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Selection of micromycetes capable of developing on technical lubricants

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This article briefly reviews literature data on industrially used lubricants. Their chemical composition, sources of origin, fields of application and function, as well as wastes formed after their usage and the importance for the environment are described. Various microorganisms, among numerous micromycetes capable of destroying lubricants and using them for nourishment, continuously find their way into a lubricant with dust or by other channels. In order to identify micromycetes capable of destroying technical lubricants, eight species of micromycete strains were isolated from dust accumulated in herb and spice hothouses. This was due to the fact that the accumulation of this dust is determined by the diversity and composition of the substances detected in herb waste; part of those components are constituents of lubricants. The following widely spread micromycetes were studied: *Alternaria alternata*, *Chrysosporium merdarium*, *Gilmoniella humicola*, *Trichoderma harzianum*, *Fusarium proliferatum*, *Aspergillus niger*, *Aureobasidium pullulans*, *Geomyces pannorum* as well as the following widely used components of lubricants: formaldehyde releasing triazine biocide (FRTB), overbased calcium aulphonate in mineral oil (OCSMO), oxidized wax with Ca in Mineral solvent (OWNCMS), low erucic rapeseed oil (LERO), mineral oil with heavy naphthenic vacuum distillates (MOHNVD), chlorinated hydrocarbon (CHC53). It has been determined that *Chrysosporium merdarium*, *Alternaria alternata*, *Fusarium proliferatum*, *Geomyces pannorum* are the most active lubricant destructors. *Paecilomyces carneus*, *Botrytis cinerea* fungal strains occupy a particular place in lubricant destruction on the list of fungi. FRTB showed the most pronounced effect on fungal growth and development under the conditions of our experiments, while the effect of LERO was the weakest. The selected micromycetes as well as the methods of stimulation of their action and technological regulation can become a tool enabling to diminish environmental pollution with wastes of technical lubricants, thus improving the ecological conditions of the environment.

Key words: micromycetes, selection, technical lubricants, deterioration, metabolite, environment, ecological condition

INTRODUCTION

Lubricants of various origin and nature are used in engineering in order to satisfy different requirements. They are almost exclusively petroleum-based. Microorganisms, either together with dust or by other means, continuously find their way from the environment into these lubricants. The conidia of micromycetes and spores can remain viable for a long time (10–20 months). When the medium contains 0.01–0.02% of water, propagules sprout, start to develop and proliferate. For their nourishment, microorganisms use oil hydrocarbons, incorporating them into their energy and substance metabolism cycle. Lubricants, their wastes and the microorganisms functioning in them become a strong technical and ecological factor perpetually existing in the contemporary natural environment (Билай, Коваль, 1980; Lugauskas et al., 1997).

Industrial and automotive lubricants are very diverse and have many different applications. Volume-wise, most of them are used as automotive engine oils, hydraulic fluids, transmission lubricants and greases. They can be composed of many different ingredients representing a broad variety of organic and inorganic chemicals. However, most lubricant components can be subdivided into the following main categories: base oil, lubricity additives, rust protection additives and surfactants. In terms of utilization volume, base oils comprise by far the largest share. They usually originate from petroleum fractions, so-called mineral oils. Synthetically produced base oils are also used, as well as farm-based raw materials such as fats and vegetable oils. Recently, however, a variety of concerns have been raised about petroleum, making it necessary to look for alternative raw materials. One of the concerns about petroleum is its effect on the environment. Petroleum products do not biodegrade and persist in the environment for long periods of time. Petroleum products released into the environment (air, water, soil) may be harmful to plants, animals, fish and people. Another problem with petroleum is that it is resource-limited and non-renewable (Biresaw, 2007).

Few vegetable oils are mono-esters of long-chain fatty alcohols and fatty acids (Lawate et al., 1997). A closer look at the effect of chemical structure on lubrication properties is a challenge yet to be addressed. The fatty acid composition of vegetable oils is a complex mixture of fatty acids of differing chemical structures such as hydrocarbon chain length, unsaturation degree, and presence or absence of functional groups in the hydrocarbon chains. Various studies have indicated that each trait of vegetable oil crops has its own fatty acid composition distinguishable from other crops or other traits of the same crop (Biresaw et al., 2002, 2007).

Products from renewable recourses are transforming the technologies of many industrial applications. Availability of new synthetic processes which utilize vegetable oils or fats suggests technologically viable routes to produce new materials for utilization as biodegradable synthetic basestocks (Wagner et al., 2001). Oxidation stability of the base oil is the key factor closely related to the content of polyunsaturated fatty acids in vegetable oils (Asadauskas et al., 2007).

In order to develop an alternative to mineral oils used for lubricating chains, tribological research on biodegradable lubricating materials – rapeseed oil (RO), rapeseed oil methyl esters (RME) and lard methyl esters (LME) – was carried out. Pure materials (RO, RME and LME) and their compositions, modified with different treat rates of a chain bar additive, were analysed. The greatest effect of an additive was found to be on the lubricating properties of LME and the minimum effect on RME (Padgurskas et al., 2007).

Owing to the recently launched worldwide development of nanotechnology, metal nanopowder additives to liquid and viscous lubricants have become again an object of intensive investigation. The lubricating effect of copper, brass and zinc additives to mineral oil has been studied. It was shown that reduction of wear rate was due to formation of anti-wear nanocrystalline films. Depending on additive type, the structures have different degrees of damage and oxidizing element concentrations (Belyev, Jankauskas, 2007). For environmentally favourable requirements, vegetable oils are the oils of choice. They are easily biodegraded for disposal. One of the basic compounded straight oils is naphthenic oil with 10–40% boundary lubricants added. These may include animal oils like lard oil or tallow, or vegetable oils like palm oil, rapeseed oil, or coconut oil. Oil-soluble esters of these oils are beneficial because they reduce the inherent biodegradation of fatty oils (Foltz, 1990; Childers, 1994; Asadauskas, 1997).

