in modern diet the amount of consumed omega-6 acids highly prevails the amount of omega-3, which results in imbalance between pro- and anti-inflammatory mediators. In state of omega-3 acids deficiency and omega-6 acids excess, an abundance of pro-inflammatory omega-6 metabolites is produced, while EPA and DHA are found in minimal amounts. The imbalance in dietary omega-3 and omega-6 acids strongly affects the homeostasis, hence the importance of correct proportions between said groups. According to FAO and WHO guidelines, PUFA intake should cover 6-10% of total energy demand. Recommended omega-3 to omega-6 ratio is about 1:3 – 1:5, while in modern diet it can reach up to alarming 1:20 [7]. In such conditions linoleic acid

derivatives' synthesis is significantly increased and promotes state of inflammation, which negatively influences general health. Therefore, higher dietary supply of omega-3 acids is a very important factor in prevention of various disorders as well as health promotion. For example, oily sea fish are great dietary sources of EPA and DHA and should be widely promoted in westernized countries. Vegetable oils such as linseed oil rich in ALA makes for a good natural and easily accessible supplement. It is of great importance that along with PUFA supply, higher consumption of antioxidants must follow. Compounds such as vitamin E and flavonoids present in fresh fruit and vegetable prevent PUFAs from oxidizing and losing their properties [8].

Apart from imbalanced omega-3 and omega-6 ratio, enzymatic pathways defects can occur. In most cases the problem concerns delta-5 and delta-6-desaturases action. When inefficient, long-chain LA and ALA derivatives are produced in very limited amounts. Even under physiological conditions only 5-10% of ALA is converted to EPA and 1% do DHA and this capability varies significantly depending on different factors [9]. Factors that can reduce desaturases activity include UV ray's exposure, alcohol, glucocorticosteroids, hypothyroidism and more. These enzymes' activity also decreases naturally in body's aging process – in such cases supplementation with EPA and DHA is especially recommended.

When it comes to health, PUFA can contribute to its maintenance in numerous ways. It is proven that they play a vital role in prenatal development when the nervous system and connections between neurons are being formed. Among omega-3 acids, DHA accounts for up to 60% of neurons' phospholipids and contributes to the correct brain and eyesight development during the fetal period. Recently, novel and unexpected role of maternal dietary supplementation has been reported, namely that formulations containing EPA promote placental angiogenesis and elevate fetal weight [10]. The role of omega-3 and omega-6 in prevention of mental and neurodegenerative diseases such as dementia and depression, schizophrenia, Alzheimer disease or Parkinson disease is emphasized [11,12]. Another proven advantage of omega-3 is their protective activity on the cardiovascular system [13]. These compounds have anti-aggregation properties and lower blood concentration of triacylglycerols and cholesterol, which prevent ischemic heart disease, hypertension and atherosclerotic lesions [14]. On contrary, omega-6 metabolites promote arrhythmia, vasoconstriction and platelet activation that increase the risk of thrombotic changes in blood vessels.

Furthermore, PUFAs are essential for proper skin functioning. Hydro lipid barrier of the epidermis is a mixture of various lipids and water excreted from sweat glands in a characteristic liquid crystal structure. Integrity of this barrier and *stratum corneum* as a whole is key as it acts as a protection against harmful environmental factors i.e. chemicals, allergens, extremely

low and high temperatures. It also prevents trans epidermal water loss (TEWL) what contributes to maintaining skin's moisture and elasticity. Lipids of stratum corneum include about 40-50% of ceramides, which are molecules composed of sphingosine and fatty acids [15]. Under physiological conditions, ceramide 1 of the epidermis should contain linoleic acid but in state of deficiency it is replaced by monounsaturated oleic acid. This change results in increased barrier permeability which is seen in impairments like atopic dermatitis, eczema or psoriasis [5,16]. Another skin condition that can be exacerbated by PUFA deficiency is *Acne vulgaris*. In absence of unsaturated fatty acids sebum becomes rich in saturated fatty acids and its consistency is less fluid. It leads to clogging the outlets of sebaceous glands and accumulating sebum in sebaceous ducts. As a result, whiteheads and blackheads are formed and combined with *Propionibacterium acnes* activity purulent acne lesions occur. What seems promising in acne treatment is antibacterial activity of EPA, DHA and GLA against *P. acnes* and *S. aureus*, which in most cases cause inflammation in acne lesions. With various antibiotics being less effective due to resistance mechanisms, introducing PUFAs into therapy is worth considering [17]. All of the above immune-mediated skin impairments are strongly connected to inflammation process. ALA and its derivatives are known to modulate the immune response and it happens through competition mechanism between omega-3 and arachidonic acid (AA). When omega-3 acids are metabolized instead of AA, synthesis of strong pro-inflammatory molecules such as PGE₂, thromboxans and leukotriens B₄ decreases [4]. Moreover, EPA inhibits TNF α induced metalloproteinase-9 expression in keratinocytes and thus prevents extracellular matrix degeneration [18].

It is worth emphasizing that desaturases activity in corneocytes is very low, therefore long chain fatty acids are produced in little amounts and have to be supplemented [3]. Apart from dietary intake, vegetable oils are great cosmetic ingredients, acting as effective emollients and vehicle for lipophilic active molecules. Topical application can alleviate skin's dryness and irritation after sunburn or dermatologic treatment (i.e. oral retinoids) as well as enhance skin's appearance during natural aging process. Including PUFA in treatment of the above skin conditions can be beneficial in many ways and what appears to be especially important for the patients is lack of significant adverse effects [19].

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