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UTILIZATION OF THE VEGETABLE RESIDUALS WITH THE HELP OF CELLULOSE DESTRUCTING MICROMYCETES OF THE SORT *CHAETOMIUM*

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Abstract

Results of research of cultural – morphological signs of soil fungus of the sort Chaetomium, secured in conditions of Northern Kazakhstan and their definition in decomposition of vegetable residuals in various agricultural crops in conditions in vitro were given in the article.

Key words: *cellulose destructing fungus, grain crops, biological product.*

1. INTRODUCTION

Minimizing processing of the soil is very actual in modern agriculture. The minimum and zero processings are considered perspective for further development of grain production in our country as they are low-cost, power - and resource-saving, demand not enough manpower, and also protect the soil from erosion, keeping fertility and soil structure.

Preservation of an eddish and all stubble residuals on a field surface practices for accumulation of organic substance in zero technology, i.e. all straw is crushed and scattered after cleaning, and crops are made directly on background which is sterned, with seeders of direct seeding (Koshayeva & Nauanova 2011).

Destruction of the regulation mechanism of accumulation processes and decomposition of organic substance in natural ecosystems is fraught with large-scale ecological disasters. Dynamics of accumulation of a biomass at natural development of biogeocenosis has to be counterbalanced by dynamics of its decomposition (Terekhova, 2007).

Biological products on the basis of cellulose destructive mushrooms can be used in increase of fertility of soils at the expense of intensive humification of the postharvest vegetable residuals at zero technology of cultivation of crops (Koshayeva & Nauanova 2011). It is established by research that exactly filamentous microorganisms make the main contribution into a mineralization of the vegetable remains in the soil: microscopic fungus make to 50% of a microbal biomass of humus. Micromycetes are the first who colonize with vegetable residuals owing to high growth rate (Mirchink 1988). Thanks to filamentous structure of a vegetative body, an absorptive way of a food and the features of enzyme systems allowing most fully colonize and utilize a substratum, fungus are the main destructors of the modern household waste which most part is made by cellulose destructive and other polymeric materials (Vedenyapina, Lebedeva & Nugayeva 2006). Lignin, hemicelluloses, cellulose and polycyclic aromatic hydrocarbones are decayed practically only fungus (Cerniglia & Sutherland 2001).

Now importance and relevance of research in the field of bioconversion of numerous agricultural and industrial wastes are obvious. It is defined by that the vegetable biomass is almost inexhaustible source of raw materials for receiving protein, enzymes and other physiologically active connections. On the

other hand, ability to growth on vegetable substrata is widespread among microorganisms. For conversion of lignocellulose materials filamentous fungus which thanks to synthesis of a wide range of hydrolytic and oxidizing enzymes, to high penetration of a mycelium in a substratum provides the most effective degradation of all components of vegetable raw materials (Babitskaya 1993) are the most adapted.

One of the main processes used for transformation of organic waste in almost valuable product is the composting, which is successfully applied through many centuries. Now at huge quantities of municipal waste there was a need to replace natural process of processing biotechnological. For this purpose in world practice various groups of microorganisms, including fungus (Vedenyapina, Lebedeva & Nugayeva 2006) are applied.

The main cellulose destructive mushrooms are fungus from the sort *Chaetomium*, a little in smaller quantity fungus from the sort *Verticillum, Cladosporium, Stachubotris, Mycor, Trichoderma, Alternaria, Aspergillius* and mushrooms with a pink and black mycelium (Terekhova 2007).

Mushrooms of the sort *Chaetomium* are widespread in land ecosystems. They meet on the vegetable remains, wood, in the soil, a dung of herbivores, birds and are an important component of food chains. The majority of known species of fungus of *Chaetomium* is included into group of the mesophilic organisms developing in the wide range of temperatures. Many representatives of the sorts *Chaetomium* can use cellulose as a carbon source. This feature allows them colonize successfully cellulose destructive substrata, including straw (Karamshuk 1971).