An interesting study was completed to evaluate the biostability of key water-soluble metalworking fluid additives. The test used recirculation aquariums of each additive that were periodically inoculated with bacteria and fungi from typical fluids. Microbial growth was monitored to determine which additives were biosupportive, biostable (neither supportive nor resistant), or bioresistent (Table 1).

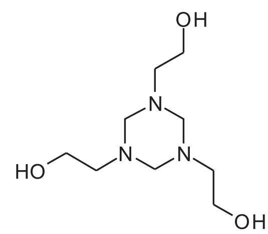
J. C. Childers (1994) first of all recommends to reduce the usage of the following compounds resistant to biological factors: corrosion inhibitors, amino methyl proponol, monoethanolamine borate ester; coemulsifiers: 2 : 1 DEA rosin fatty acid amide, sodium sulfonate; coupler: branched diacid; oils: naphthenic oil; microbiological acids: biocide / fungicide; diluent: water. However, these conclusions have not been further supported by follow-up studies.

The purpose of this work was to determine and identify micromycetes capable of developing on lubricants of various origin and nature, used in various industrial applications, their removers and other wastes, to investigate the reaction of micromycetes on different oil products, to discuss the possibilities to use the obtained species of micromycetes for environment protection from intensive pollution with lubricants and their wastes.

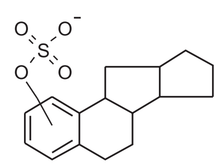
MATERIALS AND METHODS

For the studies of the capacity of micromycetes to contaminate, destroy and use for nourishment, the following widely used lubricant components were chosen:

1. Formaldehyde releasing triazine biocide (FRTB)



2. Overbased calcium sulphonate in mineral oil (OCSMO)



3. Oxidized wax with Ca in Mineral solvent (OWNCMS).
4. Low erucic rapeseed oil (LERO).
5. Mineral oil with heavy naphthenic vacuum distillates (MOHNVD).
6. Chlorinated hydrocarbon (CHC53).

Table 1. **Biostability of metalworking additives (by Childers, 1994)**

Function	Bioresistant	Biostable	Biosupportive
Emulsifiers		2:1 Tail oil amide Natural sodium sulfonate nonylphenolethoxylate (HLB 13.4)	Alkali fatty acid soap Octylphenolethoxylate (HLB 10.4) 2:1 Fatty amide sulfonate base
Corrosion inhibitors	Amino methyl propanol amine borate	Triethanolamine	Amine dicarboxylate
Lubricants		600 PEG ester Polyalkylene glycol Block polymers	Sulfated castor oil Amphoteric

Two nutrient media were used for micromycete isolation: standard malt agar (DIFCO) and dicloran glycerol agar (DG-18, OXOID), with chloramfenicol. Eight different species of micromycete strains obtained from dust accumulated in herb and spice hothouses – *Alternaria alternata* (Fr.) Keissl., *Chrysosporium merdarium* (Link ex Grev.) J. W. Carmich., *Gilmoniella humicola* G. L. Barron, *Trichoderma harzianum* Rifai, *Fusarium proliferatum* (Matsushima) Nirenberg, *Aspergillus niger* Tiegh., *Aureobasidium pullulans* (de Bary) G. Arnaud, *Geomyces pannorum* (Link) Singler et J. W. Carmich were employed.

With the purpose to determine the capacity of micromycetes to adapt to the lubricants under laboratory conditions, more detailed studies employing the following methods were carried out. Standard size round pieces of cellulose paper moistured with distilled water were placed into sterile Petri dishes, five drops of one of the mentioned above lubricants were poured out drop by drop or an appropriate quantity of a lubricant was smeared on each piece of paper contaminated with propagules of a fungus under investigation. By doing this, it was sought to select strains capable of developing on the surface of filter paper soaked with a lubricant. In later experiments, fungi of active strains were sown directly into a lubricant smeared on a covering glass plate placed in Petri dishes. The cultures of fungi sown into lubricants were kept in a moist chamber at a temperature of about 26 ± 2 °C. To evaluate the intensity of fungal growth, methods indicated in Standard 9.023–74 (Russia) were employed (Единая…, 1974).

The morphological peculiarities of fungi were studied employing a scanning electron microscope EVO 50 EP (Carl Zeiss SMT AG, Germany) and light microscope.

RESULTS AND DISCUSSION

The reaction of microorganisms to various oil products is different and depends on the composition and structure of the products' hydrocarbons. The microorganisms most easily assimilate n-paraffins, aromatic compounds and izoparaffins, while cycloparaffins are highly resistant to the action of microorganisms. For microorganisms to develop, water is needed. The latter finds its way into oil products and lubricants of other origin from the environment or is formed when water steam condenses in indoor premises. The microorganisms develop more actively when dopes of organic and mineral substances together with water find themselves in oil products and other lubricants. The conditions for microorganisms to develop are most favourable at the interface of water and oil phases, which is where microorganisms start functioning. Oil products are a specific niche for microorganisms to develop. The most typical feature of such a niche is the presence of two hydrocarbon and aqua phases. In this system, there is a rather high content of carbon and a very low quantity of nitrogen and active water.

