

MICROMYCETES IN INDUSTRIAL AND HOUSEHOLD DUST: PECULIARITIES, EFFECT ON MANUFACTURING AND PEOPLE'S SAFETY

Albinas Lugauskas¹, Ausra Selskiene², Rita Butkiene³, Alma Rucinskiene⁴,
Bronius Jasklevicius⁵, Aurelija Kemzuraite⁶, Egidijus Zvicevicius⁷

^{1, 2, 3, 4}State Research Institute Center for Physical Sciences and Technology, A. Goštauto str. 9,
LT-01018 Vilnius, Lithuania. E-mail: ¹lugauskas@chi.lt

⁵Vilnius Gediminas technical university, Saulėtekio ave. 11, LT-10223 Vilnius, Lithuania.

^{6, 7}Lithuanian University of Agriculture, Studentų str. 15, LT-53361 Academy, Kaunas district, Lithuania.

Abstract. Taking into account that dust is an aggressive environment factor which often determines the success of food-stuff production, the durability of technological equipment and people's safety, dust from 8 groups of premises of different purposes was collected and compared. One hundred test portions were taken and investigated from 28 premises of different purposes. The humidity of dust, the variety of inorganic and organic substances, dust elemental composition, its contamination with propagules and mycotoxins were determined, the micromycetes detected in dust were isolated and identified. The major part of isolates detected in dust were ascribed to the micromycetes of *Penicillium* genus, which due to their biological peculiarities are able to spread rapidly and release toxic metabolites into the environment: The degree of spreading of fungi of *Aspergillus* genus was somewhat lower. Some of the toxins mentioned which are synthesized and released into the environment (aflatoxins, ochratoxins, patulin) can be controlled.

Keywords: dust, micromycetes, environmental factor, food-staff, production durability, technological equipment, people's safety.

1. Introduction

The propagules of microscopic fungi: conidium, spores, chlamyospores, pieces of mycelium and other fragments (CFU – colony forming units) are constantly detected in the air and dust of premises.

The pollution level increases rapidly with occurrence of the source of mycological pollution especially when technological processes are carried out. Formation and movement of air streams in industrial premises are very important factors determining the rate of CFU propagation. With the help of air streams CFU propagate very rapidly over the whole premises for long distances, penetrating into various cracks find their way into the respiratory and other organs of human body. The size of most micromycetes propagules reaches 1–5 µm in diameter and their multiplicity in air reaches 10 m⁻³ propagules. It should be mentioned, that most micromycetes produce allergens, contribute to asthma progression, initiate alveolitis of atypical allergic character. Such fungi as *Aspergillus fumigatus*, *A. candidus* and others can be cause of deep mycoses. Most micromycetes are the producers of mycotoxins (Cole *et al.* 2003; Pańczyński *et al.* 2007). Therefore, they become an unfavorable factor of the environment as well as a cause of various illnesses. Workers constantly working in dusty premises inhale dust particles formed from

organic and mineral substances which are present in the air in premises and the environment which contain abundant live micromycetes propagules, ticks and other bionts organic substances are abundant in the dust of the agricultural production premises (Cole *et al.* 2003; Góra *et al.* 2009). Dust of special organic composition is formed in the premises, where cattle and poultry are kept (Magan 2006; Spaan *et al.* 2007).

The composition of dust in premises depends on the environmental factors: geographical position, season, humidity, multiplicity of inorganic particles. According to the international health standards, the quantity of dust particles in premises should not exceed 5 mg·m⁻³. The following dust components of organic origin are considered especially unfavorable: bacteria, ticks, excrement particle, fungi propagules and their metabolites, hair, scales epithelium of skins. In the agricultural production environment dust is saturated in gas, sulfides of nitrogen and hydrogen. Nitrogen can irritate or cause paralysis of mucous membrane of eyelashes. Combination of nitrogen and dust leads to a marked increase in ventilation drift (power of disperse). Dust particles, being small, easily find their way to alveoles of mouth cavity and often become the cause of inflammation (Lugauskas *et al.* 2002; Williams *et al.* 2004; Szymanska *et al.* 2008).