Use of various nutritious substrata for determination of speed of a spore formation of cellulose destructive fungus of *Chaetomium* provided one purpose – justification for receiving a biological product on the cheap and convenient nutritious material, used for a composting of various waste of agriculture.

2. METHODS OF RESEARCH

Experiments are made in vitro in 2010-2012 in laboratory of microbiology at S.Seifullin Kazakh Agro Technical University.

We determined the number and structure of a complex of soil microorganisms by a method of crops of cultivations of soil suspension on dense nutrient mediums. Colonies of the microorganisms using cellulose as a food were found when carrying out the mycologic analysis.

After repeated resowings accumulative cultures of mushrooms from the sort *Chaetomium* were received. Then pure cultures of strains of fungus of the sort *Chaetomium* (piece 1, piece 2, piece 3, piece 4) were received. At the description of fungus species of the sort *Chaetomium* used N. P. Cherepanova's monograph (Cherepanova 1989) and T.S.Kirilenko's determinant (Kirilenko 1978). At definition of types of mushrooms strains of the sort Chaetomium the structure of terminal appendages, length and the sizes of fruit bodies, volume an ascospores were attentively studied. Features of a structure, length and the sizes of fruit bodies were studied at increase by 600 times, a structure an ascospore, terminal and lateral appendages - at increase in 1600 then are photographed by a microscope with the software "Biomed-4".

For studying of growth and development of cellulose destructive fungus of the sort *Chaetomium* on various substrata straw of crops, such as soft wheat, barley, oats and pods of an oil-bearing crop of a rape was used. As control filter paper served. In experience the vegetable residuals were entered into a hungry agar in number of 2 g, 4 g and 6 g on 100 ml of the environment. For the sixth days of

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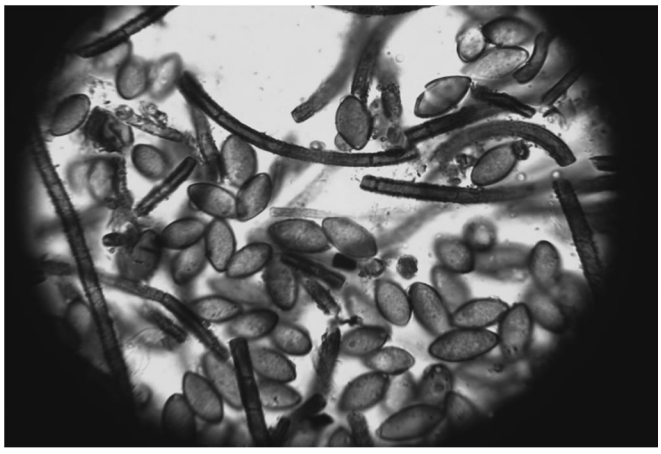
cultivation cultural-morphological signs of growth and development of cellulose destructive fungus were described, and after 30 days - weighed the residual weight of the brought vegetable residuals.

3. RESULTS OF RESEARCH

As a result of the microbiological analysis rizosphere of various crops, are allocated the microorganisms destroying cellulose. Cellulose decomposition in humus is carried out by *Cladosporium* fungus *(20%), Chaetomium (30%)*, and also ray fungus different types (25%) and mycobacterium of the sorts *Cytophaga, Polyangium, Sorangium (25%)* (figure 1).

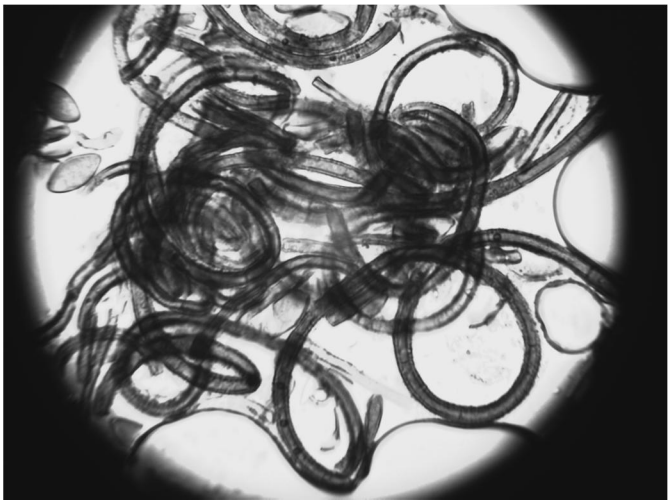


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c

Fig.1. Structure of a fungus of *Chaetomium angustum Chiv.* – *Mem. Torrey Bot. Club.*