When oil products become a medium for microorganisms' nourishment and when the latter consume paraffin and fuel fractions and assimilate up to 80% of their components, in the medium there accumulate quite a number of rather aggressive corrosive substances of microbiological origin: peroxides possessing an -O-O- group, mucus mud (pulp), organic acids which change oil pH.

Later on, unwanted processes occur in the medium, metallic parts of premises corrode, protective coatings flake and erode, films are formed on the walls, the quality of oil worsens, although this can remain unnoticed for some time because the microorganisms develop in the water phase layer enriched with hydrocarbons and gradually penetrate the hydrocarbon phase – oil products, fuels and others. The microorganisms help to assimilate hydrocarbons thus changing their properties. Gradually, the oil product looses its operational value. According to the regulations in force, fuel and other products become unfit for use when 5 to 10 thousand cells of bacteria and 1.5 thousand propagules of fungi are found in 1 ml of fuel (Darby et al., 1968; Билай, Коваль, 1980; Lugauskas et al., 1997).

Lubricants of oil and other origin are extracted, prepared, delivered and used under conditions of different geographic regions, therefore, the contamination of lubricants of oil and other origin with micromycetes differs. Micromycetes of various species can diminish the operational value of fuel, lubricants and other products. It should be mentioned that the capacity of various micromycete species to destruct and assimilate lubricants of oil origin differs. Therefore, while solving problems of microbiological destruction and waste utilization of lubricants, it is very important to reveal micromycetes whose physiological peculiarities enable them to destroy lubricants of various composition used industrially and to find the ways to control these processes and use them for solving practical problems.

Oxidation represents a variety of chemical reactions between oils and ambient oxygen at somewhat elevated temperatures on conventional surfaces. Oxidation encompasses such chemical mechanisms as free radical generation, peroxide formation, hydroperoxide decomposition, scission, branching, and polymerization. The ability of a material to resist these processes is represented by its oxidative stability which plays a major role in aging, shelf life and other performance characteristics. Oxidative stability is an important parameter in oils, fuels, lubricants, plastics, cosmetics, paints, etc.

With current trends to replace petroleum-based products which biodegradable materials from renewable resources, researchers devote more attention to newly synthesized fluids based on vegetable oils and other natural sources. The possibility to evaluate their oxidative stability primarily rests on a good understanding of the mechanisms and kinetics of these oxidative processes.

The initial cause of oxidative degradation is free radicals which are generated mainly due to the presence of metal ions. Non-radical mechanisms, such as triplet oxygen, ozonolysis and UV, usually are less significant at 50 °C or higher.

In order to select micromycetes capable of destroying lubricants, eight species of micromycete strains obtained from dust accumulated in herb and spice hothouses were chosen for investigations under local manufacturing conditions. This was done because the accumulation of this dust is determined by the variety and composition of the substances detected in herb wastes in which the part of components are constituents of lubricants. In the FT-IR spectrum of dust accumulated in herb hothouses, a greater variety of absorption bands was noted as compared with those of dust accumulated in crop grain storehouses – more adsorption bands and a wider interval in the 1210–1020 cm^{-1} region, adsorption at 1740 cm^{-1} shows up, which can be attributed to the presence of compounds possessing an ester band ($R–COOR_1$); the intensity of absorption in the 2900–2800 cm^{-1} region increases, which is indicative of increase in the number of $–CH_2$ – groups, i. e. presence of longer aliphatic chains or cyclic compounds. The dust capacity to adsorb volatile substances of plants can be concerned with this. By and large, in dust collected in herb storage and desiccation premises there were greater quantities of compounds containing groups of etheric (1100–1030 cm^{-1}), amidic (1655 cm^{-1}, 1550 cm^{-1}), carbonilic (1740 cm^{-1}) and aliphatic (2950–2830 cm^{-1}) chains.

The capacity of selected micromycetes to develop on the chosen technical lubricants can be explained by the experimental data presented in Table 2. The development of widely spread *Alternaria alternata* and *Gilmoniella humicola* micromycete species was terminated by FRTB, while OWNCMS terminated the development of *Aspergillus niger* and *Aureobasidium pullulans* species. The development of other fungi was more or less suppressed, especially by FRTB. *Trichoderma harzianum*, *Fusarium proliferatum* acted as active decomposers under the study conditions. Some lubricant components were rapidly consumed by *Alternaria alternata*: LERO, MOHNVD, CHC53. *Chrysosporium merdarium* fungi actively secrete a yellow pigment, coloured the substrates and markedly destroyed them, especially CHC53. *Trichoderma harzarium* most actively destroyed LERO, while *Aspergillus niger* harmed MOHNVD. The latter was actively used by *Geomyces pannorum* species fungi for their nourishment. The growth of certain fungal species on the lubricants is illustrated in Figs. 1–9.

