



# Survey of cosmetologists' knowledge of photoallergenic and phototoxic substances

## *Badanie poziomu wiedzy kosmologów na temat substancji fotoalergiczych i fototoksycznych*

### ABSTRACT

Phototoxic and photoallergic reactions induced by ultraviolet A radiation belong to the group of exogenous photodermatoses. To induce changes in addition to sunlight, the presence of a photosensitizer is essential. These can be both externally applied and systemically ingested substances: drugs and supplements, plants, cosmetics, essential oils.

The article aimed to assess cosmetologists' knowledge of phototoxic and photoallergic substances. The study was carried out in a group of 103 cosmetologists based on an original questionnaire survey.

Statistically significant differences were found in the level of knowledge between those with a master's degree and a bachelor's degree. The groups also differed in their willingness to expand their knowledge.

**Keywords:** ultraviolet radiation, photodermatoses, phototoxic reaction, photoallergic reaction, phototoxic and photoallergic substances

### STRESZCZENIE

Reakcje fototoksyczne i fotoalergiczne wywoływane przez promieniowanie ultrafioletowe typu A należą do grupy fotodermatoz egzogennych. Do wywołania zmian, oprócz promieni słonecznych, niezbędne jest występowanie fotosensybilizatora. Mogą to być zarówno substancje stosowane zewnętrznie jak i przyjmowane ogólnoustrojowo: leki i suplementy, rośliny, kosmetyki, olejki eteryczne.

Celem pracy była ocena poziomu wiedzy kosmologów na temat substancji fototoksycznych i fotoalergiczych. Badania przeprowadzono w grupie 103 kosmologów w oparciu o autorski kwestionariusz ankiety.

Wskazano znamienne statystycznie różnice poziomu wiedzy pomiędzy osobami z tytułem magistra i licencjata, grupy te różniły się także chęcią do poszerzenia swojej wiedzy.

**Słowa kluczowe:** promieniowanie ultrafioletowe, fotodermatozy, reakcja fototoksyczna, reakcja fotoalergiczna, substancje fototoksyczne i fotoalergiczne

### INTRODUCTION

The sun is the natural and largest source of ultraviolet radiation (UV), which can have both positive and negative effects on the functioning of the human body, with particular emphasis on the skin [1].

Due to sunlight, the synthesis of vitamin D<sub>3</sub> is induced in the skin, which has broad beneficial effects on the body [2]. The positive effects of UV radiation are also used in the treatment of certain dermatological diseases such as psoriasis [3] or vitiligo [4].



Depending on the wavelength, each type of UV radiation has different physical properties and therefore– triggers different biological reactions in the body. The longer the wavelength, the deeper it penetrates the skin, while short wavelengths strongly accelerate the photo-aging of the skin. The consequences of overexposure to UV radiation can be both acute and chronic skin changes [1].

UV radiation in the range 200-290 nm, i.e. band C (UVC), as the most dangerous, has the most destructive effect on the structure of deoxyribonucleic acids (DNA) and is also responsible for the erythema reaction. B-band (UVB) radiation influences the appearance of photochemical erythema and skin burn, causes pigmentation disorders, damages the structure of DNA, and also has negative effects on the Langerhans cells, which are components of the skin's immune system. A-band radiation (UVA) is carcinogenic and mutagenic, induces an increased synthesis of free radicals and the formation of telangiectasias, and increases the adverse effects of UVB radiation on the skin. Moreover, it penetrates window glass, affecting people in an enclosed space [1, 5]. This type of radiation is responsible for phototoxic and photoallergic reactions. Phototoxic and photoallergic reactions belong to the group of exogenous photodermatoses. In order to induce them, in addition to UV radiation, an additional component called a photosensitiser is required, resulting in skin sensitisation to radiation. Photosensitisers can be both externally applied and systemically ingested substances: drugs, dietary supplements, phytochemicals, and cosmetics [6].

