The possibility of using the waste of the lignocellulosic hydrolysates biodetoxification as a seed treater of wheat varieties zoned in the West Siberian region of the of the Russian Federation

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Abstract. In the present study we investigated the possibility of using the waste of the lignocellulosic hydrolysates biodetoxification as a seed treater for wheat varieties zoned in the West Siberian region including the Tomsk region. The wastes are microbiocenoses of activated sludge, depleted during the detoxification process and capable of growing on toxic substrates. The study was conducted on three experimental objects and on wheat varieties Iren, Novosibirskaya 3, Novosibirskaya 51. For comparison, reference objects of biological preparations for plant protection Alirin-B, Fitosporin-M were used. The study showed that the waste of lignocellulosic hydrolysates biodetoxification had antifungal activity. The effectiveness of reducing the total contamination of seed infection in different experiments with experimental samples ranged from 52 to 82%. In some cases, the reference variants proved to be ineffective; the maximum effect on reducing the total seed contamination was achieved by Alirin-B and amounted about 30%. Seed treatment of wheat by the waste biodetoxification of different origins reduced the prevalence pathogens of seed wheat. At the same time the treatment did not significantly affect the increase in the parameters of plant growth and development (germination, length and weight of sprouts).

1. Introduction

Cultivation of grain crops occupies a significant share in the agricultural sector of the West Siberian region of Russia. Complex of agrotechnical measures is required to achieve high-quality harvest, plant protection against pathogens is an essential element of the complex. Protection of cereals from diseases caused by fungal parasites is of particular importance, because they can quickly spread to large areas and cause a significant reduction in yield. The most dangerous fungal diseases include root rot caused by fungi of the genus Fusarium, Bipolaris and Helminthosporium [1], stem and brown leaf rust diseases, in which the fungi Puccinia graminis [2] and P. triticina [3] are the main causative agents. Crop shortage due to the development of these diseases can be 20-40 % [4], and with epiphytotic development reaches 50-70 % [5]. Fungal diseases of cereal crops can affect not only the vegetative organs of plants, but can also infect seed material [6]. In this regard, the protection of plants against pathogens includes a whole range of measures, an important stage of which is the pre-sowing treatment of seeds.

Currently, in accordance with the ecologization of agriculture, the use of plant protection chemicals is significantly reduced, they are replaced by biological preparations based on the ability of
microorganisms and their metabolites to have a phytoprotective effect, stimulate plant growth and increase their productivity [7, 10, 11]. In contrast to the chemical protection of plants, the biological method does not have a negative impact on the environment, preserves useful insects and microorganisms that inhibit the development of phytopathogens [8,9].

Nevertheless, despite the significant advantages of biological plant protection products, their use in agriculture is still constrained by the high cost due to the dearness of used for the cultivation of nutrient media, the need to ensure sterile conditions for the creation of biological products and the instability of positive effects [12]. It is known that the microorganisms isolated from the rhizosphere of plants, used as an active agent of the biological product, partially lose their positive properties during artificial cultivation, and in the process of cultivation their competitiveness in the natural habitat decreases.

One of the ways to solve the problem is screening for beneficial properties of microorganisms that have undergone long-term adaptation to the conditions of deep cultivation in artificial environments. This plays an important role in obtaining agents with more stable useful properties, which are saved in the process of long-term production of biological products based on them. Organisms capable of growing on toxic organic substrates, for example, phenol, formaldehyde, are particular interest. This allows cultivation in non-sterile conditions, as a result of which the cost of the finished biological product is reduced. In addition, the cost of such substrates is relatively low compared to classical sources of carbon and energy.

A promising option is to obtain agents of biological products from industrial wastes that use cheap toxic substrates in their technologies, such as phenol, formaldehyde. This will not only further reduce the cost of biological products, but also to solve the problem of effective the waste disposal.