The negative impact of dust is strengthened by the microorganisms it contains, namely microscopic fungi and bacteria of various species. The microorganisms propagate themselves and generate very rapidly. When intensive technologies are applied in production and fragile, dusty polluted raw materials are used, the concentration of fungi propagules in the air of industrial premises can reach up to 10 billion of CFU. This depends on the season. In winter the multiplicity of fungi in the premises decreases, sometimes to 10 CFU·m⁻³. In other seasons it fluctuates from 1 million to 10000 or even less CFU·m⁻³ of air. In dust there often detected mycotoxins which are produced and excreted by micromycetes into the environment. Their chemical composition – differs. The main producers of these mycotoxins under the mentioned condition are *Fusarium*, *Penicillium*, *Aspergillus*, *Alternaria* rarely micromycete of other genera. They find their way to the premises together with dust particles. Micromycetes of 15 to 20 species can be detected here. Under the conditions of store houses on the same substrates the dominants gradually change micromycetes of *Aspergillus*, *Penicillium*, *Rhizopus*, *Mucor* genera begin to dominate. Under such conditions along with fungi bacteria most often belonging to *Corynebacterium*, *Micrococcus* genera and actinomycetes are always detected, their concentration is especially high in the premises where poultry and livestock are kept (Krasauskas *et al.* 2005; Garcia and Heredia 2006). In such premises the concentration of bacteria and endotoxins is rather high. For example, the concentration of endotoxins in the air of such premises sometimes reaches 1,5 mg·m⁻³. The dust saturated with endotoxins is a risky ecological factor. In housing premises micromycetes are accompanied by ticks abundant in the dust which contains particles of hay, straw, grain. The excrements of ticks are rich in allergic substances, which markedly increase the negative impact of dust on the environment. The fungi propagules present in dust became appropriate food for ticks. Therefore under such conditions, ticks can not only survive, but these processes the environment becomes more aggressive (Piecková and Wilkins 2004). It been reported that in Sweden 38 % of people working in agriculture under such conditions have been to suffer from asthma and allergies (Liebers *et al.* 2006). Recently, the search is on for the means which could diminish environment pollution with dust, microbes and other organic pollutants. For this purpose various technical solutions have been applied, humidity is controlled, the possibilities to produce dust during the technological process are diminished (Lugauskas *et al.* 2004; Williams *et al.* 2004; Krasauskas *et al.* 2006). During the contact with substances damaged by micromycetes it is necessary to obey strict rules of safe handling in order to prevent the propagation of fungi propagules over the whole premises. The increase in humidity helps to concentrate dust and fungi propagules into dust puffs and remove, not leaving them for a longer time, because when air penetrates through cracks the fungi propagules begin to germinate. Sometimes dust is collected into specially encapsulated equipment and reservoirs. The methods of dust formation, collecting and removing are tended to be

improved in order to prevent the dust polluted with mycobionts from getting into the environment from food as well as technological raw materials, which are dried, stored, preserved, transported and sold, and vice versa from the environment where these process are carried out, into the treated raw material. The temperature and humidity of the environment, in which the technological processes are performed are monitored automatically and if necessary adjusted immediately. The state of hygiene of environmental air is constantly evaluated (Dutkiewicz *et al.* 2001; Lugauskas *et al.* 2007).

In housing premises, cattle sheds, hen houses and product processing and storage places it is very important to install and ensure proper operating of ventilation system, constantly clean to prevent propagation of the microorganisms and ensure that purification system would not because a source of mycological pollution. Water sprayed on dust encapsulates it, removes from air and collect into special storage tanks. Here the properties of dust particles containing propagules microorganisms to sediment and aggregate are used. Recently various technical means were proposed to be used for protection from dust and microorganisms propagules, however, their effect is not precisely evaluated, to protect people respiratory means with various dust filters were proposed.

Grain store houses dust is formed from grain particles, micromycetes propagules, bacteria and various inorganic substances. It is dangerous to keep grain in which the humidity is not constant or exceeds the standard requirements (by 12–13 %), the grain gets warm, grow moulds, they need shuffling and ventilation with a stream of cold air.

A peculiar mycological state is formed in premises, where various delicacies are produced from plant raw materials. In such premises the composition of organic dust is multi-component, because the raw materials used in processing is extremely diverse: rice, wheat, oats, maize flour, sugar, coconuts, milk powder, fragrances, nuts butter, malt extract, mixtures of vitamins and a variety of other components, whose particles enter into the composition of dust. It should be mentioned, that the raw materials for processing of these products are brought from different countries and together with it are brought more or less various fungi propagules, a part of which during processing can get into the environment, supplement the composition of dust or find their way into the products. Mycological monitoring of the products should be very strict and constant, because the product composition is a very good nutrient multi-component medium for development of micromycetes (Dutkiewicz *et al.* 2001; Lugauskas *et al.* 2006; Mankevičienė 2010; Spaan *et al.* 2008).

If it is remembered that dust is an aggressive environmental factor often determining the success of product processing, the wear resistance of the equipment and people's safety, the goal of this study is to collect and compare dust, forming during production of various plant and non-plant products and to determine dust pollution with micromycetes, to elucidate the biological and ecological peculiarities of detected micromycetes, as well as to determine the systematic dependence, possibilities of getting into the product, to anticipate the potential conse-

quences of their activities and their effect on people's health, to discuss the means allowing to diminish the pollution of industrial and housing premises with dust and hazardous micromycetes present in it.