The mechanisms of phototoxic and photoallergic reactions may differ. The immune system is involved in the development of a photoallergic reaction. As in the case of a phototoxic reaction, a skin reaction occurs under the influence of the sensitising agent and UV radiation, but not all exposed people show symptoms. This is because they only occur in predisposed people and therefore less frequently. In contrast to the phototoxic response, the development of a photoallergic reaction in this kind of action is not directly proportional to the quantity of photosensitizing components and radiation. The skin lesions that are observed in the course of a reaction of this type are referred to as photoallergic contact eczema. Clinically, they are itchy erythematous papules that appear within 24-48 hours after exposure to sunlight. They usually appear on unprotected parts of the body, but can also occur in sheltered areas. Furthermore, photoallergic reactions can also result in chronic photosensitivity [6].

Drugs are an important group of photosensitisers [7]. As well as plant raw materials with phototoxic and photoallergenic effects are often used by clients of cosmetic surgeries. In combination with light treatments, they will be damaging to the skin and lead to undesirable symptoms in the form of burns, swelling, erythema, or allergic skin conditions [1, 7].

## MATERIALS AND METHODS

### Characteristics of the study group

The study was conducted from 17.02.2022 to 17.03.2022 among women (n=103) working as cosmetologists. The largest group (60%, n=62) was between 20 and 30 years of age, 35% (n= 36) of the women surveyed were between 31 and 40 years of age, while 5% (n=5) were between 41 and 50 years of age. 60% (n=61) of the women resided in large cities (over 100 000 inhabitants). Almost a quarter of them (24%, n=25) lived in medium-sized cities (20-100,000 inhabitants). The remaining respondents lived in small towns (10%, n=10) or in rural areas (7%, n=7).

More than 60% of the cosmetologists taking part in the survey (64%, n=66) worked in large cities, and 25% (n=26) in medium-sized cities. The educational level of the cosmetologists surveyed is shown in Figure 1 and the time of experience in the profession in Figure 2.

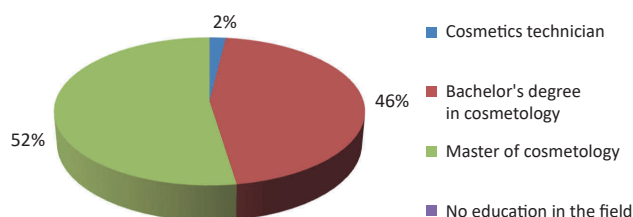


Fig. 1 Job title of respondents

Source: Own study

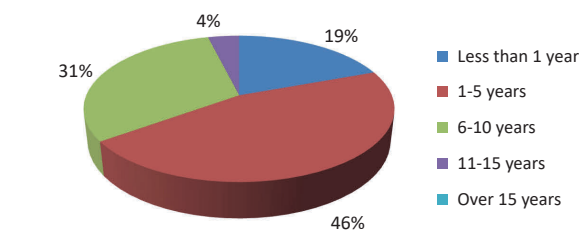


Fig. 2 Time of experience in the cosmetology profession

Source: Own study

### Study method

The study was based on the author's survey questionnaire, consisting of 28 questions: 6 questions related to the socio-demographic characteristics of the respondents, 22 questions related to the knowledge and opinions of cosmetologists on phototoxic and photoallergic substances. To assess the level of knowledge, a value of 1– was assigned to correct answers to the knowledge questions and 0– to incorrect answers, respectively. A maximum of 33 points could be obtained. All questions were in closed form: 3 with multiple choice. The questionnaire was anonymous and was conducted electronically (Google Forms). It was made available via the social network Facebook on professional groups for cosmetologists. All forms received (n=103) were completed correctly and used for analysis.

## Statistical analysis

Statistical analysis was performed using TibcoStatistica13.3 software (TIBCO Software Inc., USA). The type of distribution of the variables was tested using the Shapiro-Wilk test. A non-parametric chi-square test was used to determine the relationship between nominal and nominal and quantitative variables. Spearman's rank correlation analysis was then performed. In each case, a statistical significance level of 5% was assumed.

## RESULTS

The types of treatments performed by the interviewees are indicated in Figure 3, the most common post-treatment complications observed in clients are indicated in Figure 4.

