

## AUXILIARY DISCIPLINES

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Minina N.N.<sup>1\*</sup>, Maslova N.V.<sup>2</sup>

<sup>1</sup> ORCID: 0000-0001-6343-7283;

<sup>2</sup> ORCID: 0000-0002-9009-1254;

<sup>1</sup> Birsk branch of the Bashkir State University, Birsk, Russia;

<sup>2</sup> Ufa Institute of Biology of the Ufa Federal Research Centre of the Russian Academy of Sciences, Ufa, Russia

\* Corresponding author (mnn27[at]mail.ru)

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### FEATURES OF THE TOXIC EFFECT OF SOME MACROMYCETE FUNGI OF THE BIRSKY DISTRICT OF THE REPUBLIC OF BASHKORTOSTAN

Research article

#### Abstract

The article provides an overview of the most common poisonous mushrooms of the Republic of Bashkortostan, characterizes their toxins and toxin –induced syndromes. The toxicity of poisonous fungi (*Amanita phalloides* (Vaill. ex Fr.) Link, *Amanita muscaria* (L. ex Fr.) Hook., *Hygrophoropsis aurantiaca* (Wulfen) Maire) collected on the territory of the Birsky district of the Republic of Bashkortostan during the growing season of 2020 has been studied. To control the experiment, we took the fruit bodies of edible mushroom species *Paxillus atromentosus* (Batsch: Fr.) Fr. and *Suillus grevillei* (Klotzsch) Singer. When studying the toxicity of these types of fungi, the test object was a test culture of *Paramecium caudatum*. It has been shown that fungi containing toxic peptides that determine the phalloid syndrome exhibit a strong toxic effect in relation to the culture of *Paramecium caudatum*, toxins causing cholinergic syndrome are characterized by a toxic effect in relation to the test culture. Toxins that cause atropine and hallucinatory syndrome are characterized by a slightly toxic effect in relation to the test culture. The results of the conducted studies can be used to make an etiological diagnosis in toxicology for poisoning with poisonous mushrooms.

**Keywords:** macromycete fungi, poisonous fungi, toxic effect, test culture *Paramecium caudatum*, *Amanita phalloides* (Vaill. ex Fr.) Link, *Amanita muscaria* (L. ex Fr.) Hook., *Hygrophoropsis aurantiaca* (Wulfen) Maire), *Paxillus atromentosus* (Batsch: Fr.) Fr., *Suillus grevillei* (Klotzsch) Singer.

Минина Н.Н.<sup>1\*</sup>, Маслова Н.В.<sup>2</sup>

<sup>1</sup> ORCID: 0000-0001-6343-7283;

<sup>2</sup> ORCID: 0000-0002-9009-1254;

<sup>1</sup> Бирский филиал Башкирского государственного университета, Бирск, Россия;

<sup>2</sup> Уфимский Институт биологии Уфимского федерального исследовательского центра РАН, Уфа, Россия

\* Корреспондирующий автор (mnn27[at]mail.ru)

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### ОСОБЕННОСТИ ТОКСИЧНОГО ДЕЙСТВИЯ НЕКОТОРЫХ ГРИБОВ МАКРОМИЦЕТОВ БИРСКОГО РАЙОНА РЕСПУБЛИКИ БАШКОРТОСТАН

Научная статья

#### Аннотация

В статье приводится обзор наиболее распространенных ядовитых грибов Республики Башкортостан, дается характеристика их токсинов и вызываемых токсинами синдромов. Изучена токсичность ядовитых грибов (*Amanita phalloides* (Vaill. ex Fr.) Link, *Amanita muscaria* (L. ex Fr.) Hook., *Hygrophoropsis aurantiaca* (Wulfen) Maire), собранных на территории Бирского района Республики Башкортостан в течение вегетационного периода 2020 года. Для контроля опыта нами были взяты плодовые тела съедобных видов грибов *Paxillus atromentosus* (Batsch: Fr.) Fr. и *Suillus grevillei* (Klotzsch) Singer. При изучении токсичности данных видов грибов тест объектом являлась тест культура *Paramecium caudatum*. Показано, что грибы, имеющие в своем составе токсические пептиды, определяющие фаллоидный синдром, проявляют сильное токсическое действие по отношению к культуре *Paramecium caudatum*, токсины вызывающие холинэргический синдром характеризуются токсичным эффектом по отношению к тест культуре. Слаботоксичным эффектом по отношению к тест культуре характеризуются токсины, вызывающие атропиновый и галлюцинозный синдром. Результаты проведенных исследований могут быть использованы для постановки этиологического диагноза в токсикологии при отравлении ядовитыми грибами.