In the laboratory of Environmental Engineering and Biotechnology of TSU, a new method lignocellulosic hydrolysates biodetoxification was developed, based on the use of specially adapted activated sludge obtained on a substrate containing phenol. The main waste of the developed technology is spent activated sludge, which in the future could find its application in the agricultural sector [13]. Concentrations of toxic compounds used for the adaptation of activated sludge are not only sources of carbon and energy, but also sterilizers of the medium, which reduces the likelihood of spontaneous replacement of the original microorganisms with other ones, sometimes occurring during long-term storage of crops.

The aim of the present work was to assess the possibility of using the waste of the lignocellulosic hydrolysates biodetoxification as a seed treater of wheat varieties zoned in the West Siberian region of the of the Russian Federation

2. Experimental part

2.1 Materials

In the study, we used wheat seeds (Triticum aestivum L.) zoned in the West Siberian region. The following varieties were used:

Spring wheat Iren, the harvest of 2016. The sort included in the state register for Volga-Vyatka and Western Siberian regions. Early maturing variety. It is moderately resistant to powdery mildew, susceptible to septoriosis, root rot, stem rust. The variety is highly susceptible to loose and solid smut, brown rust. Seed treatment, fungicidal treatment during the growing season are required.

Winter wheat Novosibirskaya 51, harvest 2018 The sort included in the state register for Western Siberian region. Middle maturing variety. Moderately susceptible to powdery mildew. It is moderately susceptible to powdery mildew. The variety is susceptible to brown rust and snow mold. In the field, the variety was weakly affected by septoriosis. In the tolerance region solid smut were not observed.
Winter wheat Novosibirskaya 3, harvest 2018. The sort included in the state register for Western Siberian region. Also, the variety is recommended for cultivation in the Tomsk region. Middle maturing variety. In the field, the variety was weakly affected by root rot, by septoriosis and snow mold – moderately. It is moderately susceptible to brown rust and powdery mildew.

The following experimental objects were used as seed treaters:

Three variants of waste of the lignocellulosic hydrolysates biodetoxification, presented in the form of microbiocenoses of activated sludge used during the detoxification process and capable of growing on media containing phenol, formic acid and acetic acid. The wastes were obtained on the basis of three pre-adapted to toxicants of acetone-butanol fermentation consortium of activated sludges by using them in the process of detoxification of lignocellulosic hydrolysates [13].

The first consortium was obtained from the sewage treatment facilities of the timber processing company LLC “TOMLESDREV” (hereinafter ASTLD).

The second microbiocenosis of activated sludge (hereinafter-ASG) was obtained on an artificial nutrient medium simulating wastewater of the following composition, (g/L):

1. Nutritious broth for cultivation of microorganisms dry (GRM-broth) – 0.26;
2. Glucose – 0.2;
3. NH₄Cl – 0.057;
4. CaCl₂ – 0.004;
5. MgSO₄ – 0.002;
6. K₂HPO₄ – 0.038.

The third microbiocenosis of activated sludge (hereinafter-ASFAF) was obtained on a modified nutrient medium simulating wastewater characterized by low carbohydrate content and the presence of toxic components (g/L):

1. GRM-broth – 0.26;
2. NH₄Cl – 0.057;
3. CaCl₂ – 0.004;
4. MgSO₄ – 0.002;
5. K₂HPO₄ – 0.038
6. Phenol – up to 0.05
7. Acetic acid – up to 0.05
8. Formic acid – up to 0.035.

Waste biodetoxification of the hydrolysates were used in the form of sediment with a moisture content of more than 95%. Identification of activated sludge microbiocenoses, worked out in the process of detoxification, was not carried out at this stage, because their use as a seed protectant was carried out in the form of a consortium without maintaining sterile conditions.

Also potassium permanganate was used as a seed protectant once. In the future, we decided to abandon it because of its inefficiency as a seed protectant against fungal diseases.