a - perithecium (increase 10x16); b - ascospores; c – terminal appendages (increase 100x16)

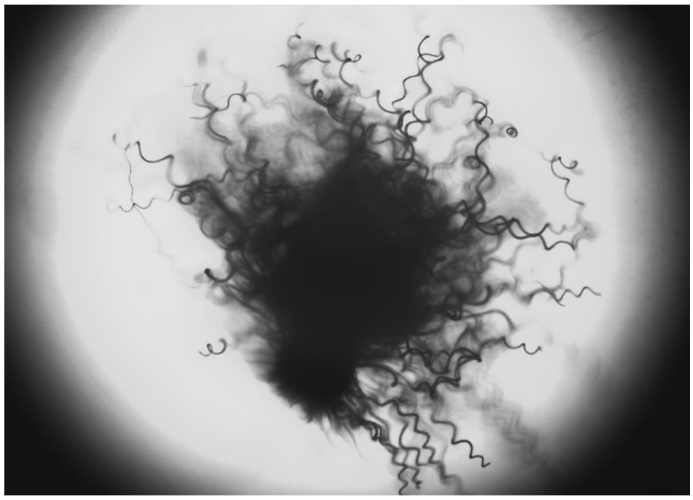
Strains of fungus the sorts *Chaetomium Ch.1, Ch.2, Ch.3* represented in figure 1, on determinants were identified as the soil microscopic fungus which are belonging to the class of *Ascomycetes*, to *Sphacriales* order, *Chaetomiaceae* family, the sort *Chaetomium*, a type of *angustum* (Chiv. – Mem. Torrey Bot. Club).

According to the morphological description of strains of a perithecium brown, spherical, micron sizes 180-290×190-300. There is a lot of terminal appendages, straight lines from below, above twirled in a spiral with 3-5 spiral turns, pointed, painted in black color, roughly asperous, 5-6 microns wide, evenly septated. Lateral appendages – short, direct, black color. Disputes dark brown, wide oval, extended on both ends, the micron sizes 9,5-9,8×7,0-8,5.

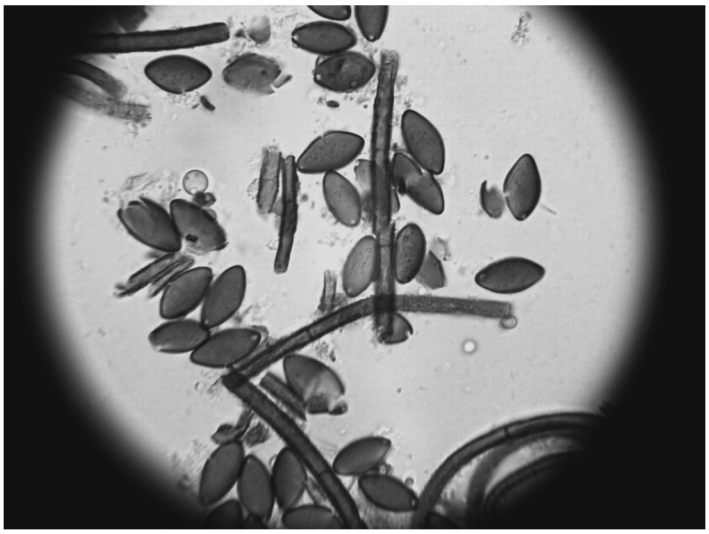
Strains of fungus of the sort Chaetomium Ch.4 (see Fig.2) on determinants were identified as soil microscopic fungus belonging to the class Ascomycetes, to Sphacriales order, Chaetomiaceae family, the sort Chaetomium, a type of spirochaete (Palliser – N. Amer. Flora).

