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PRELIMINARY TESTS TO ASSESS THE EFFECTIVENESS OF SUNSCREENS

Is sunbathing, and for that matter the sun itself, beneficial or harmful? The answers given by both experts and non experts seem to vary depending on who you talk to. Psychological research carried out in recent years shows that a person's (theoretical) behaviour when faced with certain problems and his/her actual behaviour are not always coherent. The relationship between man and sun was analyzed starting from empirical data, by taking into consideration three levels of observation: knowledge, behaviour , and psychology. The results of surveys that were carried out in Austria, Germany, France, and Australia show that human behaviour with regards to the sun is not controlled by one factor alone, but by several factors. In some climates, such as the summer climate in Perth, the effects of high temperatures, strong sun shine, low relative humidity, and strong winds on people who are exposed to the sun for several hours at a time because of their jobs can be catastrophic. The skin's pigmentary reaction to UV rays increases and some signs of degradation appear. These include, dehydration of the horny layer, thickening of the dermal tissue, dilatation of the dermal pores, while the elderly also show uneven pigmentation of the hands, face, and neck. The effects of UV rays are worsened by infra-red radiation, which increases the temperature of the cutis and of perspiration, thus leading to greater transpiration of the skin itself. This is why effective protection requires a combined, integrated, and simultaneous action against both the harmful effects of UV radiation, especially after swimming or while perspiring, and against the dehydrating effects of heat, humidity, and wind. The sunscreen index, which is one of the few existing cosmetic parameters, helps consumers who are more interested in protecting themselves than in tanning quickly, to choose the most suitable product. The positive attitude of the cosmetic industry has made it possible to define the concept of the protection index and to introduce this concept into the selection criteria. However, differing interpretations arose concerning this subject, which then led to investigating the sources of error and suggesting new measurement methods. The problems that had to be tackled in the attempt to define the protection index involve, first of all, the choice of the skin sampling area (the size and the sensitivity of the cutis, which varies depending on part of the body); secondly, the sunscreen film thickness, irradiation sources, and evaluation of the results; these experimental conditions can be perfectly controlled. Relative humidity and temperature are two key factors that must be taken into consideration when performing laboratory tests. With regards to practical applications, how well the product being tested resists to perspiration or water, based on quantitative variations must be determined. The ideal way to carry out this type of assessment would be to test the products on individuals who would alternate physical activity with swimming in water whose chemical-physical characteristics are known, and then to make macroscopic observations and take photometric readings. Though not clearly proved, we can assume that the efficacy of tanning products closely depends on how thick the layer of film applied to the horny layer is, since penetration of the sun screen into the skin reduces its protective efficacy. A method has been developed to determine the quantity of UV screen that is absorbed by the cutis in the application area. The residue that remains on the surface of the horny layer after various application periods was determined by a solvent recovery technique. The results showed that various sunscreen types

