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THE ANTIMICROBIAL PROPERTIES OF SELECTED OILS USED AS COSMETICS COMPOUNDS

Abstract: Cosmetic vegetable oils for centuries have been objects of interest as ingredients of natural personal care products. Nowadays the trend for coming back to nature has caused their increased popularity in the preparation of natural cosmetics, soaps, and fragrance oils. The aim of the study was to evaluate the antimicrobial properties of 18 selected cold pressed cosmetic oils towards human pathogens. The antagonistic activity of cosmetic oils was assayed by the disc diffusion method. Indicator microorganisms chosen for the study were the bacteria *Staphylococcus epidermidis, Staphylococcus aureus, Pseudomonas aeruginosa, Escherichia coli* and yeasts *Candida albicans*. The conducted research showed that selected cosmetic oils demonstrate different antagonistic effects towards indicator microorganisms. The highest antibacterial activity was found in tamanu seed oil. This cosmetic oil decreased the growth of *S. aureus*, *S. epidermidis* and *P. aeruginosa* to a significant level. Wheat germ oil inhibited the growth of *S. epidermidis* and *P. aeruginosa*. The oil of the black cumin seed was showed antibacterial activity towards *S. aureus*. None of the other tested cosmetics oils exhibited antimicrobial activity towards selected microorganisms as well as none of them was effective enough to inhibit the growth of *E. coli* and *C. albicans*. The antibacterial properties of the selected oils depended on their type as well as tested microorganism.

Keywords: cosmetic oils, cold pressed oils, antimicrobial activity, natural care products.

JEL classification: P46.

ANTYBAKTERYJNE WŁAŚCIWOŚCI WYBRANYCH OLEJÓW KOSMETYCZNYCH

Streszczenie: Kosmetyczne oleje roślinne od wieków są przedmiotem zainteresowania jako składniki naturalnych produktów do pielęgnacji ciała. Obecnie trend powrotu do natury spowodował wzrost ich popularności w przygotowaniu naturalnych kosmetyków, mydeł, olejków zapachowych. Celem pracy była ocena właściwości przeciwdrobnoustrojowych 18 wybranych olejów kosmetycznych tłoczonych na zimno wobec mikroorganizmów patogennych dla ludzi. Właściwości antagonistyczne olejów kosmetycznych oznaczano metodą dyfuzji krążkowej. Mikroorganizmy wskaźnikowe, które zostały wybrane do tego badania, stanowiły bakterie *Staphylococcus epidermidis, Staphylococcus aureus, Pseudomonas aeruginosa, Escherichia coli* i drożdże *Candida albicans*. Przeprowadzone badania wykazały, że wybrane oleje kosmetyczne wykazują zróżnicowane działanie antagonistyczne wobec drobnoustrojów wskaźnikowych. Najwyższą aktywność antybakteryjną wykazał olej tamanu. Ten badany olej kosmetyczny ograniczył wzrost bakterii *S. aureus, S. epidermidis* i *P. aeruginosa* na znaczącym poziomie. Olej z kiełków pszenicy zahamował rozwój bakterii *S. epidermidis* i *P. aeruginosa*. Olej z czarnuszki siewnej wykazywał aktywność przeciwbakteryjną wobec bakterii *S. aureus*. Żaden z pozostałych badanych olejów kosmetycznych nie wykazywał aktywności przeciwbakteryjnej wobec wybranych mikroorganizmów, jak również żaden z nich nie był na tyle skuteczny, aby hamować wzrost bakterii *E. coli* i drożdży *C. albicans*. Antybakteryjne właściwości wybranych olejów zależały zarówno od ich rodzaju, jak i od badanego mikroorganizmu.

Słowa kluczowe: oleje kosmetyczne, oleje zimnotłoczone, aktywność przeciwdrobnoustrojowa, naturalne produkty do pielęgnacji.