Morphological signs following: Peritetion dark brown, ellipsoidal, the micron sizes 250-320×225-280, with a narrow stomas and numerous rhizoids.

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a



b

Fig.2. Structure of a fungus of Chaetomium spirochaete Palliser – N. Amer. Flora.

and - perithecium (increase 10x16); - ascospore (increase 100x16)

Terminal appendages from the basis at considerable distance direct, then twisting from 8-10 by turns, with a diameter of 25-30 microns. Appendages in the lower part 4-5 microns thick, acanthaceous, dark brown, accurately septated. Lateral appendages simple, peritheciums in the lower part direct, rather short, become closer to a top a perithetium they longer and imperceptibly merge with topmost appendages. These appendages at the basis 3,5-4,0 microns thick, acanthaceous, brown.

Lateral appendages simple, in the lower part a perithetion direct, rather short, become closer to a top a perithetion they longer and imperceptibly merge with topmost appendages; these appendages at the basis 3,5-4,0 microns thick, acanthaceous, brown. Disputes flattened with the convex and bent parties, from the flat party wide elliptical, pointed at both ends, 8,8-10,5x8,0-8,5 microns.

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When studying growth and development of micromycetes on various substrata it is revealed that growth of fungus of *Chaetomium* on the filter paper used as control, in comparison with development on environment with the vegetable remains was weak (see Table 1).

Table 1. Growth and development of fungus of the sort Chaetomium on the various vegetable remains of crops

Pcs.	Diameter of colonies of micromycetes on a hungry agar with various quantity of the brought vegetable residuals, mm		
	2 g	4 g	6 g
Absorbent paper (control)			
Ch. 1	17,9±0,69	16,4±0,76	15,2±0,62
Ch. 3	16,8±0,62	15,0±0,72	14,3±0,66
Ch. 4	16,7±1,17	15,5±1,05	14,7±1,03
Vegetable residuals of barley			
Ch. 1	34,4±0,94	35,6±0,33	33,4±0,68
Ch. 3	32,5±1,10	36,4±0,84	28,6±1,01
Ch. 4	34,0±1,13	28,6±1,01	30,0±1,13
Vegetable residuals of oats			
Ch. 1	34,9±1,38	35,8±0,66	33,5±2,04
Ch. 3	30,8±1,30	36,8±0,66	34,0±1,13
Ch. 4	34,0±1,13	28,8±0,66	30,0±1,13
Vegetable residuals of soft wheat			
Ch. 1	28,4±1,3	28,9±1,13	32,3±0,92
Ch. 3	27,8±0,96	27,5±`1,13	32,6±0,93
Ch. 4	32,1±1,7	33,3±1,12	32,3±0,79
Vegetable residuals of rape			
Ch. 1	41,3±1,27	31,6±1,13	35,6±2,10
Ch. 3	39,7±0,86	32,3±0,72	33,3±1,44
Ch. 4	32,3±0,86	35,3±0,86	33,1±2,14

Despite a rare mycelium sort Chaetomium mushrooms nevertheless formed disputes, diameter of colonies made 14,3-17,9 mm. On the vegetable remains of barley at sort Chaetomium fungus the air mycelium of whitish and yellow color, diameter of colonies made 28-35 mm (see Fig.3).

When using straw of oats at *Chaetomium* fungus color of colonies changed from white to gray depending on quantity of the brought remains. Diameter of colonies made 28,6-36,4 mm. On straw from soft wheat fungus of the sort *Chaetomium* showed weak growth, the filamentous lawn was rare.