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(aminobenzoates, cinnamates, salicylates) penetrate the skin and that the depth of penetration may vary depending on where the sunscreen is applied, the application time, and the composition of the “carrier”. In order to better understand the mechanisms the sun deploys on the cutis, an electronic paramagnetic resonance (EPR) study was carried out on the free radicals that are formed by irradiation of the proteinaceous components of the cutis. After performing a study on models, peptides and polypeptides that was presented at the X IFSCC Congress in London, a further study was conducted on the keratin of the cutis horny layer and on collagen. With regards to keratin, UV rays cause the production of radicals such as “-NH-CH-R”, which react with the glycine content of adjacent proteinaceous chains, thus forming radicals -NH-CH-CO_3; while, for collagen, besides -NH-CH-CO_3, free radicals such as alanine radicals (-NH-CH-CH_3) at -160°C and (-NH-C(CH_3)-CO-) radicals at -20°C, can be observed. These results help us to better understand both the mechanisms leading to early ageing of the cutis when exposed to the sun, and the transformation of collagen into reticulate proteins which D.A. Hall called “false elastins”. The study that was conducted on the free radicals which are formed in the horny layer keratin also allows for an in-depth investigation of the protective role played by the melanin-based pigments of the cutis. As a preliminary measurement of UV screen affinity with the horny layer, it is possible to determine screen absorption on sheep's wool. It is also possible to measure screen affinity on pig skin by removing the cutis some time after having treated and washed it with water, and then measuring the remaining sun screen residue. According to Ippen, it is also possible to obtain “in vivo” laboratory test models by determining the sunscreen index before and after washing with water. Tangible results can be obtained by tests performed on humans exposed to the sun by means of the Fitzpatrick, Pathak, and Greiter methods. Generally speaking, the protection index is measured at intervals of several hours with one or two 15-20 minute swims in between. These methods have shown that water/oil emulsions usually withstand washing better than oil/water emulsions do, although the opposite may occur in some cases. It may also be assumed that UV rays and product application times may affect the screen's affinity with the horny layer. Another method, which is based on high-performance liquid chromatography, has been developed o analyze optical isomer traces of urocanic acid (UCA). The influence that age, gender, skin area the sample is taken from, and the season have on the quantity of UCA and on the optical (cis-trans) isomer ratio found on the cutis surface was studied. The results showed that: the total amount of UCA is not related to age or gender; it decreases in summer, while the cis isomer ratio increases; the cis-isomer ratio is higher on the forearms and cheeks, while trans isomers prevail on the back. It has been observed that photochemical irradiation causes cis-trans isomerization both ways. These reactions are quick in water and the equilibrium constant varies depending on the intensity of the light. The protection index of a watery solution of sodium urocanate that is photochemically isomerized is almost equal to the protection index of a trans isomer solution.

These results lead us to believe that both isomers act as screens and that the photoprotective effect is not only caused by isomerization energy but also by photoabsorption. This opinion is supported by the fact that 4-5imidazolyl-methylidene monosodium malonate, which is not photochemically isomerized, has a screening effect. Therefore, we believe that the amount of UCA in the cutis, the thickness of the horny layer, and the melanin content of the epidermis are all important factors for the sunscreen protection effect.