Introduction

Oils pressed from plants have been used by humans for centuries as a source of food, nutritional products, medicines and cosmetic products. Over the years the personal care industry has offered a large variety of multifunctional products consisting of chemical ingredients and synthetic intermediates. Nowadays consumers demand a limitation of chemical synthetic substitutes over cosmetic products containing natural and organic ingredients. Therefore plant products are increasingly used in a broad variety of cosmetics including makeup and personal care products. Cosmetic oils are plants, seeds or nuts raw lipidic materials which consist of a large number of active substances necessary for the proper functioning of the skin such as vitamins or organic acids including stearic, oleic and palmitic acids. Oils contain also many bioac-

tive components, as sterols, hydrocarbons, triterpene alcohols, carotenoids and chlorophylls. The amount as well as the presence of ingredients in the oil depends mainly on the type of material, its quality and variety. The high content of fatty acids in cosmetic oils have a beneficial effect on the skin [Lautenschläger 2003; Obiedzińska and Waszkiewicz-Robak 2012]. Cosmetic oils are excellent emollients which make the skin smooth and soft. During diffusion into the skin oils have different effects as: antibacterial, nourishing, smoothing, firming, moisturizing, soothing or revitalizing. The cold pressing production of oils prevents the most valuable components from heat damage. This technology for oil manufacturing does not involve heat or chemical treatment [Vermaak et al. 2011; Obiedzińska and Waszkiewicz-Robak 2012; Hassanien, Mahgoub and El-Zahar 2014]. Cold pressing also does not involve refining. Oils derived using this technology might contain higher levels of phytochemicals such as natural lipophilic antioxidants [Kiralan et al. 2014].

The microbiological stability of cosmetic products depends on many factors: the composition of the product, addition of preservatives, production hygiene, packaging handling and storage. Water is an essential ingredient for the growth of microorganisms; it is also a basic component of cosmetic products, constituting an excellent medium for microbial growth. Therefore contaminated cosmetics are a threat to the health of consumers as they may cause dangerous skin infections. The microbial contamination of cosmetics may result in the deterioration of its quality: delamination, haze, the appearance of a precipitate or changes in consistency and colour. To prevent the contamination of cosmetic products huge amounts of preservatives are used during production processes [Katušin-Ražem, Mihaljević, and Ražem 2003; Paulus 2005; Lundov et al. 2009]. Nowadays the cosmetic industry is under immense consumer pressure to produce safe but innovative natural products. For this lucrative industry, new cosmetic ingredients possessing antimicrobial properties are in demand. Plants, seeds, nuts or fruit oils among all their beneficial features may constitute antimicrobial properties, as it has already been reported in a few kinds of viscous liquids [Nair, Vasudevan, and Venkitanarayanan 2005; Kashmiri et al. 2009; Idu et al. 2014]. However data concerning the antimicrobial activity of cosmetic oils are insufficient. Therefore the aim of the study is to determine the antagonistic potential of 18 selected cold pressed cosmetic oils against the isolates of Gram positive (*Staphylococcus epidermidis, Staphylococcus aureus*) and Gram negative (*Pseudomonas aeruginosa, Escherichia coli*) bacteria, in addition to pathogenic yeasts, *Candida albicans*. The microorganisms chosen for the study were bacteria and yeasts which are present in the physiological and pathogen

microflora of the human skin or gastrointestinal tract. Ensuring the safety of cosmetics it is required to document their microbiological purity and resistance to secondary contamination. Therefore, cosmetic products are tested for the presence of skin pathogens and microorganisms which may be harmful to human health. Furthermore, it is unacceptable that microorganisms such as *C. albicans*, *S. aureus* and *P. aeruginosa* were present in cosmetic products [Lundov et al. 2009; Detmer, Jørgensen, and Nylén 2010].