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The sizes of colonies of *Chaetomium* made 27,5-33,3 mm. Spore bearing was late. *Chaetomium* fungus on the environment with the crushed pods of a rape showed good growth. Air mycelium of colonies of fungus was of white color. On colonies star-shaped prints of secondary growth were observed. Spore bearing was plentiful.

As showed results of research, color of colonies and intensity of development of cellulose cellulose destructive fungus changed from a type of the used vegetable remains that is explained by a various chemical composition of plants.

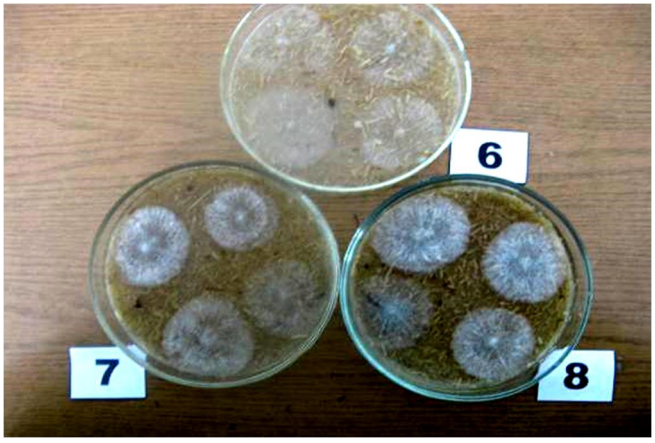


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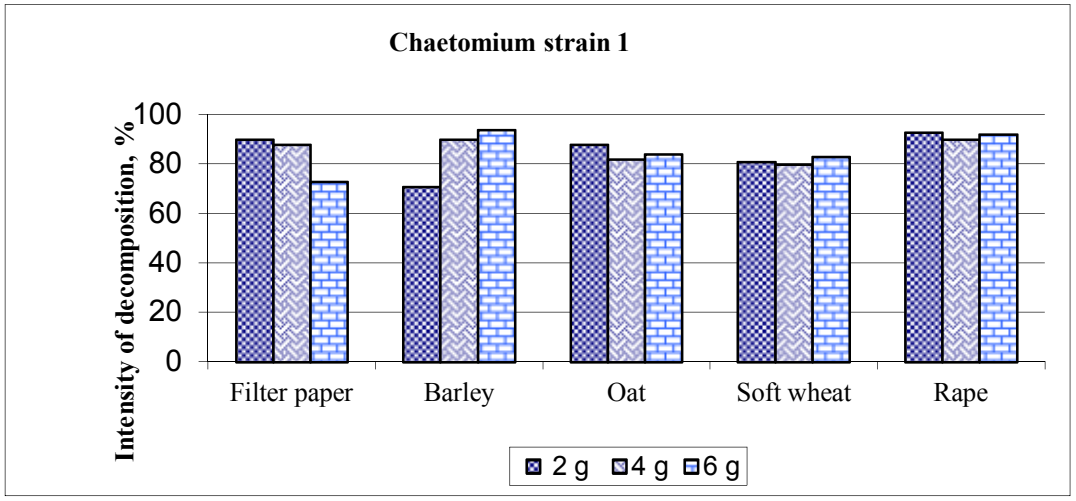