As a control option, wheat seeds were soaked with tap water. As reference objects for seed treatment were used biopreparations Fitosporin-M and Alirin-B (in accordance with the instructions for use), registered in the State catalogue of pesticides and agrochemicals permitted for use on the territory of the Russian Federation. Biopreparation Fitosporin-M (manufacturer LLC NVP “Bashinkom” Bashkir RIA Russia) is intended for the treatment and prevention of fungal and bacterial diseases, including Phytophthora, powdery mildew, root rot, etc. The active beginning of the biological product is the bacteria Bacillus subtilis 26 D. Biopreparation Alirin-B (manufacturer LLC “Agrobiotechnology”, Russia) is used for the treatment and prevention of root and basal rot, late blight, powdery mildew and other diseases. The bioagent of the biological preparation is the bacterium B. subtilis B-10 VIZR.

2.2 Research Methods

For seed treatment wheat seeds were laid out in signed Petri dishes of 100 pcs. The Petri dishes were filled with test samples with a volume of 10 ml for 20 minutes at room temperature. Evaluation of the
effectiveness of the use of bioagents for the treatment of wheat seeds against seed pathogens was carried out by the method of phytopathological examination of seeds in rolls of sterile filter paper (Biotest). For the analysis were prepared tapes of filter paper size 10x100 cm (±2 cm), tapes of tracing paper 3x100 cm (±2 cm), packed in envelopes, then carried out their steam sterilization at 0.15 MPa for 20 minutes. From the sterilized envelopes, we took out the filter paper with tweezers and immersed it in a container with hot distilled water (+95°C) for a few seconds. The treated wheat seeds were placed on filter paper by embryos downwards at a distance of 2–3 cm from the upper edge of the leaf. Seeds spread on paper were covered with a strip of tracing paper, moistened in boiling water. Then it neatly we rolled up into a roll. The rolls were placed vertically in a sterile plastic bag (wet chamber) to prevent drying and incubated in a thermostat at a temperature of 24±1°C for 7 days. After 7 days, the infectious agents were determined under a binocular microscope. This method allows to estimate the efficiency of seed treatment against Helminthosporium, Fusarium, Alternaria, Bacteriosis and mold fungi. Also, this method allows to obtain additional data on the growth-stimulating activity of bioagents. To assess the growth-stimulating activity, the morphometric parameters of wheat sprouts (length, weight) were measured. The length was measured for each sprout, and the weight was determined for the sum of the dry sprouts of each recurrence. All variants of experiments were carried out in three repetitions.

The data obtained during the experiments were processed using the STATISTICA package, version 6.0. The data are presented in the form of an average with a confidence interval, taking into account the Student criterion for 95% significance level. The data of phytopathological analyses of seeds are presented taking into account the Fisher criterion for the probability of less than 25% and more than 75%.

3. Results and Discussion

3.1 Phytopathology

The results of the biotest on wheat seeds showed that the waste of biological detoxification of lignocellulosic hydrolysates has fungistatic properties. The results of phytopathological examination of wheat seeds on the variety Iren in different variants of the experiment are presented in table 1.

Table 1. The contamination of wheat seeds Iren by seed infections in different versions of the experiment.

| Version           | Total Of Them | Affected (%) |
|-------------------|---------------|--------------|
|                   | Fusarium      | Helminthosporium | Alternaria | Bacteriosis | Mold       |
| Control           | 62±9,7        | 13±7,3        | 10±6,6      | 4±5,2       | 32±9,1     |
| Potassium permanganate | 54±9,8     | 15±7,6        | 4±2,9       | 14±7,4      | 7±5,7      |
| Alirin-b          | 50±9,8        | 12±7,0        | 23±8,7      | 6±5,5       | 7±5,7      |
| ASFAF             | 28±8,8        | 12±5,6        | 1±2,9       | 4±2,9       | 7±5,7      |
| ASTLD             | 30±9,0        | 9±4,9         | 5±3,9       | 5±4,2       | 9±3,5      |
Used batch of wheat seeds had a high percentage of contamination by mold fungi, and the seeds were also affected by the pathogens of helmintho-sporiosis-fusarium root rot at a level of 26% (table 1). It was noted that in relation to the control, there was a decrease in the total contamination of wheat seeds with pathogens of seed infections in the variant with the treatment of seeds by ASFAF (about 55%). This result was achieved mainly by reducing the number of seeds with mold and reducing the prevalence of pathogens of alternariois. In the variant with the use of ASTLD a decrease in the total contamination of seeds by infections by about 52% in relation to control was also revealed. This result also was achieved mainly by reducing the number of seeds with mold and alternariois. Bacterization of wheat seeds with potassium permanganate and Alirin-B proved to be less effective in comparison with experimental variants. In this case, the contamination of seeds by alternariois in the reference version with Alirin-B was approximately 2 times higher than in the control version.