2. Materials and methods

The dust from 8 groups of premises of different purposes was collected and compared. They were as follows: 1) dwelling premises, 2) granaries and store houses of other purposes, 3) grain treatment and food-stuff production premises, 4) potato and other food row materials store houses, 5) cattle and poultry housing premises, 6) workshops of textile industry, 7) granite, metal and wood machining premises, 8) premises of various purposes (restoration centre, computer and physics classes in school). One hundred test portions were taken and investigated from 28 premises of different purposes.

Airborne fungi were collected with a slit to agar stage impactur "Krotov 818" (OJSC "Krasnogvardejec" 3 Instrumentalnaya St., Saint Petersburg, Russia). Simultaneously with the collection was the uses of the gravitation settle plate's method for qualitative analysis of micromycetes. Dust settled on different surfaces was gathered with a sterile brush in to sterile glass vessels. The number of micromycetes propagules was expertised as CFU per 1 g of dust. Two nutrient media were used micromycetes isolation: standard malt agar + chloramphenicol and Sabouraud dextrose agar + chloramphenicol. The morphological peculiarities of fungi were studied employing light and scanning electron microscope EVO 50 EP (Carl Zeiss SMTAG, Germany) Micromycetes were identified according to various manuals (Samson, Frisvad 2004). The thin-layer chromatography method was used for estimation of toxins produced by fungi. Silicagel with fluorescent indicator UV 254 (Macherey Nagel, Germany) was used. Produced mycotoxins were identified according to Rf (distance of compound/distance of solvent) and to fluorescence in the UV, as compared with standard (ISO 8128-2 Part 2. 1993), Determination of toxins in the samples of dust was performed by the ELISA method (Frisvad and Thrane 2000; Lugauskas *et al.* 2006; Supronienė *et al.* 2010). Extraction of mycotoxins and test were performed according to manufactures instructions.

The organic substance, ash, humidity in the studied specimens were determined according to the procedures described in ASTM D 2974-87 standard. FT-IR spectra were recorded in KBr pellets with a BOMEN spectrometer (Hard and Brown, Canada). Spectra were interpreted using literature sources (Socrates 2001).

To determine the elemental composition of dust, it was homogenized and tablets of 8 mm in diameter were formed by the press method. The elemental composition of dust tablets was studied by using a scanning electron microscope EVO 50 XVP with an X-ray energy dispersion spectrometer. The measurement conditions: the accelerating voltage 20 KV, the electron beam current 1 nA, the pressure in the specimen medium 50 Pa, measurement time 200 s. In every specimen the concentrations of elements were measured in soluble areas of 100–200 µm each. The

average values are presented in the study. The statistical analysis of the data obtained was performed using the MICROSOFT EXCEL 2000 statistic 5.1 program.

3. Results and discussion

3.1. Micromycetes detected in housing premises

Housing premises of Lithuanian people differ. In towns and cities there are many new well-equipped houses. Along with them, there are abundant old, damp houses, whose wooden lumber and plastering go to ruin, crumble, get dusty. In block houses in joining places crack often are formed and through them rain water filter, the walls get damp. All that make favorable condition for microorganisms to propagate, and after sedimentation with dust on the walls, ceiling, window-sills, various things – to develop and colonize them. During adaptation micromycetes produce various metabolites among which there are amines and substances of other chemical composition possessing antibiotic and toxic properties. Most often they are acidic aliphatic or aromatic compounds, actively regulating the permeability of cells membranes. Largely micromycetes, especially, those of *Fusarium* species, synthesize compounds of polyene type, which contain not less than 3 double C=C bands.

Cyclic compound, various derivatives of benzene, organic acids, aldehydes, ketones form a large part of the metabolites synthesized by micromycetes. Micromycetes of some species can produce various aflatoxins (B₁, B₂, G₁, G₂ and others). Only fungi from all microorganisms can synthesize nitrogen compounds of amine class, which are extremely toxic to warm blooded animals. Cells of some fungi contain serotonin and other alkaloids close to lysergen. These are hallucinogenic compounds. When adapting to a new medium and beginning to function, micromycetes propagules excrete all these substances into the environment.

Dust was collected in a new house with all modern conveniences and its analysis showed that its humidity was 6,49 %, ashes quantity – 18,24 %, organic compounds – 81,76 %, whereas dust collected in an old individual farmhouse contained 8,49 % humidity, 26,76 % ashes, 73,24 % organic substances. In this case dust was considered, on the one hand, as a substrate for micromycetes development, from the other hand, as a pollutant with which people are in constant contact as well as all environmental components. Although, the dust collected in a new house was drier, but it contained more organic substances as compared to the dust collected in an old wooden house. This was partly determined by the lay-out of the premises and exploitation, as well as humid environment, the house is situated on the bank of river dam and the presence of a dog.