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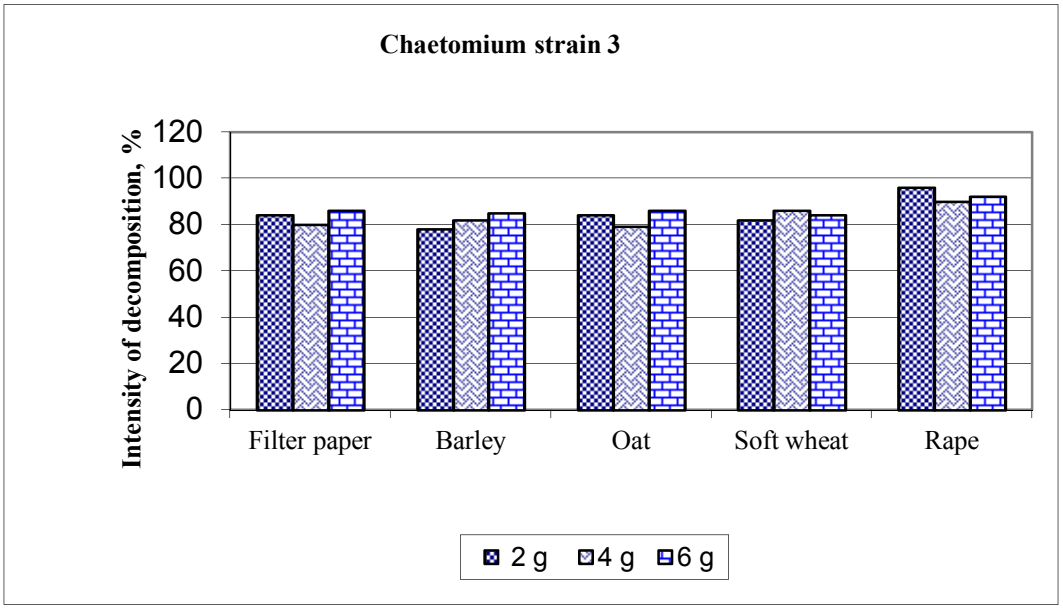
Fig.3. Cultural – morphological features of growth of cellulose destructive fungus on various substrata

A - on pods of a rape: 3, 4, 5 – colonies of a fungus of Ch.1; B - on barley straw: 7, 8, 9 – colonies of a fungus of Ch. 4; C – on oats straw: 6, 7, 8 – colonies of a fungus of Ch. 4

Cellulose activity of micromycetes differed depending on types of the vegetable remains. Judging by figure 4, on intensity of use of the vegetable remains all strains of fungus of the sort Chaetomium showed high activity of decomposition of straw of barley and a rape (see Fig.4).



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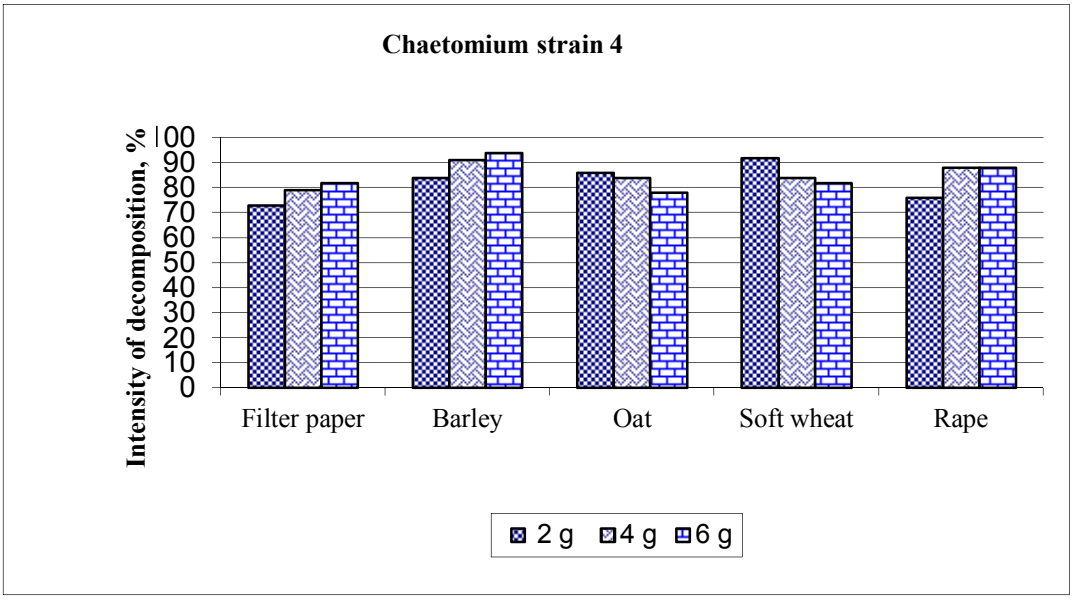


Fig.4. Intensity of decomposition of the various vegetable remains sort *Chaetomium* mushrooms

The strain of Ch.1 showed high extent of decomposition on all options, except control. Especially high cellulose activity was on barley and a rape where decomposition increased from 70 to 97%. Straw of oats and soft wheat used within 80-87%.