Table 2. Evaluation of micromycetes growth (on a five-point scale) on six lubricants after staying 28 days in a moist chamber at a temperature of 26 ± 2 °C

Fungal species	Number of Lubricant (1 – 6)					
	1	2	3	4	5	6
Alternaria alternata	Does not grow 0	Grows slowly 1	Grows slowly 1	Grows intensively 4	Grows intensively 4	Growth is somewhat retarded 4
Chrysosporium merdarium	Grows slowly, intensively releases a yellow pigment 2	Grows slowly, releases a yellowish pigment 2	Develops forming a white mycelium, releases a yellowish pigment 3	Develops a white mycelium 3	Develops around the lubricant forming a white ring 3	Grows intensively 4
Gilmoniella humicola	Does not grow 0	The mycelium is whitish, not abundant 2	The mycelium is not abundant, next to the lubricant colonies are formed 2	Weak growth 2	The fungus develops more intensively from the point of contact 2	Fungal colonies form around the fungi 2
Trichoderma harzianum	Grows slowly 1	Growth is observed in all cases 2	Grows and spreads laterally 2	Intensively develops, abundantly sporulates 4	A thick mycelium, intensive sporulation 3	Develops on the whole surface 3
Fusarium proliferatum	Grows slowly 1	Growth is observed with an intensive release of a reddish pigment 3	Fungi develop next to the lubricant and spread laterally 3	Grow intensively, the whole surface is covered with a mycelium 5	On the surface of the lubricant a thin mycelium extends 4	The lubricant is covered with a whitish deposit, releases a reddish pigment 4
Aspergillus niger	Grows slowly 1	Growth is observed 2	Does not grow 0	Growth is observed 2	Grows intensively, covers the surface of the lubricant 4	Covers the surface of the lubricant with a thin mycelium, forms conidia 3
Aureabasidium pullulans	A slow development of the fungi 0.5	Forms a continuous film on the surface of lubricant 3	Does not develop 0	The fungi develop slowly 2	Non-continuous growth of fungi 2	Develops slowly 1
Geomyces pannorum	A whitish mycelium is formed 2	A whitish, mycelium is formed 2	Growth is observed 2	Fungal growth is observed 2	Very intensive growth 5	Intensive growth 3
Control (lubricants not contaminated with fungi)	Does not develop 0	Does not develop 0	Does not develop 0	Does not develop 0	Does not develop 0	Does not develop 0

The following lubricants were used: 1 – formaldehyde releasing triazine biocide (FRTB), 2 – overbased calcium sulphonate in mineral oil (OCSMO), 3 – oxidized wax with Ca in mineral solvent (OWNCMS), 4 – low erucic rapeseed oil (LERO), 5 – mineral oil with heavy naphthenic vacuum distillates (MOHNVD), 6 – chlorinated hydrocarbon (CHC53).

According to the data presented in Table 2, the micromycetes differently reacted to the impact of the components of the lubricants studied. The growth of *Alternaria alternata* fungi was completely suppressed by FRTB. The reaction on the components of other lubricants of the fungi of this species was weaker, which is seen from the pictures of their growth on the lubricant, made by the light microscopy method (Figs. 1–3).

The lubricant FRTB stopped the growth of *Gilmoniella humicola* under the experimental conditions. Under the action of the lubricants, the fungus was capable to develop and form conidia, which is evident from the pictures obtained with optical and scanning electron microscopes (Fig. 4).

Trihoderma harzianum developed on all the lubricants studied. FRTB was the strongest to suppress the development of the fungus, while LERO was assimilated by these fungi most easily. This was proved by the pictures of fungus development during 10 days (Fig. 5).

The fungi developed on LERO in a very specific way: they covered oil with a slim mass due to abundant sporulation, yellow, creamy, light pink or light brown, sometimes finally changing to black due to the production of chlamydospores. Blasteniospore codidia are simultaneously formed in usually dense groups; when sporulation is abundant, they are produced all over the cell surface (Fig. 6a).

After lubricants had been contaminated with a mixture of various fungi, it became clear that, on the one hand, various fungal species possessed different adaptation abilities and, on the other hand, the sensibility of the studied lubricants to fungal impact also differed. This is seen in the pictures obtained by the method of scanning microscopy (Fig. 7).

After processing the data, it has been found that most of fungi applied to lubricants adapted and intensively developed on LERO (Fig. 7c), while only some fungi slowly developed on MOHNVD (Fig. 7d).

Thus, it has been determined that LERO, which is proposed for technical purposes, is not resistant to the impact of fungi. Micromycetes from *Alternaria alternata*, *Trichoderma harzarium*, *Fusarium proliferatum* fungal species are capable to use intensively this natural lubricant. Micromycetes of *Chrysosporium merdarium* species are the most active in abundant pigmentation, destruction and yellow colouring of the lubricants.

In order to use these micromycetes for acceleration of lubricant waste utilization, it is needed to select certain micromycete strains and apply conditions stimulating their activity in those places where an excess of lubricants and lubricant waste is collected. The biological destruction of lubricant wastes can become a promising technological solution only when certain active micromycete strains are selected and when favourable conditions for the active populations to function are maintained or promising colonies of various fungal species are formed.

Along with the micromycetes mentioned, *Botrytis cinerea* Pers. ex. Fr. Micromycetes, which is often regarded as parasites, acted as active lubricant destructors. However, their wider application for technological needs is restricted by their marked parasitism (Fig. 8).

The micromycetes of *Paecilomyces carneus* (Duche et Heim) A. H. S. Brown et Sm. species have a capacity to contaminate various lubricants, as well as to develop on them and perform conidiogenesis. Fungi of this species were often ascribed by a number of authors to the genus *Spicaria* and named as *Spicaria carnea* Duche et R. Heim; S. carnosa J. H. Miller, Giddens et Foster; *Spicaria viridis* Szilvinyi, sometimes as *Spicaria decumbens* Oudem.