In order to precisely determine the chemical composition of the collected dust, its FT-IR spectra were recorded (Fig 1).

In both the dust specimens saturated and unsaturated carbohydrates of linear and branched chain were detected. Absorption bands of C-H stretching vibrations of all carbohydrates were in the region of 2840–2975 cm⁻¹ the bands of C-H deformation vibrations of linear ali-

phatic carbohydrates were in the region of 1370–1465 cm^{-1} , C-C vibration bands of branched chain carbohydrates were in the region of 1040–1175 cm^{-1} and the vibration bands of the same kind of unsaturated carbohydrates were in the region of 1000–1130 cm^{-1} . In these specimens organic compounds possessing the amide group (-CO-NH-) comprise a rather large part. Bands observed in the region of 1650–1670 cm^{-1} , 1620–1650 cm^{-1} and 1322–1457 cm^{-1} are typical of the compounds of this type. Judging by the intensities of the absorption bands, the quantity of the mentioned compounds is greater in specimen 1 (Fig 1, curve 1).

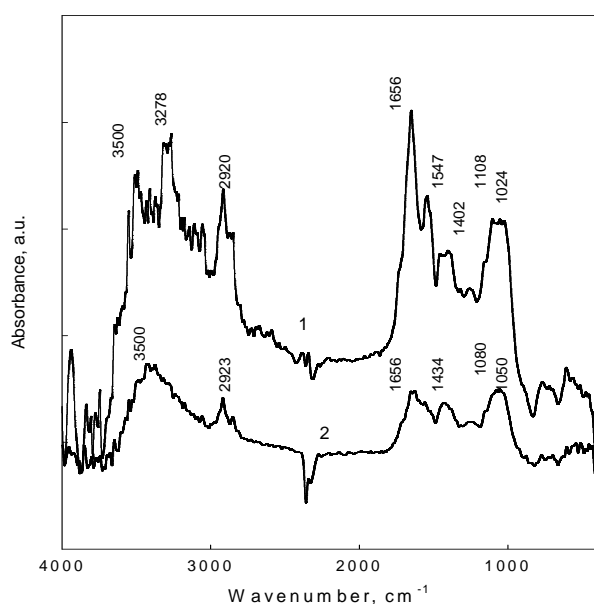


Fig 1. FT-IR spectra of the dust collected in the housing premises: 1 – a detached house with all modern conveniences; 2 – an old individual wooden house in farmstead

Carbohydrates of various structures can make their appearance from the cells of human and animal skin as well as from plants. Amide group is characteristic of natural polymers such as chitin.

O-H valent vibrations are observed in the remote region of the spectra. They are ascribed to the vibrations of hydroxylic group of water and alcohol molecules. In this case, most probably OH groups belong to water molecules, as the specimens were not dried prior to FT-IR spectra recording, but 6,49 % and 8,49 % humidity were detected in the specimens studied.

The chemical compositions of dust collected in both the housing premises did not differ markedly, that collected in the old house contained a slightly more carbon, less oxygen, more aluminum, magnesium, phosphorus, potassium.

The reason is that both the objects studied are in good condition, the surroundings are properly tidied and protected, less polluted, planted with trees.

The data obtained support our earlier data, which testify that dust microbionts possess such peculiarities of anthropogenic community that differ from those of myco-communities formed under natural conditions: by the

organization of structure, by the variety of species, by the frequency of detection, the ratio of taxons difference and their dynamic of change with time.

In the dust of the newly build house *Alternaria*, *Cladosporium*, *Penicillium*, *Mortierella*, *Rhizopus*, *Sclerotinia* dominate, sterile mycelium not forming conidium wall also abundant (*Mycelia sterilia*). All in all micromycetes of 22 species were detected in this object. Their detection frequency was not the same however each of them can begin to intensively develop if the conditions are favorable and pose unwanted consequences.

According to the data obtained and data reported by other authors (Cole *et al.* 2003) the following potential producers of mycotoxins were detected in the dust collected in the new house: *Alternaria tenuissima* – producing tenuazonic acid, *Cladosporium herbarum* – producing a complex of mycotoxins, which causes damage in the mucous membranes of horses muzzle; *Fusarium semitectum* – producing trichothecenes: anguidine, moniliformin and others; *Fusarium solani* – solaniol, neosolaniol, T-2, MT-25 toxin and many others. Fungi of *Penicillium* species make the major part of the micromycetes detected in these premises which produce mycotoxins, allergens and other toxic substances.