Ch strain. 3 I decomposed the vegetable remains of all cultures to 78-88%, except a colza where extent of decomposition reached 86-95%.

Ch.4 strain on use of straw of barley was more active, than Ch.3 strain, but is weaker in comparison with Ch.1 where extent of destruction made 90-93%. If on oats and a rape this indicator was at the level of 76-87%, on filter paper cellulose activity didn't exceed 75-81%. Straw of soft Ch.4 wheat I decomposed to 81-92%, in comparison with control.

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When studying a spore formation of cellulose destructive mushrooms of the sort *Chaetomium* on various substrata it is established that all strains of studied mushrooms are capable to spore formation process irrespective of character of a substratum. The greatest accumulation and spore formation at a strain of Ch.1 is revealed on straw, sawdust and on seeds of the barley, respectively 131 million dispute/ml, 121 million dispute/ml and 129 million dispute/ml of suspension (see Table 1).

Table 2. Caption of strains of mushrooms of the sort *Chaetomium* on various substrata

Substrate	Titer of biopreparation, mln. spores			
	Ch. 1	*Ch.* 2	*Ch.* 3	*Ch.* 4
Straw	131±3,30	67±1,56	58±1,34	233±6,78
Sawdust	121±3,65	53±1,65	96±2,75	238±7,31
Barley	129±3,2	153±4,45	126±3,67	271±7,64

Among strains of a fungus of Chaetomium Ch.2 strain appeared the most whimsical, the caption of a biological product didn't exceed 67 million dispute/ml on sterile pieces of straw.

At Ch.3 strain on sterile grains of barley the most intensive spore formation where for the 20th days of cultivation the quantity dispute reached 126 million dispute in 1 ml of suspension is observed.

On all substrata high rates of a spore formation at Ch.4 strain are noted. And intensive spore formation of a strain of Ch. 4 233 million dispute/ml and 238 million suspension dispute/ml respectively are established on straw and sawdust. On barley a caption dispute of a fungus was maximum - 271 million dispute/ml.

As a whole, among the tested substrata for active strains of Ch.1 and Ch. 4 the most suitable there was a straw, seeds of barley and sawdust.

The next time of research testify that active strains of cellulose destructing fungus of the sort *Chaetomium* can be a basis for receiving biological products for use in increase of fertility of soils at the expense of effective decomposition of the postharvest vegetable remains.

4. CONCLUSIONS

In the conditions of the dry steppe of Northern Kazakhstan decomposition of the vegetable remains goes extremely slowly. Strains of mushrooms of the sort *Chaetomium* (Ch.1, Ch.2, Ch.3, Ch.4,) are well adapted for conditions of soils of Northern Kazakhstan, possess high destructive ability concerning the vegetable remains.

As showed results of research of growth and development of cellulose destructing mushrooms of the sort *Chaetomium* on various substrata, color of colonies and intensity of development of cellulose destructing fungus changed from a type of the used vegetable remains that is explained by a various chemical composition of plants. Intensity of decomposition of the vegetable remains of various crops fungus of *Chaetomium* depends on quantity of used substrata. The more the mass of the brought vegetable remains, occurs their decomposition more intensively.

Among the tested substrata for active strains of Ch.1 and Ch. 4 the most suitable there was a straw, seeds of barley and sawdust.

Active strains of cellulose destructing mushrooms of the sort *Chaetomium* can be used in increase of fertility of soils at the expense of intensive humification of the postharvest vegetable remains at zero technology of cultivation of crops, and also in bioconversion of cellulose destructing materials in various industries.

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