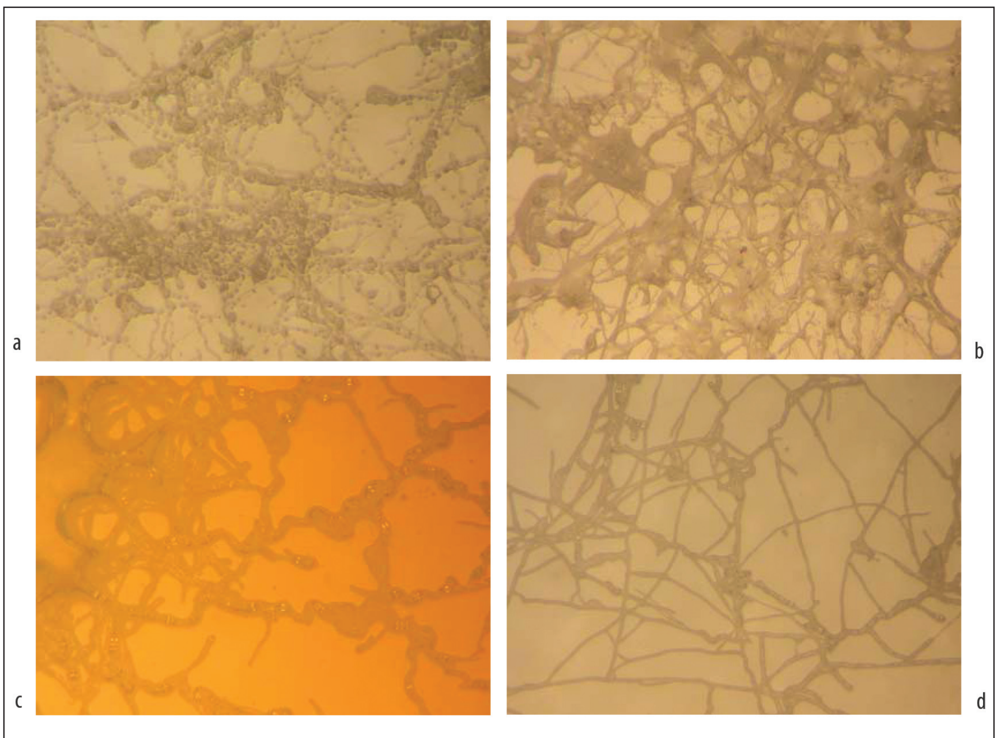


Fig. 1. General view of fungus *Alternaria alternata* development on various lubricants: a) oxidised wax neutralised with calcium in mineral solvent; b) low erucic rapeseed oil; c) mineral oil with heavy naphthenic vacuum distillates; d) chlorinated hydrocarbon. ×100

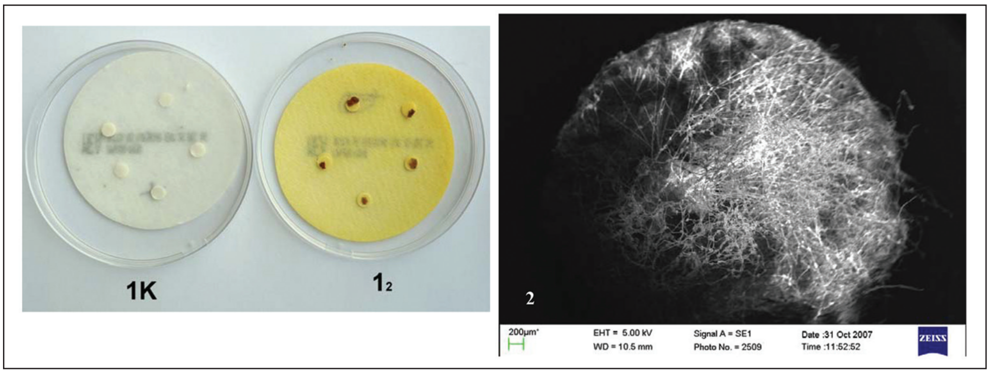


Fig. 2. *Chrysosporium merdarium* micromycete growth: 1K – on cellulose; 1_2 – on cellulose saturated with formaldehyde releasing biocide triazine, intensive pigmentation is observed; 2 – a view of micromycete development, obtained with a scanning microscope on saturated cellulose (No. 1)