The fungi of mentioned above species were also detected in the old individual farmhouse (*P. crysogenum*, *P. expansum*, *P. janthinelum*). *P. atramentosum* and *P. verrucosum* species were ascribed to the group of dominating fungi under these conditions. The fungi of the former species produce roquefortine C, rugulovasine A and B while the fungi of the latter species produce rugulovasine A, verruculogen TR-2, 15-acetoxy-verruculogen. Little is known about the potential ability of the fungi of *Mucor* species to excrete toxic metabolites into the environment. There are data (Cole *et al.* 2003) that *Mucor rouxii*, like yeast *Saccharomyces cerevisiae* synthesize C₂₈ (Ergosta-5, 7, 9(11), 22 tetraen-3 β-ol) and sterols of another composition.

3.2. Micromycetes in grain store houses and another purpose

It was determined earlier, that growing winter and summer grain-crops cereals and leguminous plants in Lithuania, micromycetes contaminate them on the first ripening stages (Krasauskas *et al.* 2005) a variety of factors determine this. The main of them are considered to be atmospheric precipitation, relative air humidity and temperature, during the ripening of plants grains and seeds the plant genotype, the place in the rotation of crops, the soil where plant are grown, the used agrochemical means. Dust plays a very important role in the propagation of fungi propagules over a huge areal it provides the initial nutrition elements, present possibilities to consolidate under extreme environmental conditions and function. Thus, the grain crops are polluted not only with organic pollutants present in the environment, but with metabolites which are intensively excreted by fungi as well.

It has been determined (Mankevičienė 2010) that, on the grain crops grown in Lithuania fungi of *Fusarium* species are often detected. About 90 % of the samples

taken during harvesting are contaminated with mycotoxins produced by them.

The fungi species which developed on the grain crops in the field, dominate in the freshly pored grain bulks, granaries of limited space, tower storages. Storing grains for a longer period under such conditions, the composition of the detected fungi rapidly changes depending on the humidity, the temperature, the quantity of oxygen in the environment: the multiplicity of fungi of *Fusarium* species diminishes, the composition of *Penicillium* and *Aspergillus* species change, while the initial composition of *Alternaria*, *Drechslera*, *Cladosporium* remains unchanged for a longer period.

A high level of dustiness of grains transported from temporary storage places has been observed. Here *Cladosporium cladosporioides*, *C. herbarum*, *C. sphaerospermum* fungi species dominate. The fungi from genera *Oidiodendrom*, *Alternaria*, *Drechslera*, *Penicillium*, *Gliocladium* are encountered, more rarely *Aspergillus*, *Rhizopus*, *Mucor*, *Rhizomucor*, *Circinella*, *Mortierella*, *Scopulariopsis*, *Acremonium*, *Aurebasidium* and other fungi genera. *Fusarium* fungi species were detected only in some samples they most often belonged to *Fusarium avenaceum*, *F. oxysporum*, *F. graminearum*, *F. solani*, *F. proliferatum*, *F. poae* and *F. moniliforme* species.

The multiplicity of fungi detected in the threshed grain in great, but serious danger can be caused by numerous *Cladosporium* and *Alternaria* fungi species which get into storage places with dust and with are resistant to the impact of outer factors. In the storage they are in the latent anabiosis state. The least outer environmental irritant (increased humidity, a contaminants dose, changed temperature etc.) can stimulate vitality of the fungi and affect the environmental by the excreted metabolites in the direction that is useful for them: to provide themselves nutrients, accumulate humidity, perform energy exchange process. There is little data on the functioning of *Cladosporium* fungi species under such conditions. Biologic peculiarities make it possible for their conidium easily separate from the substrate or mycelium fragments, to rise with dust into the air and stay viable for a long time. These fungi can be one of the main pathogenic organisms causing allergies (Lugauskas *et al.* 2002). The fungi of this species are cosmopolitan they are spread in all countries. They are often detected on food products, birds feather, nests, therefore birds are active spreaders of them, especially when birds migrate over great distances. One of the species of these fungi (*C. sphaerospermum*) found in Lithuania is identified with *Hormodendron* fungi species, which are one of the skin disease, chromblastomycosis common in tropical countries pathogens. In mentioned fungi can also cause the skin disease in humans living in mid-latitude zone a problem arises, how to limit the spread of *Cladosporium* fungi species in order to diminish the quantity of them getting into granaries, and from there into human's environment and food stuff. It should be mentioned, that these fungi easily grow on the brick walls of factories and became a constant source of mycological contamination.

The peculiarities of dust in some granaries are reflected by the following data: humidity 5,09 to 8,94 %,

ashness 21,75 to 42,68 %, the quantity of organic substances 57,32 to 78,25 %. These data show that granaries and other store houses are specific premises, where dust of various compositions can accumulate.

