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THE EXAMINATION OF THE ROLE OF NATURAL SUBSTANCES IN THE PROTECTION AGAINST UV RADIATION

Abstract

UV radiation is one of the serious risk factors among the extreme external factors for our soldiers serving in missions. In the military health care, the advanced sunscreen products play an important role as being integral part of the new UV radiation protection system and the training system the authors have planned. These substances must meet the following criteria: efficient, natural, easily available in large quantities, cheap, non-toxic, antioxidant. In our series of experiments, the authors were looking for substances complying with these principles. As a first step, fulvic acids were taken into account, and the authors examined if, on the basis of the UV absorption of these substances, it may be used as the component of the sun protection cream the authors have imagined.

Missziókban szolgáló bajtársainkat érő több extrém külső fizikai tényező közül az egyik nagyon komoly kockázati tényező az UV sugárzás. A katonai egészségvédelemben a szerzők tervezett új UV sugárvédelmi rendszer és kiképzési rendszer szerves részeként fontos szerepet játszanak a korszerű napvédő anyagok. Ezeknek az anyagoknak a következő szempontoknak kell megfelelniük: hatékony, természetes, nagy mennyiségben könnyen előállítható, olcsó, nem toxikus, antioxidáns tulajdonságú. Kísérlet sorozatukban ezen elveknek megfelelő anyagokat kerestek a szerzők, így első lépésként a fulvósavak kerültek látóterükbe és azt vizsgálták, hogy ezek az anyagok UV abszorbciója alapján alkalmas lehet-e az általuk elképzelt napvédő krém komponenseként alkalmazni.

Keywords: *UV radiation, personal UV protection,skin cancer, fulvic acid, absorbance of fulvic acid, mission, prevention. ~ UV sugárzás, személyes UV védelem, bőrrák, fulvosav, fulvosav abszorbancia, misszió, megelőzés*

INTRODUCTION

In the following, the authors will present that for personal UV protection, as being part of the complex UV protection planned in the Hungarian Army, the authors plan to examine an efficient, cost effective substance of natural origin.

UV radiation is one of the most predictable health-endangering agents among the extreme external factors affecting soldiers serving in missions far away from our country (e.g. Afghanistan, Iraq, Cyprus and Egypt).

In these duty stations, the number of hours spent in the direct sunlight is high in working ours or rest period, entailing short and long-term risks of irreversible effects. In Cyprus for example, the approximate number of the sunny days can be 300 per year, the UV index is almost always in the in the range of 8 to 10 in the summer, and even the extreme value of 11+ is not rare, based on personal experience. [1]

This subject needs to be a requirement as part of military culture for those on military service in Hungary on a regular basis, because even here this environmental factor is a danger of increasing significance. Because of its adverse effects, it may jeopardise the performance abilities of the military personnel both short term (e.g. immune suppression) and long term (e.g. melanoma).

PERSONAL UV PROTECTION

The complex UV protection is divided into three parts:

1. education
2. prevention - regulation, personal protection
3. screening tests (pre- and post-test)

Personal protection is one of the forms of prevention, it can be by the usage of personal protective equipment (e.g. sunglasses), appropriate clothing (sun cap hat, shell-jacket) and sunscreen (sun protection creams).

The currently available sun protection creams, ointments, solutions are mostly artificial, multicomponent and relatively expensive.

However, the protective material the authors have imagined contains 1 or 2 natural materials apart from the carrier that can be produced in large quantities very cheaply. The UV absorption is in the appropriate range and has significant antioxidant effects, which can slow down, prevent or reverse disease processes.

That is how the authors started the work with fulvic acid, which can be recovered from peat that occurs in the nature and is a cheap source in large quantities.

HARMFUL UV SPECTRUM

7% of the sunlight is in the ultraviolet range (Nicholson et al., 2005) [2], but only a fraction reaches the surface of the earth. According to the absorption in the atmosphere, further division of the high-energy optical radiation is possible on the basis of wavelength. UVC between 100-280 nm is fully absorbed and dispersed by nitrogen and oxygen molecules of the atmosphere. UVB, 315 – 280 nm, is absorbed by ozone, generated by UVC. UVA with longer wavelength reaches the surface without hindrance, similar to the visible light. [3]

UVA (315-400 nm)	Biological effect: It causes neither erythema nor pigmentation in low doses. At higher doses, together with UVB, it is followed by erythema or pigmentation. At high doses, erythema is caused without direct pigmentation.
UVB (280-315 nm)	Biological effect: Direct erythema, after 12-24 hours, indirect pigmentation, which regresses It irritates conjunctiva and cornea Synthesis of vitamin D3 synthesis Carcinogenesis!
UVC (180-280 nm)	It does not reach the surface.