1. Materials and methods

The object of the study were 18 selected seeds, nuts and plants cold pressed oils including: hemp seed oil (*Cannabis sativa*), organic argan kernel oil (*Argania spinosa*), organic sunflower seed oil (*Helianthus annuus*), strawberry seed oil (*Fragaria ananassa*), black cumin seed oil (*Nigella sativa*), apricot kernel oil (*Prunus armeniaca*), grape seed oil (*Vitis vinifera*), black currant oil (*Ribes nigrum*), coconut oil (*Cocos nucifera*), wheat germ oil (*Triticum vulgare*), jojoba seed oil (*Simmondsia chinensis*), tamanu seed oil (*Calophyllum inophyllum*), red raspberry seed oil (*Rubus idaeus*), watermelon seed oil (*Citrullus lanatus*), brazil nut oil (*Bertholletia excelsa*), acai fruit oil (*Euterpe oleracea*), sesame seed oil (*Sesamum indicum*), avocado fruit oil (*Persea gratissima*). All of the studied cosmetics oils were freshly purchased from Polish manufacturers for the conducted tests.

The antibacterial properties of cosmetic oils were assayed by an improved disc diffusion method [Sacchetti et al. 2005; Zaouali, Bouzaine, and Boussaid, 2010]. Indicator microorganisms chosen for the study were the *Staphylococcus epidermidis* ATCC 12228*, Staphylococcus aureus* ATCC 33862*, Pseudomonas aeruginosa* ATCC 9027*, Escherichia coli* ATCC 8736 and yeasts *Candida albicans* ATCC 10231 bacteria. All of the tested bacteria were cultivated for 24 h before the experiment in Nutrient Broth medium (Biocorp Polska Ltd.) at 37°C. The yeasts were cultivated at 30°C for 24 h in worth broth medium which composition is in accordance with the nutritional requirements of *C. albicans*. The sterile saline inoculum of each microorganism was adjusted to the optical density 0.5 according to the McFarland standard. The amount of 1 ml of the microorganism inoculum was plated into the 90 mm Petri plate and overlaid with 20 ml of the appropriate medium for each microorganism. The nutrient LAB-AGAR (Biocorp Polska Ltd.) was used for the bacteria and Sabouraud Dextrose with the Chloramphenicol LAB-AGAR (Biocorp Polska Ltd.) was used for yeasts. After the solidification of the medium, 6 mm sterile

paper discs containing 10 µl of cosmetic oils were placed on the surface. The incubation took place in aerobic conditions at 30°C or 37°C for 24 h, depending on the indicator microorganism. Antagonistic activity was determined as an inhibition zone around the paper discs; the diameter was measured in millimetres. A sterile paper disc containing 10 µl of paraffin was used as a negative control.

2. Statistical analysis

Each value of the antibacterial activity determination is the mean of three replications. Data obtained from the study were analysed using Microsoft Excel®. The results were precisely summarized with a standard deviation (SD).

3. Results and discussion

The conducted laboratory trials indicate differentiated antimicrobial activity of the tested cosmetic oils towards indicator microorganisms. The impact of the selected oils on the growth of *S. epidermidis, S. aureus, P. aeruginosa, E. coli* and *C. albicans* is presented in Figure 1. Among all of the selected products tamanu seed oil demonstrated the highest antibacterial properties. According to the results shown in figure 1. tamanu seed oil decreased the growth of *S. aureus*, *S. epidermidis* and *P. aeruginosa* to a significant level. Next, the average inhibition of *S. epidermidis* and *P. aeruginosa* was observed by wheat germ oil activity. Zones of antagonistic activity towards the growth of *S. aureus* were also observed around the paper discs containing oil of the black cumin seed (Figure 1). Fifteen oils failed to inhibit any of the tested bacteria. None of the selected cosmetic oils inhibited the bacteria *E. coli* and yeasts *C. albicans* (Figure 2).