The results of phytopathological examination of wheat seeds on the variety Novosibirskaya 51 in different variants of the experiment are presented in table 2.

**Table 2.** The contamination of wheat seeds Novosibirskaya 51 by seed infections in different versions of the experiment.

| Version | Total | Of Them | Fusarium | Helminthosporium | Alternaria | Bacteriosis | Mold |
|---------|-------|---------|----------|------------------|------------|-------------|------|
| Control | 31±6.7 | 4±2.2 | 4±3.4 | 12±5.3 | 4±7.4 | 7±3.3 |
| Fitospirin-M | 30±7.3 | 6±4.0 | 2±1.6 | 19±6.4 | 0.6±1.7 | 2.7±3.0 |
| Alirin-B | 22±5.4 | 8±4.5 | 0.6±1.7 | 8±4.5 | 2.7±3.0 | 2.7±3.0 |
| ASFAF | 6.4±1.2 | 4±2.4 | 0.6±1.7 | 0 | 0.6±1.7 | 0.6±1.7 |
| ASG | 13.3±2.3 | 4.7±4.0 | 0 | 3.3±1.1 | 1.3±4.4 | 4.3±3.4 |
| ASTLD | 8.6±3.2 | 2.7±1.9 | 0.6±1.7 | 0 | 3.3±3.1 | 2±1.6 |

It was noted that in comparison with the control, there was a decrease in the total contamination of wheat seeds by seed infections in variants with the treatment of seeds by the activated sludge of different origin. In particular, there was a complete absence of contamination of wheat seeds by Alternaria in the variant with seeds treatment by ASFAF, in the variant with seed treatment by ASTLD, and a statistically significant reduction in the contamination of wheat seeds by this pathogen in the variant with the treatment seeds by ASG was also achieved. In all variants of wheat seeds treatment with the biodesinfection wastes there was a statistically significant reduction of helminthosporiosis contamination. In the treatment of wheat seeds by ASG there was a complete absence of seeds affected by the pathogens of helminthosporiosis. In the treatment of wheat seeds by ASFAF there was a statistically significant reduction of bacteriosis contamination.

The results of phytopathological examination of wheat seeds on the variety Novosibirskaya 3 in different variants of the experiment are presented in table 3. The used batch of wheat seeds had a fairly low percentage of total infection (17 %), of which the highest percentage belonged to alternariois about 8%.

It was noted that in comparison with the control, there was a decrease in the total contamination of wheat seeds in variants with the treatment of seeds by the wastes of the biodesinfection. This result was achieved mainly by reducing the number of seeds with of helmintho-sporiosis-fusarium root rot. The decrease in the total contamination of seeds in the experimental variants was at the level of 63-84% in comparison with the control. We also want to note the reduction in the prevalence of alternariois pathogens in the version with the treatment of wheat seeds by ASG and the complete absence of this pathogen in the variants with the treatment by ASTLD.
Table 3. The contamination of wheat seeds Novosibirskaya 3 by seed infections in different versions of the experiment.