Figure 1. Biological effects of UV radiation[4]

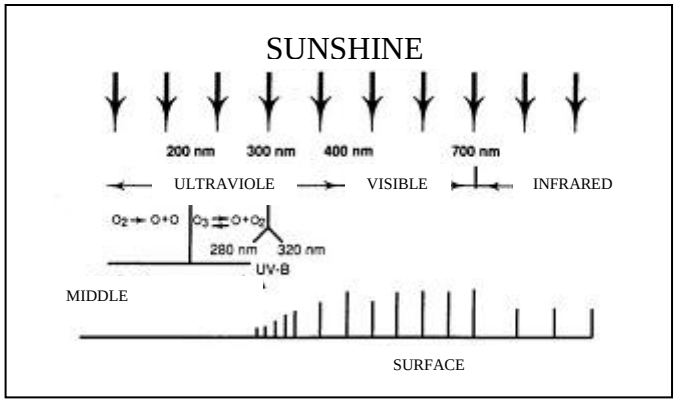

Figure 2. Ultraviolet Reflections[5]

Thus, the sunscreen substances sought must absorb in UVA and UVB range.

HISTORY OF SUNSCREEN

„The first effective sunscreen may have been developed by chemist Franz Greiter in 1946. The product, called Gletscher Crème (Glacier Cream), subsequently became the basis for the company *Piz Buin* (named in honor of the place Greiter allegedly obtained the sunburn that inspired his concoction), which is still today a marketer of sunscreen products. It has been estimated that Gletscher Crème had a sun protection factor of 2.

The first widely used sunscreen was produced by Benjamin Green, an airman and later a *pharmacist*, in 1944. The product, Red Vet Pet (for red veterinary petrolatum), had limited effectiveness, working as a physical blocker of ultraviolet radiation. It was a disagreeable red, sticky substance similar to petroleum jelly. This product was developed during the height of *World War II*, when it was likely that the hazards of sun overexposure were becoming apparent to soldiers in the Pacific and to their families at home. Sales of this product boomed when *Coppertone* acquired the patent and marketed the substance under the *Coppertone girl* and *Bain de Soleil* branding in the early 1950s.

Franz Greiter is credited with introducing the concept of sun protection factor (SPF) in 1962, which has become a worldwide standard for measuring the effectiveness of sunscreen when applied at an even rate of 2 milligrams per square centimeter (mg/cm^2). Some controversy exists over the usefulness of SPF measurements, especially whether the 2 mg/cm^2 application rate is an accurate reflection of people's actual use.

Newer sunscreens have been developed with the ability to better withstand contact with *water*, *heat* and *sweat*." [6]

The authors have imagined an advanced sunscreen products must meet the following criteria: efficient, natural, easily available in large quantities, cheap, non-toxic, antioxidant. As a first step, fulvic acids were taken into account, and the authors examined if, on the basis of the UV absorption of these substances, it may be used as the component of the sun protection cream.

FULVIC ACID

"Agricultural soils contain approximately 3% soil organic matters, 3% water and 94% inorganic compounds. The soil organic matters consist of humic substances (humic acid , fulvic acid and humin) and smaller amounts of carbohydrates, N-containing compounds and lipids . Chemically, the structure of humin is similar to that of humic acid but it is strongly complexed by clays and hydrous oxides and cannot be extracted by either dilute base or acid. humic acid and fulvic acid consist of similar amounts of aliphatic and aromatic carbon atoms. In addition, fulvic acid has components with lower molecular weight but it is richer in carboxylic groups." [7]

Humic substances include fulvic acids. The real humic substances are macromolecules of complex composition, having acidic character formed of plant and animal residues in soil. They cannot be described by a molecular formula, and their molecules have similar characteristics, but their molecular structure and configuration is different.

The classification of humic substances

The humic substances are divided into three basic groups in the soil science literature, by selective solution:

1. fulvic acids
2. humic acids
3. humin materials

Fulvic acids dissolve in dilute alkali solution, and even if using weak acidic solution they are not precipitated. These substances are the smallest molecular size, they have a molecular weight of about 2000 daltons. It has the highest oxygen content (45-48 %) and lowest nitrogen content (less than 4%). Due to the low molecular weight, in neutral or slightly alkaline pH range, the excess of negative charge on their surface is sufficient for the peptization of the macromolecules, thus means a significant mobility in soil. [8] *"Fulvic acid (Buffle's model) consists of naphthalene rings substituted with hydroxyl, carboxyl and short aliphatic chains containing alcohol, methyl, carboxyl and carbonyl groups. "* [7]