The vast majority of the cosmetologists surveyed indicated that clients report to cosmetology practices once/sometimes a year with adverse effects in the form of the development of hyperpigmentation (79%, n=81) or allergic reactions (70%, n=73). In the case of demarcation lines, 67% of respondents (n=71) indicated that they have never been approached by a client with such an adverse effect.

More than half of the respondents (51%, n=53) declared that they had basic knowledge about phototoxic and photoallergic reactions, as these issues were covered in their studies/training. Only 11% of the cosmetologists surveyed (n=11) would like to further develop their knowledge on these topics. The most frequently indicated sources of knowledge are illustrated in Figure 5.

The majority of respondents had encountered a phototoxic or photoallergic reaction in their careers. Almost 3/4 of the respondents (71%, n=45) declared that they had seen a phototoxic or photoallergic reaction in their female clients between 1 and 2 times during their professional year. Only 5% of respondents (n=3) encountered such a reaction more than 5 times per year.

Almost two-thirds of the cosmetologists surveyed (65%, n=67) declared performing light treatments in their daily cosmetology practice. Among those surveyed, the vast majority would/do interview the client prior to performing a light treatment on the following topics: treatments recently performed on the treatment area (99%, n=102), medications/hormones taken (98%, n=101), current or past illnesses and cosmetics used on the treatment area (95%, n=98). On the topic of the use of dietary supplements and the consumption of herbs/herbal teas, 17%

(n=18) and 10% (n=11) of respondents, respectively, would not include these issues in the pre-treatment interview.

Almost three-quarters of respondents (73%, n=75) correctly characterised the mechanism of the phototoxic reaction. When describing the mechanism of the photoallergic reaction, the number of correct answers was lower at 70% (n=72).

The drugs most frequently indicated by the respondents as likely, in their opinion, to cause phototoxic and photoallergic reactions are presented in Fig. 6. Almost 80% of the cosmetologists (78%, n=80) correctly indicated paracetamol as a safe analgesic drug that does not generate phototoxic and photoallergic reactions. Some respondents also indicated other drugs such as naproxen (7%, n=7) and ibuprofen (3%, n=3). Plant raw materials and essential oils indicated as potential photosensitisers are shown in Figures 7 and 8.

Vegetables that, according to respondents, when consumed in large quantities, can cause adverse reactions are celery and parsley (80%, n=82). The absence of phototoxic and photoallergic properties was attributed by respondents to vegetables such as tomato (78%, n=81) and peppers (72%, n=74).

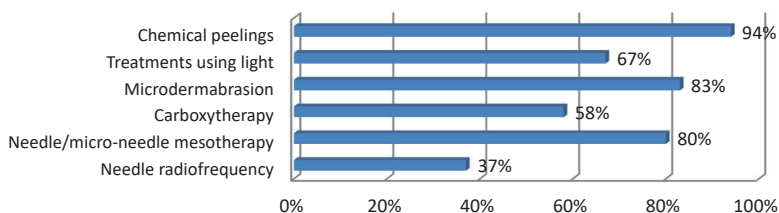


Fig. 3 Treatments performed on a daily basis

Source: Own study

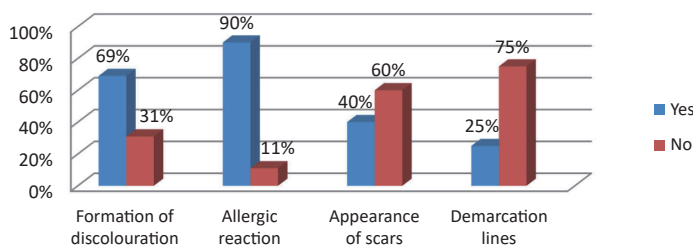


Fig. 4 Types of post-treatment complications observed in the professional work of the cosmetologists surveyed