Growth of the *P. aeruginosa* and *S. epidermidis* was decreased by tamanu seed and wheat germ oils. Oil of the black cumin seed and tamanu seed oil inhibited *S. aureus*. Comparing the results of the experiments tamanu seed oil showed the highest antibacterial activity towards the growth of *S. aureus*, the diameter of the zone of inhibition was almost 18 mm. Growth of the *S. epidermidis* was also decreased by this oil to a high level. The diameter of the inhibition of this Gram positive bacteria by tamanu seed oil ranged to 14 mm. This oil decreased also the growth of the *P. aeruginosa* up to 12 mm of the diameter of the zone. Wheat germ oil antagonistic activity towards the

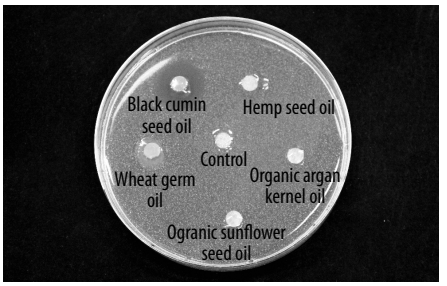

Figure 1. Antibacterial activity of chosen tested cosmetic oils towards *S. aureus*

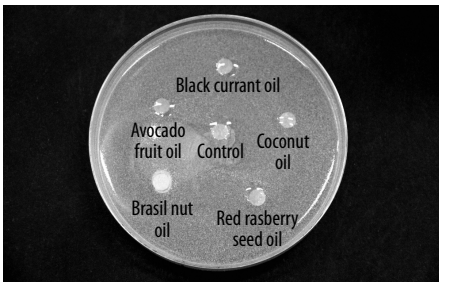

Figure 2. Lack of antimicrobial properties of chosen cosmetic oils towards *C. albicans*

S. epidermidis and *P. aeruginosa* was observed up to 10 mm inhibition zones. Assay conducting antagonistic activity of the black cumin seed oil showed the inhibition of growth of the *S. aureus* to the size of a 10 mm zone (diameter). The tamanu seed, wheat germ and black cumin seed oils did not show antimicrobial activity towards *E. coli* and *C. albicans*. The antagonistic properties of the selected oils depended on their type as well as the tested micoorganisms.

Although several groups of researchers conducted experiments in order to determine the antibacterial and antifungal properties of different oils [Nair, Vasudevan, and Venkitanarayanan 2005; Ramadan, Asker, and Tadros 2012; Idu et al. 2014], there are not many studies concerning the antimicrobial influence of a huge range of cold pressed oils.

The conducted studies involved determining the antagonistic activity of 18 cold pressed natural oils dedicated for cosmetic use. The results obtained in this study indicated only the antibacterial properties of three among all of the tested oils. Tamanu seed oil, wheat germ and black cumin seed oil also known as nigella or black caraway seed oil inhibited the growth of some indicator microorganisms. The antibacterial activity of black cumin seed oil has also been reported by Nair, Vasudevan, and Venkitanarayanan [2005]. These authors notified the inhibition of different strains of *Listeria monocytogenes* growth by cold pressed black cumin oil. In our research this seed oil presented antibacterial activity towards Gram positive bacteria – *S. aureus*. In the research conducted by Hassanien, Mahgoub, and El-Zahar [2014], six different cold pressed black cumin seed oils were tested. These seed oils were supplemented to cheese for an inhibitory effect towards food spoilage bacteria during cold storage. Authors have stated that in *vitro* and *in situ* supplementation with black cumin oils showed the antibacterial impact on the growth of the *S. enteritidis, S. aureus*, *E. coli* and *L. monocytogenes*.