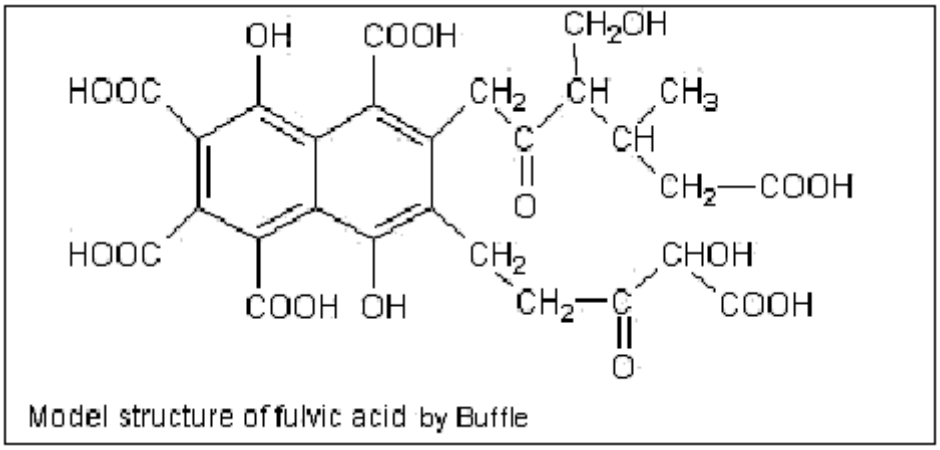

Figure 3. Model structure of fulvic acid [9]

Production of fulvic acid

After the extraction of peat, acidify the solution of the humic acid with dilute hydrochloric acid and then the grey brown humic acids exude and precipitate. The fulvic acids remain in the solution and they are yellow. This yellow aqueous layer is separated by aspiration or decantation and concentrated where the temperatures do not exceed 70°C. The dried residue is the fulvic acid.

UV absorption of fulvic acid

In order to use the fulvic acid as sunscreen substances, need to examine if it absorbs in the adequate ultraviolet spectrum. During the study, the authors found that the solution of fulvic acid absorbs in both UVA and UVB spectrum. This is illustrated in the following graph:

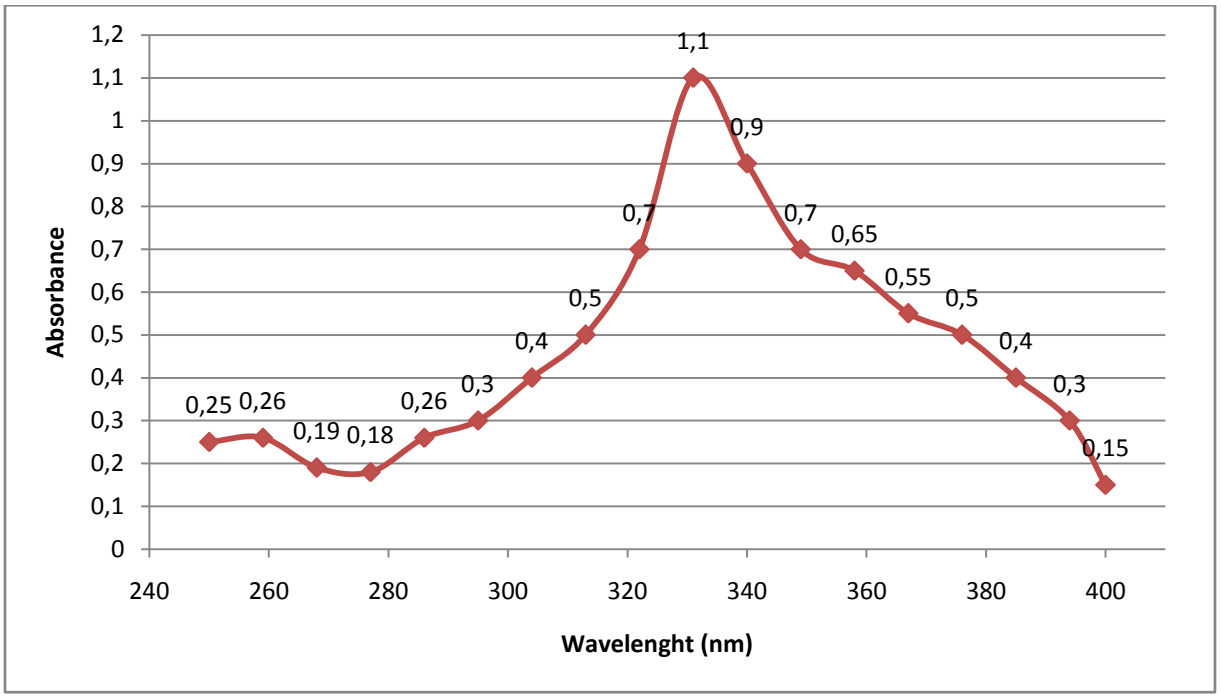

Figure 4. Rate of absorbance of fulvic acid (source: authors)

SUMMARY:

In this article, the fulvic acid was presented, a naturally occurring, non-toxic substance that can be expensively produced as potential sunscreen substance. As a result of the absorption test, a new substance fitted in their planned set of experiments was known, that can be the component of the sunscreen substance the authors had planned.

The authors are planning the similar analysis of other substances i.e. red grape extract, polyphenol, and the UV protective effect of the different composition of these substances.

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