In order to determine the differences in dust compositions more precisely FT-IR spectra were recorded (Fig 2).

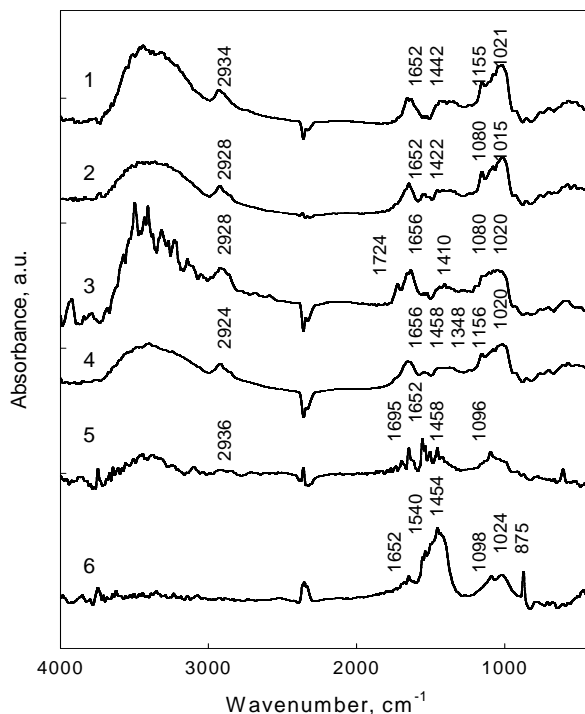


Fig 2. FT-IR spectra of the dust collected in the grain store house and other store house: 1 – bread bakery, 2 – grinding mill, 3 – crops with honey production premises, 4 – corn flakes production premises, 5 – store house of finished products, 6 – large potatoes store house

According to the data of physical chemical studies the dust of groups 2–4 is mainly formed from organic substances (95,30–98,03 %). Although samples 1 and 5 contain almost half the quantity of organic substances (45,31–68,43 %) as compared to samples 2–4, in all the infrared spectra absorption bands at 1652–1656 cm^{-1} and 1410–1458 cm^{-1} characteristic of the polypeptide amidic group are observed. In sample 3 a band at 1724 cm^{-1} manifests itself, which is characteristic of C-O vibrations of the anion of organic acids. In spectra of other samples a band of such an intensity was registered on the shoulder of amidic band vibrations (curve 1, 2 and 4), therefore, it can be suggested, that sample 3 contains more salts of organic acids, while in the other samples peptides dominate.

Bands in the regions of 2924–2936 cm^{-1} and 1015–1156 cm^{-1} are ascribed to C-H stretching and skeleton C-C vibrations of carbohydrates. In the latter region C-O-C vibration bands of aliphatic polyethers. Thus, it can be stated, that the dust mixture contains polysaccharides. Absorption of lower intensity in the region of 3230–3670 cm^{-1} can be explained by a lesser water quantity in the sample.

In the dust of sample 6 dominate inorganic carbonates. Strong absorption bands in the region 1320–1530 cm^{-1} are characteristic of these compounds, weaker ones

in the region 1020–1100 cm^{-1} , and those of a medium strength in the region 800–890 cm^{-1} . A minor shift of bands is observed (curve 6, 1540 cm^{-1} and 1024 cm^{-1}) due to overlapping of carbonate absorption bands with the bands of other substances present in the mixture. The band registered at 1652 cm^{-1} suggests that there are organic compounds comprising an amidic group in the mixture. According to the data obtained this sample contains 10,09 % of organic substances.

Analysis of the elemental composition of dust collected in granaries and other store houses showed that carbon concentration fluctuate from 46,0 % to 41,9 %.

The quantity of detected nitrogen was markedly higher in grain storage, and packing premises. This fact is difficult to explain. The quantity of sodium and magnesium was higher in the dust collected in the granulated forage shop. The quantity of sodium and magnesium was higher in the dust collected in the granulated forage shop. The quantity of aluminum and silicium was higher in the litter and granary premises. That of phosphorus and calcium were higher in granary and granulated forage room; that of iron – in the dust of granary and litter premises.

Often impurities of the elements used in technological processes are detected in dust, for example, during feed granulating works dust contains more sodium and magnesium, phosphorus, potassium. All this has its impact on the sanitary state of the premises and affects the bionts developing in grain crops and premises as well as health of the workers.

In the dust collected in granaries and store houses of other type the multiplicity of fungi is rather large according to the data obtained the micromycetes show in Fig 3 are considered to be dominants in the store house dust.