Source: Own study

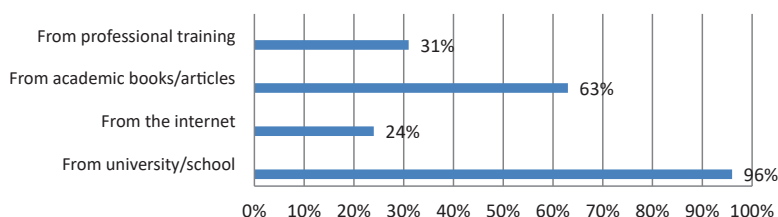
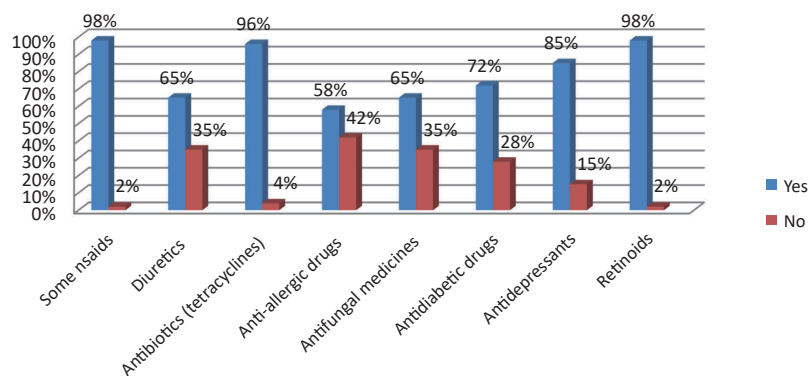
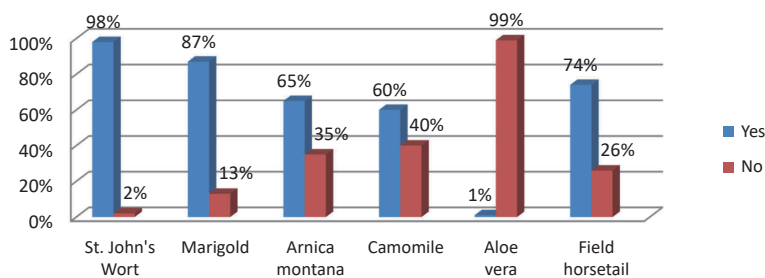


Fig. 5 Sources of knowledge about phototoxic and photoallergic reactions indicated by surveyed cosmetologists

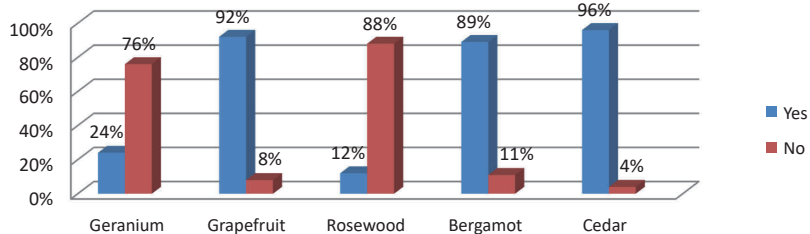
Source: Own study



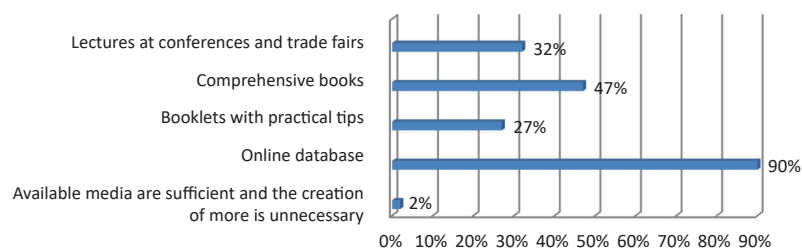
**Figure 6** Knowledge of respondents about drugs that cause phototoxic and photoallergic reactions  
Source: Own study



**Fig. 7** Plant raw materials likely to generate phototoxic and photoallergic reactions according to the cosmetologists surveyed  
Source: Own study



**Fig. 8** Essential oils likely to generate phototoxic and photoallergic reactions according to surveyed cosmetologists  
Source: Own study



**Fig. 9** Media indicated by cosmetologists wishing to expand their knowledge of phototoxic and photoallergic agents  
Source: Own study

**Table 1** Descriptive statistics of the level of knowledge of phototoxic and photoallergic substances of the interviewees

	Average	SD	Minimum	Median	Maximum
Knowledge	27,4	5,2	13	29	33

Source: Own study

Almost 80% of the cosmetologists surveyed (79%, n=81) correctly identified psolarene as a natural chemical with phototoxic properties. For 9% of respondents, such a compound is beta-carotene, and for 12% lycopene.