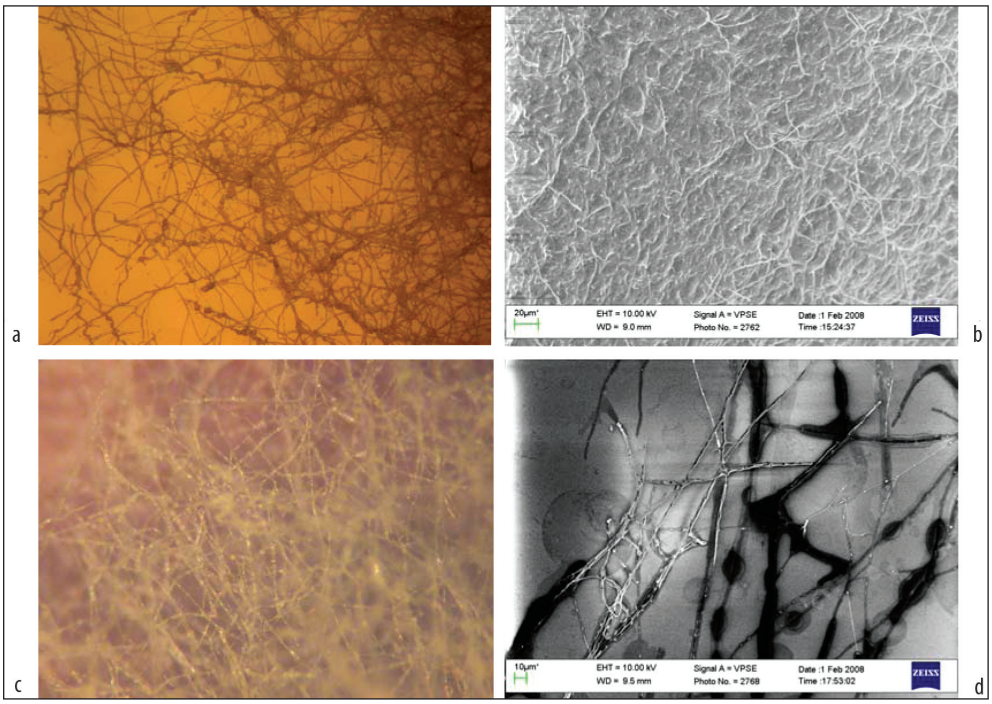


Fig. 3. Development of *Chrysosporium merdarium* fungal species obtained with a light (a, c; ×100) and scanning microscope (b, d) on low erucic rapeseed oil (a, b) and chlorinated hydrocarbon (c, d)

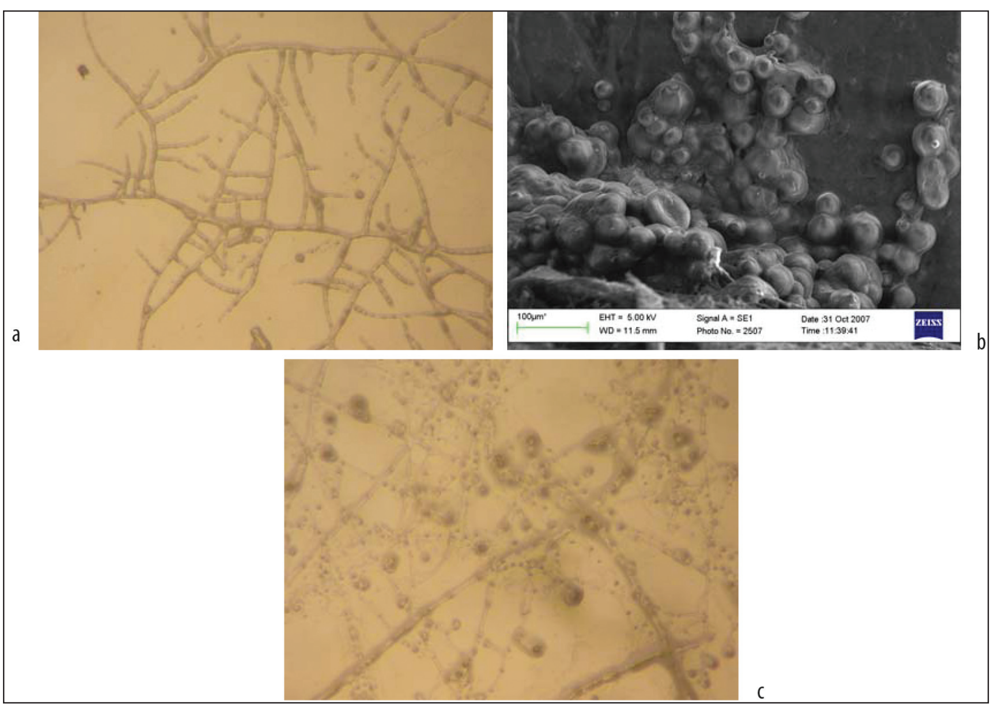


Fig. 4. Development of *Gilmoniella humicola* fungal micromycetes on: a) overbased calcium sulphonate in mineral oil (light microscopy, ×100) and b) the same obtained with scanning electron microscopy; c) oxidised wax neutralised with calcium, ×100

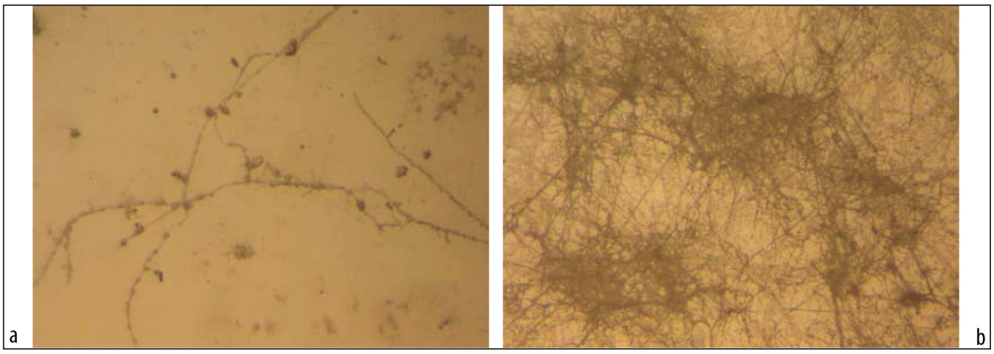


Fig. 5. General view of development of *Trihoderma harzianum* fungi after 10 days of growth on: a) formaldehyde releasing biocide triazine; b) low erucic rapeseed oil, ×100