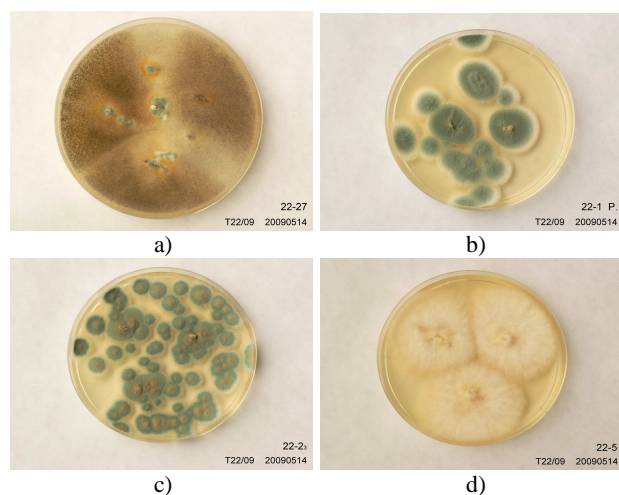


Fig 3. Micromycetes dominating in the store house dust:
a – *Rhizomucor pusillus*, b – *Penicillium commune*,
c – *Penicillium chrysogenum*, d – *Fusarium oxysporum*

It has been observed, that the mycological state of grain processing premises depends on the suitability of the building to the performance of these processes, its age, planning and the sequence of technological processes and installation and exploitation of ventilation systems. It is important to prevent the grain contaminated

with fungi propagule from getting into premises which are directly connected with industrial premises, where bread baking and other products processing are performed. This is also true for transportation and storage of other products such as seasonings and various additives. They should be kept in a separate room, because many new fungi species arrive with them and there is little or no information about them. In such case it is difficult to foresee how they can affect the quality of final product.

Fungi of some species of genera *Penicillium*, *Aspergillus*, *Cladosporium*, *Mucor*, *Scopulariopsis*, *Acremonium*, *Alternaria*, *Scytalidium*, *Wallemia*, *Monilia*, *Geotrichum*, *Athrobotrys* and some others can be ascribed to the mentioned group.

The performed studies show that extrusion used at present in the processing technologies diminishes the mycological contamination of grains and the multiplicity of species by 50 to 70 %. During this process a change in the fungi species composition is observed. The main part of fungi detected on extruded grains were fungi of genera *Aspergillus* (*A. flavus*, *A. oryzae*, *A. versicolor*, *A. candidus*, *A. carneus*, *A. cervinus*, *A. penicilloides*, *A. wentii*) and *Penicillium* genera (*P. commune*, *P. corylophilum*, *P. verrucosum*, *P. chrysogenum*, *P. claviforme*, *P. expansum*, *P. corymbiferum*, *P. roqueforti*, *P. oxalicum*, *P. viridicatum*). The frequency of detection in different samples of grains and products differs greatly and depends on the species, environmental conditions, under which the grain crops were grown, ripened, harvested, later stored, transported and processed. After extrusion the quantity of *Alternaria* genera fungi on the grains diminished. *Fusarium* genera fungi disappeared on some kinds of grains completely. The quantity of *Rhizopus oryzae* fungi decreased, only in some samples *Rhizomucor pusillus* and *Rhizopus stolonifer* fungi were detected.

Extrusion does not remove mycological contamination from grains but only diminishes it. Further germination of micromycetes propagules and their development depends on the conditions of storage of the raw materials and the technologies of products processing and the environment where the final product are stored.

Dust of a peculiar composition was formed in a potato storage house of a capacity of 1100 tons, in which loading-and unloading works were mechanized. Here an automatic ventilation system functions well. Potato piles are constantly ventilated, the nidus of decay are rare.

However, when performing loading-and unloading works a lot of dust is formed, which propagates very quickly over the whole premises where the people work. The humidity of dust was only 2,58 %, it also contained about 10 % of organic compounds, while inorganic substance comprised about 90 %. Dust of a similar composition was detected in a store house, where a factory kept various raw materials, spare parts of technical equipment, sometimes there was performed repair work. Here the humidity of collected dust was 3 %, it contained 18 %, of organic substances and 82 % of inorganic substances.

Analysis of the elemental composition of dust collected in other premises marked differences in the amounts of carbon, aluminum, silicium, potassium, iron. This was deter-

mined by the peculiarities of the equipment and exploitation of premises, which have a direct impact on the formation of pests in dust, on the product stored in premises and on the workers.