Just under 70% of the cosmetologists surveyed (68%, n=70) acknowledged that clients of cosmetology practices occasionally want to obtain information regarding which drugs, supplements or foods they should not use when planning any light treatments, 15% (n=15) declared that their clients often ask about the contraindications mentioned earlier. 17% that they never receive such questions.

The relevance of knowledge in the cosmetology profession, regarding drugs and phototoxic and photoallergic substances, was rated by the cosmetologists interviewed as very important (62%, n=64), important (37%, n=38) and 1% as not very important.

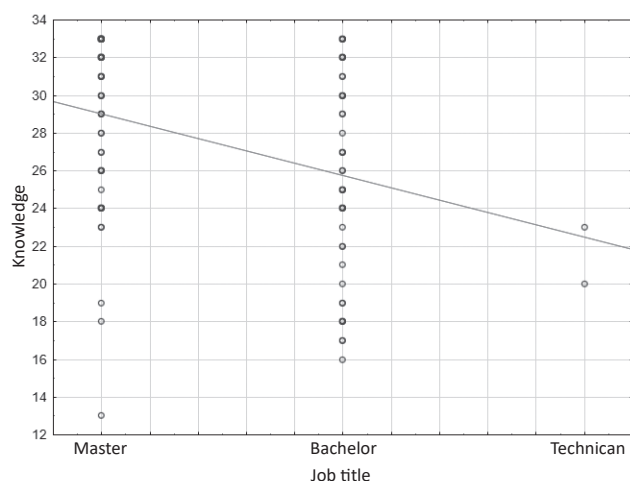
The vast majority of respondents identified an online database as the most convenient medium through which to expand their knowledge. Respondents would also appreciate books with comprehensive coverage of the issue, as well as lectures at conferences and trade fairs. Only 2% of the respondents stated that the currently available media are sufficient and the creation of further media is not necessary (Figure 9).

Almost 70% of the respondents (69%, n=71) acknowledged that the sources of knowledge currently available on the market are convenient and easy to access, however, information obtained from different sources is often contradictory. A smaller group (16%, n=17) declared that they had no problems finding information on ingredients with potential phototoxic and photoallergic effects. Just under two-thirds of the cosmetologists surveyed (59%, n=61) admitted that they would not be willing to pay for access to an online database of phototoxic and photoallergic ingredients because, in their opinion, such a medium should be available for free. Slightly more than 1/4 (26%, n=27) of the respondents would be willing to use such

a database on the condition that the employer would pay for the access. Only 15% (n=15) would be willing to pay a fee for access to a reliably and carefully prepared database.

Table 1 presents descriptive statistics on the level of knowledge of those taking part in the survey.

In the results, a significant statistical relationship ( $p=0.012$ ) was observed between job title and knowledge level. Figure 10 shows the point distribution of the level of knowledge of masters, bachelors, and technicians. No relationship was observed between knowledge level and seniority ( $p=0.162$ ) or age ( $p=0.698$ ).



**Figure 10** Relationship between level of knowledge of phototoxic and photoallergenic substances and job title

Source: Own study

A statistically significant relationship was observed between the job title and the opinion of how important the knowledge of phototoxic and photoallergenic substances is in the cosmetology profession ( $p=0.004$ ). Respondents with a master's degree are more likely to say that knowledge of phototoxic and photoallergenic substances is important in their profession. No relationship was noted between the other variables.

No significant difference was observed between the indicated medium that would be most convenient for a cosmetologist wishing to expand their knowledge according to age, job title or seniority. However, a correlation at the level of statistical trend ( $p=0.059$ ) was observed between seniority and the choice of an online database as the optimal medium.