Prove preliminari sull’efficacia dei filtri solari

Il sole ed i bagni di sole sono salutari o pericolosi? La risposta, sia per gli esperti che per le persone prive di conoscenze scientifiche, sembra variare da individuo ad individuo. La ricerca psicologica di questi ultimi anni rivela che il comportamento dell’uomo d’innanzi ad un certo tipo di problema ed il suo comportamento effettivo costituiscono due livelli non necessariamente sovrapponibili. A partire da dati empirici, si é analizzato il problema uomo-sole, considerando i tre livelli di osservazioni: sfera della conoscenza, del comportamento e psicologica. I risultati di una inchiesta estesa all’Austria, Germania, Francia ed Australia rivela che il comportamento umano riguardo al sole non è controllato da una motivazione unidimensionale ma da più fattori. Gli effetti di un clima come quello di Perth in estate, caratterizzato da temperature elevate, notevole irradiazione solare, debole umidità relativa e venti forti sono catastrofici per quelle persone esposte per lungo tempo al sole per motivi di lavoro. La risposta pigmentaria della pelle ai raggi UV. risulta accresciuta ed appaiono segni di degradazione quali disseccamento dello strato corneo, ingrossamento del tessuto superficiale, dilatazione dei pori e, negli anziani, pigmentazione ineguale delle mani, del viso e del collo. Gli effetti dei raggi UV sono aggravati inoltre dall’irraggiamento infrarosso che accresce la temperatura della pelle e la sudorazione, provocando una maggiore traspirazione della pelle stessa. Una protezione efficace richiede dunque contemporaneamente un’azione combinata contro gli effetti nocivi degli UV, soprattutto dopo il bagno e in periodo di traspirazione, e contro gli effetti disidratanti del calore, dell’umidità e del vento. L’indice di protezione solare, uno dei rari parametri misurati in cosmesi, facilita la scelta del consumatore più desideroso di proteggersi che di abbronzarsi rapidamente. L’attitudine positiva dell’industria cosmetica ha permesso di definire questa nozione di indice di protezione e di introdurla nei criteri di scelta. Tuttavia sono sorte interpretazioni divergenti a questo riguardo ed hanno portato a considerare le sorgenti di errore ed a proporre nuovi metodi di misurazione. I problemi incontrati nel corso della determinazione dell'indice di protezione sono, prima di tutto, la scelta del campione di superficie cutanea (le sue dimensioni, la sensibilità variabile della pelle a seconda della zona), la misura dello spessore del film di protezione, le scelte delle sorgenti di irraggiamento e la valutazione dei risultati; è possibile controllare perfettamente queste condizioni sperimentali. Due fattori importanti relativi al controllo di laboratorio sono l'umidità relativa e la temperatura. Per l'applicazione pratica è necessario determinare la resistenza del prodotto in esame alle variazioni quantitative dovute al sudore o all'acqua. Il metodo di valutazione ideale sarebbe un test su individui che alternino attività fisiche con bagni in acqua, con caratteristiche chimico-fisiche note, ed effettuare quindi osservazioni macroscopiche e letture fotometriche. Nonostante non sia chiaramente provato, si suppone che l'efficacia dei prodotti solari sia legata direttamente allo spessore del film lasciato sulla superficie dello strato corneo dal momento che la penetrazione del filtro riduce il suo effetto protettore. È stata messa a punto una metodica per determinare la quantità di sostanza filtrante i raggi UV penetrata nella cute nel sito di applicazione. Il residuo che permane sullo strato corneo, dopo periodi di applicazione di diversa durata, viene determinato con l'aiuto di una tecnica di recupero mediante solventi. I risultati hanno mostrato che diversi tipi di filtri (aminobenzoati, cinnamati, salicilati) penetrano nella pelle ed il grado di penetrazione dipende dal sito, dal tempo di applicazione e dalla composizione del *carrier*. Al fine di meglio comprendere i meccanismi di azione del sole sulla pelle sono stati studiati, tramite risonanza paramagnetica elettronica (RPE) , i radicali liberi formati per irradiazione dei costituenti proteici cutanei. Dopo studio su modelli, peptidi e polipeptidi, presentati al X Congresso IFSCC di Londra, si è intrapreso lo studio della cheratina dello strato corneo e del collagene della pelle. Per quanto riguarda la cheratina, i raggi UV producono radicali del tipo –NH-CH-R che reagiscono con la glicina, contenuta nelle catene proteiche vicine, per formare dei radicali $-NH-CH-CO_3$; per il collagene invece si osservano, oltre ai radicali $-NH-CH-CO_3$ dei radicali liberi del tipo dell'alanina ($-NH-CH-CH_3$) a -160°C e radicali ($-NH-C(CH_3)-CO-$) a -20°C. Questi risultati permettono una migliore comprensione dei meccanismi che conducono all'invecchiamento prematuro della pelle esposta al sole ed alla formazione, a partire dal collagene, di proteine reticolate chiamate da D.A. Hall "pseudoelastine". Lo studio dei radicali liberi formati nella cheratina dello strato corneo permette inoltre una discussione più approfondita sul ruolo protettore dei pigmenti melaninici cutanei. Come misura preliminare dell'affinità delle sostanze filtranti dei raggi UV per lo strato corneo, si possono effettuare misurazioni di assorbimento dei filtri sulla lana di montone. Si può in seguito determinare la loro affinità per la pelle di maiale, asportando la pelle precedentemente trattata e lavata con acqua dopo un tempo dato e dosando infine il filtro. È possibile ugualmente realizzare in laboratorio dei modelli sperimentali in vivo secondo Ippen, determinando l'indice di protezione solare prima e dopo detersione con acqua. Dei risultati concreti possono infine essere ottenuti grazie a prove effettuate sull'uomo, esposto al sole, secondo i metodi di Fitzpatrick, Pathak e Greiter: in generale, si determina l'indice di protezione a diverse ore, intercalando uno o due periodi di bagni della durata di 15-20 minuti. Questi metodi hanno mostrato che normalmente le emulsioni acqua/olio resistono meglio delle emulsioni olio/acqua al lavaggio, anche se in qualche caso può avvenire il contrario. Si può altresì supporre che i raggi UV ed i tempi di applicazione del prodotto giochino un ruolo sull'affinità dei filtri per lo strato corneo. È stato inoltre messo a punto un metodo utilizzante la cromatografia liquida ad alta *performance* per analizzare tracce di isomeri ottici dell'acido urocanico (UCA). Si è studiata l'influenza dell'età, del sesso, del sito cutaneo prelevato e della stagione sulla quantità di UCA ed il rapporto di isomeri ottici (cis-trans) trovati sulla superficie della cute. Sono stati ottenuti i seguenti risultati: la quantità totale di UCA non ha alcuna relazione con l'età od il sesso; essa decresce in estate, ma il tasso dell'isomero cis aumenta; il tasso di questo isomero è più elevato sull'avambraccio e sulla guancia, contrariamente alla schiena dove il trans è predominante. È stato osservato per irradiazione fotochimica l'isomerizzazione cis-trans nei due sensi. Questa isomerizzazione nell'acqua sono rapide e la costante di equilibrio varia con l'intensità luminosa. L'indice di protezione di una soluzione acquosa di urocanato sodico isomerizzato fotochimicamente è sensibilmente uguale a quella di una soluzione di isomero trans.