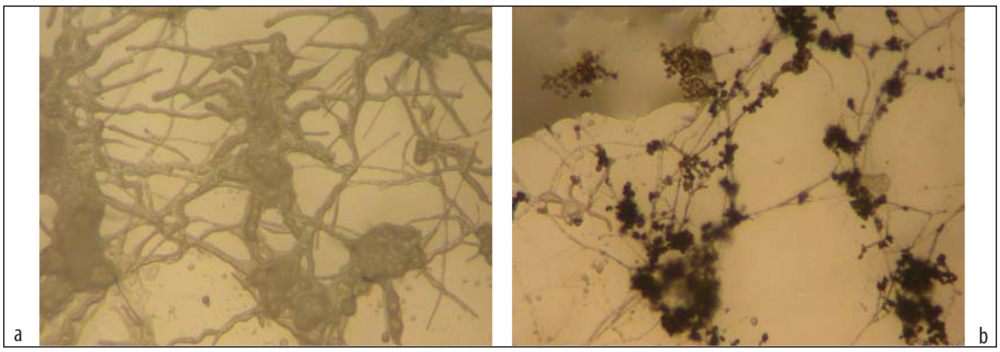


Fig. 6. Development of *Aureoabasidium pullulans* fungi on low erucic rapeseed oil (a), development of *Geomyces pannorum* fungi on mineral oil. The pictures obtained by light microscopy after 10 days of growth, ×500

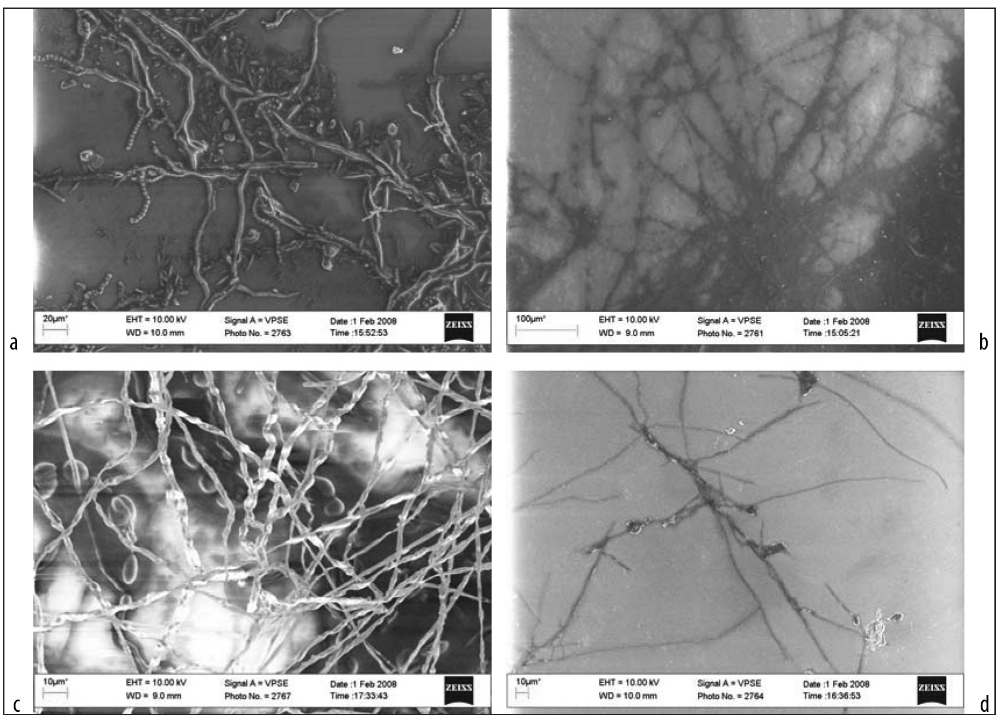


Fig. 7. Micromycetes development on: a) overbased calcium sulphonate suspended in mineral oil contaminated with a mixture of fungal propagules; b) oxidised wax neutralised with calcium; c) low erucic rapeseed oil; d) mineral oil with naphthene vacuum distillates

They are the species of micromycetes common in soils in various climatic zones and in other substrates; they grow slowly but intensively and quickly utilize various substances. According to Domsch et al. (1980), these fungi utilize cellulose and substrates rich in chitine, quickly grow on n-paraffines, produce antibiotics of the cephalosporinum group. In our experiments, these fungi actively grew and sporulated on OWNCMS (Fig. 9).

CONCLUSIONS

1. Lubricants used for technical needs are of various origin and composition. Micromycetes and other microorganisms enter lubricants by different ways depending on the composition and state of a lubricant, and start functioning. Most of them can assimilate components of lubricants, but these processes are of different intensity which to a large extent depends on the envi-

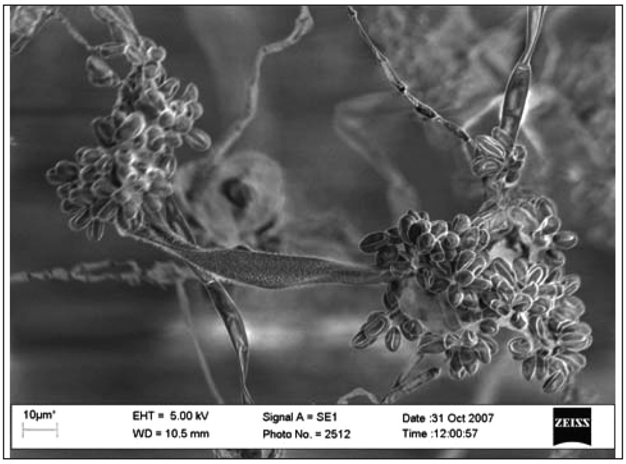


Fig. 8. *Botrytis cinerea* conidiogenesis of fungi developed on overbased calcium sulphonate suspended in mineral oil