A significant statistical correlation ( $p=0.001$ ) was found between job title and ratings of convenience and ease of accessibility to current sources of knowledge about photoallergic and phototoxic agents. A weak positive correlation was found between the variables. Respondents with a master's degree rated online sources of knowledge as convenient and easily accessible. This rating did not correlate with age or seniority.

A statistically significant association ( $p=0.019$ ) was observed between age and willingness to pay for access to an online database of phototoxic and photosensitising ingredients. This assessment did not correlate with job title or seniority.

## DISCUSSION

Cosmetologists, during their daily professional work, are in constant contact with potential phototoxic and photoallergic substances. These are components of cosmetic preparations, but also drugs and supplements used by clients of cosmetic salons. This study is the first attempt in Poland to assess the level of cosmetologists' knowledge of photo-sensitising substances and their attitude to the necessity and form of expanding this knowledge.

The survey shows that almost 90% of the cosmetologists surveyed were familiarised with the concepts of phototoxic and photoallergic reactions during their studies or professional training and declared that they had good or basic knowledge of them. This fact can be confirmed by the high percentage of correct answers to questions on the mechanisms of action of both reactions, as the phototoxic reaction was correctly characterised by 73% of the respondents and the photoallergic reaction by 70%. Nevertheless, it should be noted that 1/3 of the respondents gave the wrong answer. This is particularly important with regard to the large proportion of people (67%) who perform light treatments in their professional work.

Working with light emission-based devices involves a detailed and thorough pre-treatment interview. When asked about the topics covered in this interview, more than 90% of cosmetologists would ask about the issue of medications/hormones taken, drinking slimming herbs/teas, current or past illnesses, as well as cosmetics used on the treatment area or treatments performed. However, almost one-fifth of cosmetologists declared that they did not ask the clients about the dietary supplements, which is an incorrect procedure. Indeed, a 2017 study 'Poles and dietary supplements' showed that around three-quarters of the Polish population declares consuming dietary supplements, with almost half (48%) take them regularly [8]. A similar result was also obtained in a study by Kozłowski et al. in which more than 65% of respondents admitted to using dietary supplements, of which more often were women with higher education [9], i.e. potentially the most frequent clients of cosmetic surgeries. A study by Matysek-Nawrocka et al. in which as many as 77% of respondents took supplements, with the greatest emphasis on supplements 'for beauty', i.e. to support the condition of the skin and its appendages [10] confirmed the earlier observations. The results of the cited studies clearly show that dietary supplements, especially among women, have become very popular in Poland. In order to guarantee the safety of cosmetological treatments, it is important for cosmetologists to verify information in the pre-treatment interview regarding



the intake of both drugs and dietary supplements (often herbal) by clients, as both groups of substances may cause adverse reactions, including phototoxic and photoallergic reactions.

Among the groups of drugs that cosmetologists indicated most frequently as agents likely to cause phototoxic and photoallergic reactions were retinoids (98%) and antibiotics, especially tetracyclines (96%). Almost 90% also indicated antidepressants. These results confirm previous studies conducted among cosmetology and medical students [11]. In the study by Zuba et al, when asked about phototoxic and photoallergic drugs, a group of cosmetologists most frequently indicated retinoids (36%) and, although to a lesser extent, tetracyclines (16%). The authors showed that cosmetology students are familiar with the characteristics of the most commonly used dermatological drugs, which was confirmed in this study. The vast majority of respondents (98%) indicated that NSAIDs are a group of compounds with phototoxic and photoallergic potential. Among these drugs, there are compounds with weaker and stronger interference with UV radiation. Knowledge of this subject is extremely important in view of the high prevalence of analgesic use in Poland. In a study conducted by Neumann-Podczaska et al, more than 80% of the respondents reported using non-steroidal anti-inflammatory drugs both generally and topically [12].