| Version   | Total Affected (%) | Of Them | Fusarium | Helminthosporium | Alternaria | Bacteriosis | Mold |
|-----------|--------------------|---------|----------|------------------|------------|-------------|------|
| Control   | 17 ± 8.1/6.9       | 4 ± 3.6| 1 ± 2.8  | 8 ± 9.1          | 3 ± 4.2    | 1 ± 1.0     |      |
| Fitosporin-M | 19 ± 8.2/7.0     | 0       | 2 ± 3.6  | 9 ± 4.8          | 4 ± 3.6    | 4 ± 2.9     |      |
| Alirin-B  | 19 ± 7.0          | 0       | 3 ± 4.2  | 12 ± 5.6         | 1.0 ± 2.8  | 3 ± 4.2     |      |
| ASFAF     | 4 ± 3.9           | 0       | 0        | 4 ± 3.6          | 0          |             |      |
| ASG       | 7 ± 3.4           | 4 ± 3.8| 0        | 1 ± 2.8          | 1 ± 2.8    | 1 ± 2.8     |      |
| ASTLD     | 3 ± 2.4           | 0       | 0        | 3 ± 2.4          | 0          |             |      |

3.2 Evaluation of growth-stimulating activity of the waste of biodetoxification lignocellulosic hydrolysates

When assessing the germination of wheat seeds Iren it was shown that the lowest percentage was observed for the option with seed treatment by potassium permanganate (figure 1). There was a statistically significant decrease of this parameter by 21% in comparison with the control. Seed treatment ASG and ASTLD also showed a statistically significant decrease in seed germination relative to control by 16% and 2%, respectively. The germination rate of the control group was 68%.

![Figure 1. Germination of wheat seeds Iren with different variants of treatment by seed protectants: 1 – Control, 2 – Potassium permanganate, 3 – Alirin-B, 4 – AlIFAF, 5 – ISTLD.](image)

The obtained data on the length of seedlings (figure 2) showed a slight change in the investigated parameter in the experimental variants. In variants with seed treatment by ASFAF and ASTLD there were no statistically significant differences in the length of seedlings from the control plants. When we used the potassium permanganate for seed treatment, there was a tendency to increase the length of wheat seedlings by 5% relative to the control. However, despite a slight decrease in length, the seedlings of wheat in variant treatment by wastes of biodetoxification looked more healthy and strong. The total weight of dry sprouts was higher than in the control treatment (about 15%) and than in the
treatment with potassium permanganate (about 17 %), which had the best effect on the length of the sprouts (figure 3).

![Figure 2. The effect of treatment of wheat seeds Irene by different protectants on the length of the seedlings: 1-ASFAF, 2-ASTLD, 3-Alirin-B, 4-Potassium permanganate, 5-Control.](image)

![Figure 3. The effect of treatment of wheat seeds Irene by different protectants on the weight of the seedlings: 1-ASFAF, 2-ASTLD, 3-Alirin-B, 4-Potassium permanganate, 5-Control.](image)

When assessing the germination of wheat seeds Novosibirskaya 3 it was shown that the lowest percentage was observed for the option with the treatment of seeds with ASG and ASFAF (figure 4), but there was no statistically significant difference, there was a tendency to reduce the indicator of this parameter by 1.08%. In the treatment of seeds by ASTLD no statistically significant differences in the germination parameter from the control plants were shown, but there was a tendency to increase this parameter by 3% in relation to the control.

![Figure 4. Germination of wheat seeds Novosibirskaya 3 with different variants of treatment by seed protectants: 1 – control, 2 – Fitosporin-M, 3 Alirin-B, 4 – AIFAF ,5 – ASG, 6 – ASTLD.](image)

Treatment of wheat seeds Novosibirskaya 3 different protectants had a different effect on the length of the seedlings (figure 5). In this experiment, there was a tendency to increase the length of wheat seedlings in all variants in relation to the control, except for the treatment by ASTLD. The best result was achieved in the variant of seed treatment by ASFAF, in which the improvement of this parameter
was approximately 9%. In the variant of seed treatment with ASTLD, the reduction in the length of the seedlings was about 2%.