Wosene Kosrof.

Questi risultati lasciano pensare che i due isomeri esercitino un'azione filtrante e che l'effetto fotoprotettore è dovuto non solamente all'energia di isomerizzazione ma anche al fotoassorbimento. Questa supposizione è confermata dal fatto che il 4-5 imidazolilmetilidene malonato monosodico, che non è isomerizzato fotochimicamente, presenta un effetto filtrante. Si pensa quindi che la quantità di UCA nella pelle sia importante per la protezione *vis-a-vis* del sole, come pure lo spessore dello strato corneo ed il contenuto in melanina dell'epidermide.

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Skin and Sun Radiations

Excessive skin exposure to sun radiations may acutely cause inflammation, while chronically leading to skin ageing and cancer. **(1)**

(1) UV.B negative effects are the following: sunburn; DNA damages; early skin ageing, skin cancer; immuno-suppression; photodynamic reactions; photodermatitis; eye inflammations. **UV.A** negative effects are the following: collagen damage; loss of skin elasticity; immuno-depression; photodynamic reactions; photodermatitis; eye in-flammation. Individuals who, as children or adolescents, have once or several times suffered from sunburns with blisters have double probability to develop **malignant melanoma**. Among these individuals, the risk for those with a light skin is three times higher [R.S. Stern, M.C. Weinstein, S.G. Baker: *Risk reduction for non melanoma skin cancer with childhood sunscreen use*. Arch. Dermatol. 122:537-545 (1986)]. The regular use of **sunscreens** reduces the incidence of non melanoma skin cancer by only 70%, with a 78% value when sunscreens are regularly used since childhood. The results thought to be obtained from oral administration of β-**carotene** do not exactly meet the expectations. As a matter of fact, α-carotene and not β-carotene, has a ten times higher antiproliferative effect (H. Nishino, J. Takayasu, A. Iwashima, M. Murakoshi, J. Imanishi, 1988). Moreover, of the **three different carotenes** which in nature are always mixed together, namely α, β and γ-carotene, α-carotene is the only optically active one with different cyclic ends: one is an α-ionone, the other a β-ionone. Therefore, in order to obtain the same effect as α, β-carotene should be taken in great quantities, which would even stain the skin. Moreover, empirical oral administration of natural substances, namely those containing the three carotenes, is only potentially effective. Therefore β-carotene is no guarantee today.