**Ключевые слова:** грибы макромицеты, ядовитые грибы, токсичное действие, тест культура *Paramecium caudatum*, *Amanita phalloides* (Vaill. ex Fr.) Link, *Amanita muscaria* (L. ex Fr.) Hook., *Hygrophoropsis aurantiaca* (Wulfen) Maire), *Paxillus atromentosus* (Batsch: Fr.) Fr., *Suillus grevillei* (Klotzsch) Singer.

## 1. Introduction

The diversity of macromycete fungi in the Republic of Bashkortostan has not been sufficiently studied. Basic information about mushrooms can be found in the works of B.M. Mirkin and L.G. Naumova [1], A.M. Khabibulina [2], S. V. Kucherova [3], [4], M.V. Petrova [5]. General information about the macromycetes of the Republic of Bashkortostan is contained in the publication "Mushrooms of Bashkiria" [6]. Every year a large number of mushroom lovers go to the collection and every year a fairly large number of mushroom poisoning is registered. Rospotrebnadzor data show that 45 cases of mushroom poisoning were registered in Bashkortostan in 2020 [7].

Poisoning most often occurs with poisonous mushrooms resembling edible mushrooms. Mycetism occurs when mushrooms are poisoned – food intoxication caused by high-molecular proteins [8], [9]. Mycetisms, as a rule, are very difficult to diagnose in the laboratory and have a low frequency of laboratory-confirmed cases [10]. This is due to the rapid breakdown of protein toxins in the digestive system, which affects the biological activity of mycotoxins and clinical manifestations of intoxication.

Most often, the fatal outcome when used is caused by *Amanita phalloides* (Vaill. ex Fr.) Link, (*Amanita muscaria* (L. ex Fr.) Hook.). Mycetism of these species is caused by the action of toxic peptides primarily on the nervous and digestive systems, as well as specific damage to cells and tissues of the body. The false chanterelle (*Hygrophoropsis aurantiaca* (Wulfen) Maire) also has a toxic effect. The syndrome caused by macromycetes includes phalloid, atropine, cholinergic, resinoid, coprine, and paxiloid, etc. [11].

Mushroom poisoning is very difficult for children, for whom the lethal dose may be much less than for an adult. Therefore, toxicologists recommend banning the ingestion of mushrooms for children under 12 years of age. Mortality in adult mushroom poisoning reaches 12–16%, and in *Amanita phalloides* poisoning up to 35% [12], [13], because the poison of this type of fungus is characterized by a multiplicity of toxic effects on the human body [14].

*Amanita muscaria* contains the deadly poison muscarine, which causes death in a dose of 0.2 mg per 1 kg of human body weight. When it penetrates into the stomach, a person begins to develop muscarinic syndrome, in which there is excessive salivation, sweating, slowing of the pulse, a drop in blood pressure, narrowing of the pupils. The victim quickly falls into a coma, from which it is possible to withdraw only in the case of quickly provided medical care with the introduction of an antidote – atropine. Otherwise, death occurs quickly.

*Amanita phalloides* contains – amanitin, a lethal dose for humans of only 0.1 mg/kg of human weight. The danger of poisoning is that the onset of symptoms is noted only a day after consumption, and symptoms such as diarrhea or seizures pass quickly. The main effect is manifested in the breakdown of tissues at the cellular level. On the 7th–10th day, the liver and kidneys are destroyed and death quickly occurs in acute renal or hepatic insufficiency [14].

Amanitin is known in three forms – $\alpha$ ,  $\beta$  and  $\gamma$ . Its content in the fruit body of fresh *A. phalloides* ranges from 0.1 to 0.5 mg / g, and respectively from 1 to 5 mg / g in dried. On average, fresh basidioma *A. phalloides* weighing 100 g contain more than 20 mg of active amatoxins. The lethal dose for a person weighing 70 kg is only 7 mg, so one average is 3.0 LD<sub>50</sub> [15]. As part of *A. phalloides* basidiome toxophallin is present – a toxin having a mass of 55 kDa, which includes 503 amino acid residues, among which about 7% is represented by proline, which has membranotoxic properties [16]. Proteins homologous to proline have also been isolated from other species of poisonous fungi, such as *A. virosa* (Fr.) Bertill.) [17].