However, despite the negative impact on the length of sprouts in the variant of seed treatment by ASTLD, their total dry weight was approximately 19% higher than in the control variant (figure 6). In all experimental variants sprouts were stronger and healthier in comparison with control and reference variants.

![Figure 5](image1.png) **Figure 5.** The effect of treatment of wheat seeds Novosibirskaya 3 by different protectants on the length of the seedlings: 1 – control, 2 – Fitosporin-M, 3 – Alirin-B, 4 – ASG, 5 – ASFAF, 6 – ASTLD.

![Figure 6](image2.png) **Figure 6.** The effect of treatment of wheat seeds Novosibirskaya 3 by different protectants on the weight of the seedlings: 1 – control, 2 – ASG, 3 – ASFAF, 4 – ASTLD, 5 – Fitosporin-M, 6 – Alirin-B.

The treatment of seed wheat Novosibirskaya 51 also gave mixed results. Seed treatment by ASTLD showed a statistically significant increase in seed germination relative to control by 4.8% (figure 7). When we used for the treatment of the seeds by ASG, there was a tendency to increase the germination of wheat by 3.5% in relation to the control. At the same time, the best result was achieved in the variant of wheat seed treatment with Alirin-B and was at the level of 99%; the germination in the control variant was at the level of 94.6%.

![Figure 7](image3.png) **Figure 7.** Germination of wheat seeds Novosibirskaya 51 with different variants of treatment by seed protectants: 1 – control, 2 – Fitosporin-M, 3 Alirin-B, 4 – AlIFAF ,5 – ASG, 6 – ASTLD.
However, despite the improvement in germination, treatment of wheat seeds Novosibirskaya 51 had a negative impact on the length of seedlings (figure 8). The obtained data on the length of seedlings showed a statistically significant decrease in the studied parameter in experimental and reference versions. The lowest result was achieved in the variant of seed treatment by the preparation Alirin-B. The deterioration of this parameter was about 19%. In the experimental versions, the decrease in the length of the sprouts was at the level of 9-15%. The results obtained in this experiment also demonstrated no statistically significant effect on the weight of sprouts in the processing of wheat seeds by experimental objects, despite the fact that the sprouts were stronger and healthier in comparison with control and reference samples (figure 9).

![Figure 8](image1.png)  
**Figure 8.** The effect of treatment of wheat seeds Novosibirskaya 51 by different protectants on the length of the seedlings: 1 – control, 2 – Alirin-B, 3 – Fitosporin-M, 4 – ASFAF, 5 – ASG, 6 – ASTLD.

![Figure 9](image2.png)  
**Figure 9.** The effect of treatment of wheat seeds Novosibirskaya 51 by different protectants on the weight of the seedlings: 1 – ASTLD, 2 – Alirin-B, 3 – ASFAF, 4 – Fitosporin-M, 5 – ASG, 6 – control.

4. Conclusion

The results obtained in the study showed that the waste of biological detoxification of lignocellulosic hydrolysates has fungistatic properties. Reduction of the total contamination of wheat seeds Iren in the version of treatment by waste of biodetoxification was achieved by reducing mold fungi and alternariosis. In relation to the control it was reducing the total infestation of wheat seeds by seed pathogens infections in the variant with seeds treatment by ASTLD and ASFAF at 52-55%, respectively. The reference treatment with potassium permanganate was effective by 13%, and the biopreparation Alirin-B was able to reduce the overall contamination of seeds by about 20% compared to the control.

As a result of bacterization of seeds of winter wheat Novosibirskaya 3 it was noted that in comparison with the control, there was a decrease in the total contamination of wheat seeds by seed infections in variants with the treatment of seeds by the activated sludge of different origin. The reduction of the overall contamination of wheat seeds in comparison with control was about 80% in the treatment of seeds by ASFAF, 57% – by ASG, 62% – by ASTLD. The reference variants showed a decrease in the contamination of the seeds by less than 10% for Fitosporin-M and less than 30% for Alirin-B.