In the store house of various raw materials where dust was collected from metallic construction, the fungi of *Cladosporium herbarum* and *Penicillium chrysogenum* species dominated. The fungi excrete an especially wide variety of toxic metabolites: PR-toxin, patulin, ochratoxin A, roquefortine C, secalonic acid and other. A great variety of the fungi of *Penicillium* genera was observed in the dust samples taken from potatoes store house (*P. crysogenum*, *P. atramentosum*) are able to synthesize and excrete into the environment roquefortine, rugulovasine A and B, *P. aurantiogriseum* are able to excrete peculiar compounds of mycotoxins from penicillic acid, such as verucozidin and nephrotoxic glycopeptides, *P. brevicompactum* – brevianamide C, D, E, mycophenolic acid, etc.; *P. commune* – roquefortine C, cyclopiazonic acid; *P. nalgioense* – cyclopiazonic acid. They were accompanied by the fungi of *Aspergillus terreus* species – which synthesize toxic substances under certain conditions terretonin, patulin, claviform, clavacin, expansion, penicidin, mycoin, citrinin and other toxic compounds and their mixtures. The potential hazard of the mentioned fungi was strengthened by the fungi of *Trichoderma viride* species, which excrete into the environment viridin, viridiol, trichodermin and other toxic compounds.

3.3. The other premises of various purposes

Micromycetes propagules which find their way into the dust collected in premises remain vital for a long time and at sufficient humidity can germinate, begin to develop, function, excrete metabolites and vary the composition of organic substances present in dust, begin to propagate themselves, contaminate new substrates, increase their ecological importance.

Acrylic fiber and other wool fibers mixture are mentioned as chubby threads. In the dust of chubby threads manufacture micromycetes of *Penicillium* genera dominated (*P. chrysogenum*, *P. verrucosum*) in the dust of knitting-shop *P. daleae*, *P. lanosum*; in the dust of sewing-shop the multiplicity of detected species was larger (*Alternaria alternata*, *Cladosporium cladosporioides*, *P. albocoremium*, *P. expansum*). This can be explained by usage of a wide range of goods and their specificity, higher humidity of dust.

In the dust of granite workshop *Cladosporium sphaerospermum* and *Trichoderma harzanium* fungi which are unfavorable health dominated. The fungi of *Cladosporium herbarum* and *Oidiodendron echinulatum* species were the major dominants in the metal articles enterprise. In the dust of woodworking premises micromycetes of *Penicillium* genera dominated *P. aurantiogriseum*, *P. coprobium*, *P. commune*, *P. expansum*, *P. funiculosum*, *P. spinulosum*. It is well to bear in mind that yeast fungi of *Candida albicans* species are abundant in the timber dust.

In the cattle sheds and turkeys houses the following micromycetes hazardous to human and livestock health

were detected: in the cattle shed – *Aspergillus niger*, *Penicillium verrucosum*, *P. chrysogenum*, *Rhizopus oryzae*; in the houses of gets of cattle – *Aspergillus fumigatus*, *Aspergillus (=Eurotium) repens*, *Penicillium spinulosum*, *Rhizomucor pusillus*; in the turkey house dominated micromycetes of *Aspergillus* and *Penicillium* genera which potentially can synthesize and excrete into environment toxic metabolites or simply grow up in the organism (*Aspergillus candidus*, *A. fumigatus*).

4. Conclusions

1. The origin of dominating compounds did not have a profound effect on the accumulation of micromycetes in dust and the multiplicity of species. This is determined by the absorption ability of accumulated dust and outer factors. Micromycetes of some species were detected almost in all the sample studied which were taken in rather distinct object. First and foremost these are micromycetes of some *Penicillium* genera species (*P. chrysogenum*, *P. expansum*, *P. verrucosum*) and *Aspergillus* genera species (*A. niger*, *A. terreus*).
2. The multiplicity of micromycetes propagules in the dust accumulating in premises is determined by the technological process, their intensity and duration, direct contact with exterior, the efficiency of ventilation system, though the index of mycocontamination is rather relative, constantly changing not reflecting the real state at given time. Dust microbionts possess peculiar features of anthropogenic community, which differ from the structure organization of mycocommunities formed under natural conditions which is based on the multiplicity of species, their frequency of detection, the rate of taxons difference and the dynamics of change with time.
3. In the housing premises micromycetes which are potential producers of toxic substances such as *Alternaria alternata*, *A. tenuissima*, *Ulocladium chartarum*, *Cladosporium herbarum*, *C. cladosporioides*, *Fusarium semitectum*, *F. solani* as well as a major part of the fungi of *Penicillium* genera which also can synthesize a quite wide variety of toxic substances are commonly encountered.
4. The multiplicity of species and biological, especially physiological peculiarities of micromycetes, detected in the dust collected in granaries and grain processing premises are closely related to the character of performed technological operations, the chemical and physical peculiarities of the raw materials used, and the environment were grain treatment processing and production proceeds.
5. Means that are taken at present to diminish the mycocontamination in the housing and various industrial premises are not sufficient, not always the required procedures are followed, therefore dust particles and micromycetes spreading with them often because a serious cause of disruption of workers health and production losses.

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