The content of toxophallin in the fresh fruit body of *A. phalloides* is 60 mg/kg, while the concentration of toxovirin in *A. virosa* is less than 10 mg/kg. The oxidative stress that it causes also manifests itself as in amanitins some time after consumption [18]. A number of authors believe [17] that when consuming raw fruit bodies of *A. phalloides* (if they are mistaken for similar mushrooms), a phalloidin syndrome is observed, in the manifestation of which amanitins play the main role.

As for the *A. phalloides*, its low variability in the content of toxins is noted, as well as the rare occurrence of fruit bodies in the composition of the species in which toxins are absent. In turn, *A. verna* is characterized by a higher spread: there are cases of identification of only phallotoxins in the absence of amanitotoxins, or their complete absence in the composition of fruit bodies [19].

*Hygrophoropsis aurantiaca*, which some authors refer to edible [20] or conditionally edible mushrooms that require long-term processing [21]. *Hygrophoropsis aurantiaca* is also considered inedible due to an unpleasant taste [22] or causing gastrointestinal poisoning [23], [24]. D. V. Gavryuchenkov, E. Y. Lemeshchenko [14] note that when eating the basidiomas of *Hygrophoropsis aurantiaca*, toxic gastroenteritis and kidney damage occur. The fruit bodies contain the poison arabitol, a polyatomic alcohol related to glycerin. This poison causes the toxic effect of the fungus *Hygrophoropsis aurantiaca*. The changes are mainly functional in nature, but lead, as a rule, to severe multiple organ pathology.

The aim of our work was to study the toxicity of poisonous fungi (*Amanita phalloides* (Vaill. ex Fr.) Link, *Amanita muscaria* (L. ex Fr.) Hook., *Hygrophoropsis aurantiaca* (Wulfen) Maire) collected on the territory of the Birskey district of the Republic of Bashkortostan during the growing season of 2020.

## 2. Materials and methods of research

To control the experiment, we took the fruit bodies of edible mushroom species *Paxillus atromentosus* (Batsch: Fr.) Fr. and *Suillus grevillei* (Klotzsch) Singer. When studying the toxicity of these types of fungi, the test object was a test culture of *Paramecium caudatum*. The main criterion for determining the toxicity of fungi was the time of complete death of paramecia when exposed to the extract under study. The death was confirmed by the complete absence of movement of all individuals of

*Paramecium caudatum*. For the study, an aqueous extract was prepared from fresh basidiomas of the studied mushroom species (0.3 g. crushed fruit body per 10 ml of distilled water). The studies were conducted according to the standard methodology [25].

### 3. The research results

A sharply toxic effect was shown by an aqueous extract of the fruit bodies of *Amanita phalloides* (Vaill. ex Fr.) Link, in the experiment an almost instantaneous death of *Paramecium caudatum* was observed. A slightly toxic effect was noted for *Amanita muscaria* (L. ex Fr.), which is consistent with the data of Nikitina O. A. *Paramecium caudatum* died within 3 hours in an extract from the fruit body of *Hygrophoropsis aurantiaca* (Wulfen) Maire). In extracts from the fruit bodies of *Paxillus atrotomentosus* (Batsch: Fr.) Fr. and *Suillus grevillei* (Klotzsch) Singer. *Paramecium caudatum* remained active and viable for more than 4 hours, which indicates the absence of toxic effects of these fungi on *Paramecium caudatum*.

### 4. Conclusions

Analyzing the data obtained and the belonging of fungal species to groups having a certain toxic effect, it can be noted that fungi containing toxic peptides that determine the phalloid syndrome exhibit a strong toxic effect against the culture of *Paramecium caudatum*. Toxins of *Amanita muscaria* (L. ex Fr.) Hook. they cause cholinergic syndrome and are characterized by a toxic effect in relation to the culture of *Paramecium caudatum*. Extracts from the fruit bodies of *Hygrophoropsis aurantiaca* (Wulfen) Maire), causing atropine and hallucinatory syndrome, are characterized by a slightly toxic effect in relation to the culture of *Paramecium caudatum*. The results of the conducted studies can be used to make an etiological diagnosis in toxicology for poisoning with poisonous mushrooms and contribute to more effective and timely therapeutic measures for this category of poisoning.

#### Conflict of Interest

None declared.

#### Конфликт интересов

Не указан.

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