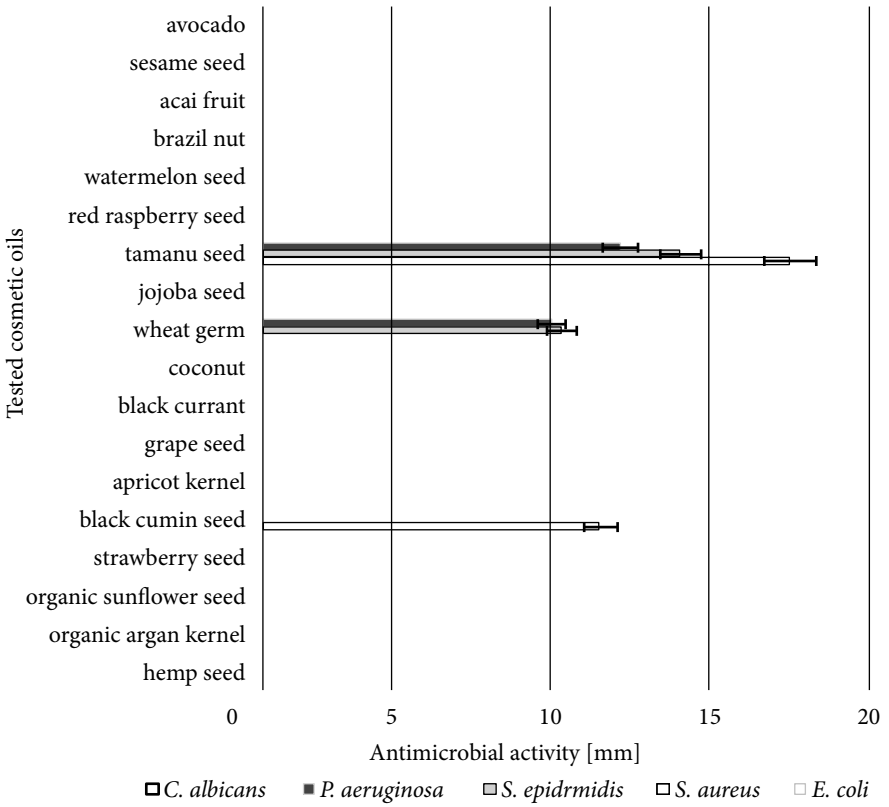

Figure 3. The antimicrobial effect of the tested cosmetic oils towards selected bacteria and yeast

No literature data was obtained in the case of the antimicrobial activity of wheat germ oil.

Information provided in the book edited by Canapi et al. [2005] indicates that coconut oil possess antifungal, and antibacterial properties. Research conducted by Oyi, Onaolapo, and Obi [2010] confirmed that formulated coconut oil creams exhibited both antibacterial and antifungal properties. Among numerous properties of the usage of coconut oil DebMandal and Mandal [2011] lists antibacterial, antifungal, antiviral and antiparasitic activity. Authors have indicated that coconut oil, received from nuts (concentrations 5–40% of oil) exhibited antagonistic properties against *P. aeruginosa, P. vulgaris, E. coli* and *B. subtilis.* However the result of our studies did not reveal any antagonistic activity of 100% coconut cosmetic oil.

In spite of all the information available in the literature concerning cold pressed cosmetic oils the authors were not able to receive information on the antimicrobial properties of the other tested oils.

Conclusions

In conclusion the tested bacteria strains as *S. aureus, S. epidermidis* and *P. aeruginosa* were susceptible towards antagonistic activity of only a few selected cosmetic oils. From an amount of 18 different oils merely three demonstrated the ability to inhibit the growth of some indicator microorganisms. Summing up, tamanu seed, wheat germ and black cumin oils may find an application as antimicrobial compounds in cosmetics. However, their antagonistic activity towards the tested microorganisms was observed at an average level. More detailed research is required in order to determine the antimicrobial constituents of these oils. Therefore for cosmetics production including these oils, it is recommended to use additional natural compounds with antimicrobial activity, for example selected essential oils. The relationship between the chemical composition of cold pressed cosmetic oils and their antibacterial activity will be crucial for use as preservative compounds taking into account that at the same time they will also exhibit many beneficial properties for skin. Laboratory trials evaluating the antimicrobial properties of market cosmetic oils, without their detailed specifications should also be expanded to obtain the composition of the product. It is worth underlining that the qualitative and quantitative composition of oil determines its antagonistic properties.

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