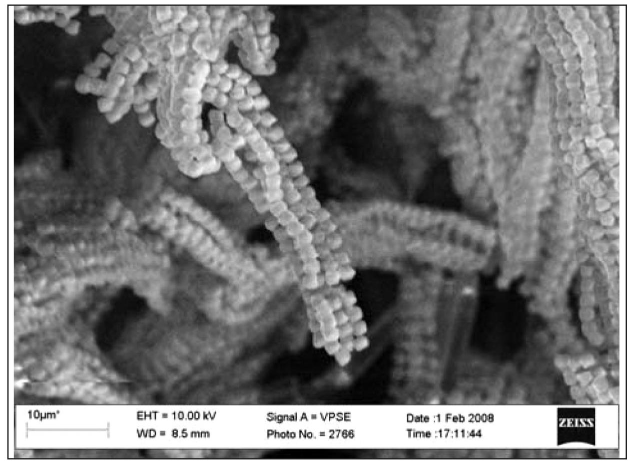


Fig. 9. General view of conidiogenesis of *Paecilomyces carneus* fungal species developed on oxidized wax with calcium in mineral solvent

ronmental conditions when the relation between the micromycete and the lubricant is established during the first contact and strengthened during further contacts.

2. Micromycetes reacted differently to the impact of various lubricant components such as a hexaheterocyclic compound with biocidic properties, calcium sulphonate suspended by various hydrocarbons, as well as in a mixture of oxygen, sulphur and nitrogen compounds. Under the influence of a biocide, only *Chrysosporium merdarium*, which abundantly released a yellow pigment, and *Geomyces pannorum* could develop more or less noticeably (2 points of 5 possible). Fungi of the *Fusarium proliferatum* and *Aureobasidium pullulans* species responded somewhat weaker. Oxidized wax completely stopped the development of *Aspergillus niger* and *Aureabasidium pullulans* fungi; the effect was notably weaker for *Chrysosporium merdarium* ir *Fusarium proliferatum* (3 points of 5 possible). The fungi studied destroyed LERO more intensively: *Fusarium proliferatum* – 5 points of 5 possible, *Alternaria alternata* and *Trichoderma harzianum* – 4 points of 5.

3. The proposed lubricants are not resistant to the action of micromycetes and can be destroyed by micromycetes of the *Paecilomyces carneus* and *Botrytis cinerea* species and by the above-mentioned micromycetes.

4. Micromycetes on which biotechnologies diminishing pollution of the environment can be based were selected, provided their activity is promoted and regulated.

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ATRANKA MIKROMICETŲ, GEBANČIŲ VYSTYTIS ANT TECHNINIŲ TEPALŲ

Santrauka

Pateikiama trumpa literatūros šaltiniuose paskelbtų duomenų apie technikoje naudojamus tepalus apžvalga, nurodyta jų cheminė sudėtis, kilmės šaltiniai, naudojimo sritys ir paskirtis, susidarančios atliekos juos naudojant ir poveikis aplinkai. Pabrėžiama, kad į tepalus įvairiais keliais nuolat patenka įvairūs mikroorganizmai, tarp kurių gausu mikromicetų, gebančių tepalus ardyti ir jais maitintis. Siekiant išaiškinti mikromicetus, galinčius ardyti techninius tepalus vietinėmis aplinkos sąlygomis, tyrimams buvo pasirinktos 8 rūšių mikromicetų padermės, išskirtos iš vaistažolių ir prieskoninių augalų džiovyklose susikaupusių dulkių. Tai padaryta dėl tos priežasties, kad šių dulkių kaupimąsi lemia vaistinių augalų atliekose ir nuobirose aptinkamų medžiagų įvairovė ir sudėtis, kurios dalis komponentų yra ir tepalų sudėtyje. Tirti tokie mikromicetai: *Alternaria alternata*, *Chrysosporium merdarium*, *Gilmoniella humicola*, *Trichoderma harzianum*, *Fusarium proliferatum*, *Aspergillus niger*, *Aureobasidium pullulans*, *Geomyces pannorum*. Tyrimų metu substratais naudoti tokie junginiai: 1. Biocidas (heksahidro-1,3,5-tris(2-hidroksietil)-s-triazinas – šešianaris heterociklinis junginys); 2. Kalcio sulfonatas, suspenduotas mineralinėje naftoje (įvairiausių angliavandenilių bei deguonies, sieros ir azoto junginių degiame mišinyje); 3. Oksiduotas vaškas, neutralizuotas kalciu ir ištirpintas mineraliniame tirpiklyje; 4. Rapsų aliejus; 5. Mineralinė alyva su mažai lakiais vakuuminiais distiliatais; 6. Chloruotas angliavandenilis (53% Cl). Nustatyta, kad aktyviausi įvairios sudėties tepalų ardytojai yra šių rūšių mikromicetų tirtos padermės: *Chrysosporium merdarium*, *Alternaria alternata*, *Fusarium proliferatum*, *Geomyces pannorum*. Pagal gautus tyrimo rezultatus išskirtinę vietą tepalų destrukcijos procesuose reikėtų skirti *Paecilomyces carneus* ir *Botrytis cinerea* rūšių grybams. Stipriausiu grybų augimo ir vystymosi slopintoju laikytinas formaldehidą atpalaiduojantis biocidas triazinas. Lengviausiai visų rūšių grybai įsisavina augalinį rapsų aliejų.

Raktažodžiai: mikromicetai, atranka, techniniai tepalai, destrukcija, metabolitai, aplinka, ekologinė būklė