When asked about plant raw materials likely to cause phototoxic and photoallergic reactions, St. John's wort was the most frequently indicated by the respondents (98%). This result corresponds to a study by Zuba et al. in which cosmetology students also selected this plant most frequently [11]. Among the other plant raw materials listed in our study, the respondents mostly correctly classified them into the group of phototoxic and photoallergic substances indicating: calendula, field horsetail, arnica montana, and common chamomile. However, it should be pointed out that 40% of the respondents did not attribute phototoxic and photoallergic properties to chamomile and more than 1/4 to field horsetail. Essential oils that can sensitise the skin to sunlight are citrus oils (bergamot, orange, lime, lemon, grapefruit), as well as cedar and sandalwood [13]. The cosmetologists surveyed chose correctly among the oils listed, indicating cedar oil (96%), grapefruit oil (92%) and bergamot oil (89%) as potentially sensitising ingredients. What is surprising here is that it was bergamot oil that received the lowest percentage of indications.

A natural chemical with phototoxic properties found in plants and some food products is psoralen [14]. In a study carried out, as many as 79% of cosmetologists identified it, choosing it over other given substances, as an ingredient with the above-mentioned properties. In a study by Zuba et al. a large percentage of the cosmetology students surveyed also mentioned psoralen in the context of causing hypersensitivity reactions [11]. A big surprise was the choices of the other

respondents in our own study, who identified lycopene (12%) and beta-carotene (9%) as photosensitising compounds. Both of these compounds belong to the group of carotenoids, substances with high antioxidant, protective, and skin care potential, which makes them frequently used in cosmetic products including photoprotective preparations. Carotenoids have the ability to absorb UV radiation and neutralise free radicals [15], and they also prevent hyperpigmentation by reducing the number of melanocytes and the skin pigment melanin. Furthermore, they contribute to the reconstruction of collagen and elastin fibres damaged by UV radiation [16]. Beta-carotene shows very strong antioxidant properties and is also the most active precursor of vitamin A. It is used in cosmetics for, among other things, acne-prone skin, thanks to the regulation of sebum secretion, as well as in preparations for mature skins and in the levelling of increased keratinisation. In addition, it is a popular ingredient in sun care cosmetics, as it reduces the skin's sensitivity to sunburn [16]. Lycopene has also found its way into UV protection formulations. It has a regenerative effect and supports the skin's defence mechanisms [17].

The average number of points the respondents received from the questions testing their knowledge of phototoxic and photoallergic substances was 27 out of 33 possible points (82%). The lowest number of points scored was 13 (39%) and the highest was 33 (100%). This result indicates a fairly high level of knowledge of the respondents, but the knowledge is not complete. Statistical analysis showed that, as more education levels are attained, the level of knowledge of the respondents increases. Those with a master's degree achieved the highest results. Another significant correlation was also indicated: the higher the education, the more frequent the opinion that knowledge of phototoxic and photoallergenic substances is important in the cosmetology profession. Thus, it can be concluded that cosmetologists with a master's degree will have more accurate knowledge and will also be more willing to deepen this knowledge. The study also showed that people in this group declared greater ease in using commercially available sources of knowledge.

The study also indicated that with age, the cosmetologists surveyed were more willing to pay for access to an online database of phototoxic and photoallergic ingredients, which is probably related to their greater financial stability and ability to use such a database for a fee. Nevertheless, respondents indicate a willingness to access various sources of knowledge on photosensitising and photoallergic substances in the form of databases, books and lectures, and training.

## SUMMARY

Cosmetologists' level of knowledge regarding phototoxic and photoallergic substances is generally high, but there is room for further improvement and expansion of this knowledge. They encounter phototoxic and photoallergic reactions in

their daily professional work, and more than half of those surveyed have experienced at least one of these reactions in their clients. This happens no more than 1-2 times a year. The level of knowledge did not correlate with age or seniority. However, a correlation with education was indicated: the level of knowledge increases in direct proportion to the increase in the level of education.

As the degree of education increases, respondents declared greater ease and freedom in using the available sources of knowledge. In contrast, the willingness to pay for access to the online database of photosensitising ingredients increases with age. The cosmetologists surveyed show initiative to expand their knowledge and would be most willing to use an online database, and books comprehensively describing the issue and also declare that they would attend thematic lectures.

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