From a biologic point of view, the most active part of the solar electromagnetic spectrum lies between 280 and 700 nm. UV.C radiations, namely those with wave length below 290 nm, are filtered through the stratosphere. (2)

(2) These radiations are more exactly filtered by the **ozone** layer. Therefore, should the excessive use of chloro-fluorocarbonates lead to the loss of this protective layer, UV.C radiations will have to be taken into account.

UV.C radiations are used for their germicidal action.**(3)**

(3) Quite often, observations based on few experimental data were for a long time considered to be sufficient to correctly define the course of a phenomenon. This was also the case of **UV.B and UV.C radiations induced erythemas** which, on the basis of studies conducted many years ago, were thought to have a different course. Namely the UV.C induced erythema was thought to have its onset, reaching its maximum intensity and disappearing more rapidly than when induced by UV.B. This assumption is based on data reports resulting from limited studies which do not specify whether the compared UV.B and UV.C erythemas had the same intensity. Since a different course of these two types of erythema is likely to involve also a different pathogenetic mechanism, with a particular role played by prostaglandins as inflammation mediators, Farr and coworkers correctly decided to review the problem under experimental conditions permitting a more exact lesion degree quantification (1988). They conducted their research on 8 adult volunteers (4 males and 4 females) by using their central back skin. The radiation equipment employed was supplying 30 W/m^2 between 200 and 290 nm (namely within the UV.C spectrum, with 96% emission at 254 nm wavelength) and 80 W/m^2 between 290 and 320 nm (namely within the UV.B spectrum). At both sides of the median dorsal line, 6 areas were identi-fied with a 20 mm diameter each, 5 of which underwent increasing UV.B radiation doses for factors 1, 3 or increasing UV.C radiations for factor 2, with an initial minimum amount of 0.6-1.2 kJ/m^2 UV.B and 0.08-0.25 kJ/m^2 UV.C radiation dose respectively. The erythema degree was assessed after 4-8-12-24-36 and 48 hours after radiation exposure with a suitable reflectance instrument to evaluate the quantity of red and green light reflected by the skin. This method is employed to obtain an "erythema index" which is proportional to skin blood content. The sixth radiation-free area was used as control. Radiation induced vasodilation increase was calculated by subtracting from the values obtained at several time intervals the erythema index value recorded at zero time. A 0.05 increase corresponds to a minimum erythema producing dose, namely a uniform clear-cut edge rash in the radiation exposed area, whereas a 0.3 increase corresponds to marked erythema. Finally, to better identify the erythema course in each subject, data obtained under different radiation dosages at each observa-tion time have been added together thus obtaining a dose independent index. The results have shown that at both wave lengths, namely with both UV.B and UV.C, the erythema appears 4 hours after radiation exposure with its peak between 8 and 24 hours. Moreover, although peak time varies considerably from person to person, in each of them the peak for both radiation types seemed to coincide. Obviously enough, UV.B and UV.C radiation induced inflammation duration depended on radiation dose and, when the erythema index increase at 12 hours was lower than 0.1, the erythema subsided within 48 hours. Finally, by comparing the course of UV.B and UV.C induced erythemas, significant differences were observed only in three out of eight subjects examined. Major differences were observed between individual subjects regarding erythema course, especially with reference to the time interval from exposure to inflammation peak. Yet, in most of them, UV.B and UV.C radiations were observed to lead to an alteration sequence which was substantially similar with respect to time-dependence. This would suggest that in both radiation types the same action mechanism is at the origin of inflammation. Furthermore, the results obtained would indicate that previous reports about a more rapid onset and shorter course of UV.C radiation induced erythemas should be considered as questionable and even likely to be wrong, since they were based on the comparison of radiation doses causing different intensity and duration reactions. …

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