Seed treatment of winter wheat Novosibirskaya 51 has reduced the overall infestation of the seed infections by 69% for ASG, 77% – for AIFAF, 82% – for ASTLD in comparison with the control. The reference variants Phytosporin-M and Alirin-B, despite the decrease in the contamination of seeds with helminthosporiosis, were ineffective in this case to reduce the overall damage of the seeds.

The obtained results on the evaluation of the growth-stimulating ability of biodetoxification waste were ambiguous. In the result of the seed treatment of wheat IREN germination decreased compared
to the control by 16% for ASG, 2% – for ASTLD, 21% – for potassium permanganate and 3% – for Alirin-B.

However, as a result of seed treatment of wheat Novosibirskaya 3 germination using ASTLD increased by 3% in comparison with the control, seed treatment by ASG and ASFAF did not show statistically significant differences compared with the control. Reference variants Fitosporin-M and Alirin-B showed germination by 6% and 4% higher than in the control.

Processing seeds wheat Novosibirskaya 51 by experimental options slightly increased the germination of wheat by 1.4–2%. The same effect was observed in the treatment of seeds by Fitosporin-M, and the best effect was observed in the treatment by Alirin-B, so the germination was increased by 4.7% and amounted to 99.3%.

Treatment of wheat seeds of different varieties had an impact on the length and weight of the seedlings. Thus, in all cases of seed treatment by experimental variants with wastes of biodetoxification lignocellulosic hydrolysates of raw materials, seedlings were healthier and stronger, but their average length, as a rule, was reduced, while the total weight of the seedlings of each repetition could be higher in comparison with the control.

When processing the seeds of wheat Iren by experimental variants were not statistically significant differences in the length of the seedlings with the control plants, but the total weight of dry sprouts was higher than in the control treatment (about 15%) and than in the reference version with potassium permanganate (approximately 17%), which had the best effect on the length of seedlings (about 5%).

As a result of treatment of seeds wheat Novosibirskaya 3 there was an increase in the length of wheat seedlings in all variants in comparison with control, except for the treatment with ASTLD. The best effect was achieved as a result of treatment of the seeds by ASFAF, in which the improvement of this parameter was approximately 9%. Due to seed treatment by ASTLD reducing the length of shoot was approximately 2%. However, despite the negative impact on the length of sprouts in this embodiment, their total dry weight was about 19% higher than in the control version. In all experimental variants sprouts were stronger and healthier in comparison with control and reference variants.

As a result of the treatment of seeds wheat Novosibirskaya 51 by experimental and reference options, there was a statistically significant decrease in the length of sprouts in comparison with the control. In the experimental variants, the decrease in the length of the sprouts was at the level of 9–15%. Treatment of seeds with Alirin-B reduced the length of sprouts by 19%, Fitosporin-by 12%. At the same time, there was no statistically significant effect on the weight of sprouts in the experimental variants, despite the fact that the sprouts were stronger and healthier in comparison with the control and reference samples.

Thus, studies have shown the possibility of using wastes of the biodetoxification lignocellulosic hydrolysates as a basis for the creation of a biological product with antifungal properties against seed infections. The most effective the biodetoxification wastes were against mold, alternariosis and helminthosporiosis. Treatment of wheat seeds by the biodetoxification wastes of different origin contributed to the reduction of seed infection, while not significantly affect the increase in the parameters of growth and development of plants. For more effective use of these bioagents and the creation of biological products for plant protection, it is necessary to conduct additional studies to improve the growth-stimulating ability of these bioagents. In the future, a biopreparation against fungal seed infections can be created on the basis of the waste of biodetoxification lignocellulosic hydrolysates, which can be used not only in the West Siberian region, but also in other regions of Russia and foreign countries.

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