ISSN 2072-0831 (print)
ISSN 2307-9428 (online)

В мире научных открытий

Том 9, №3, 2017

Научный журнал

Электронная версия журнала размещена на сайте discover-journal.ru

Журнал включен в Перечень ВАК ведущих рецензируемых научных журналов

Журнал основан в 2008 г.
ISSN 2072-0831
Импакт-фактор РИНЦ 2015 = 0,262

Siberian Journal of Life Sciences and Agriculture

Volume 9, №3, 2017

Scientific Journal

The electronic version takes place on a site discover-journal.ru

The journal is in the list of leading peer-reviewed scientific journals and editions, approved by Higher Attestation Commission

Founded 2008
ISSN 2072-0831
RSCI IF (2015) = 0,262

Красноярск, 2017
Научно-Инновационный Центр

Krasnoyarsk, 2017
Publishing House Science and Innovation Center

12+

Издательство «Научно-инновационный центр»

ISSN 2072-0831

Журнал зарегистрирован в Федеральной службе по надзору в сфере связи, информационных технологий и массовых коммуникаций (РОСКОМНАДЗОР)

ПИ № ФС 77-39604 от 26 апреля 2010 г.

В мире научных открытий. Красноярск: Научно-инновационный центр, 2017. Том 9, № 3. 96 с.

Периодичность – 4 выпуска в год.

Журнал включен в Реферативный журнал и Базы данных ВИНИТИ РАН: http://catalog.viniti.ru/, а также в международную реферативную базу данных и систему цитирования Agris, Chemical Abstracts.

Решением Президиума Высшей аттестационной комиссии Минобрнауки России журнал «В мире научных открытий» включен в Перечень ведущих рецензируемых научных журналов и изданий, в которых должны быть опубликованы основные результаты диссертаций на соискание ученых степеней доктора и кандидата наук.

Сведения о журнале ежегодно публикуются в международной справочной системе по периодическим и продолжающимся изданиям «Ulrich's Periodicals directory» в целях информирования мировой научной общественности.

Журнал представлен в ведущих библиотеках страны, в Научной Электронной Библиотеке (НЭБ) – головном исполнителе проекта по созданию Российского индекса научного цитирования (РИНЦ) и имеет импакт-фактор Российского индекса научного цитирования (ИФ РИНЦ).

Статьи, поступающие в редакцию, рецензируются. За достоверность сведений, изложенных в статьях, ответственность несут авторы публикаций. Мнение редакции может не совпадать с мнением авторов материалов. При перепечатке ссылка на журнал обязательна.

Правила для авторов доступны на сайте журнала: http://discover-journal.ru/guidelines.html

Адрес редакции, издателя и для корреспонденции:
660127, г. Красноярск, ул. 9 Мая, 5 к. 192
E-mail: open@nkras.ru
http://discover-journal.ru/

Подписной индекс в объединенном каталоге «Пресса России» – 94089.
Подписной индекс в каталоге периодических и сетевых изданий «Сиб-Пресса» – 94089.

Учредитель и издатель: Издательство ООО «Научно-инновационный центр»

Свободная цена

Члены редакционной коллегии

Editorial Board Members

ПРОФИЛАКТИЧЕСКАЯ МЕДИЦИНА
PREVENTIVE MEDICINE

DOI: 10.12731/wsd-2017-3-10-18
UDC 613.2

HYGIENIC ASSESSMENT OF ACTUAL DIETING OF THE KHAKAS REPUBLIC ADULT RESIDENTS WITH LOW ENERGY EXPENDITURE[1]

Kondrashova E.A.

The paper presents statistical data on foods consumption by the residents of the Khakas Republic. It also contains an analysis of actual dieting of the adult population with low energy expenditure in terms of dietary adequacy indications. A number of suggestions aimed at dieting optimization are made.
Keywords: *foods; energy content; nutrients; vitamins; minerals; dieting.*

ГИГИЕНИЧЕСКАЯ ОЦЕНКА ПИТАНИЯ ВЗРОСЛОГО НАСЕЛЕНИЯ РЕСПУБЛИКИ ХАКАСИЯ С НИЗКИМИ ЭНЕРГОТРАТАМИ

Кондрашова Е.А.

В статье отражены статистические данные о потреблении пищевых продуктов населением Республики Хакасия. Приведен анализ фактического питания взрослого населения с низкими энерготратами по показателям пищевой адекватности. Изложены предложения по оптимизации питания.

[1] Кондрашова Е.А. Гигиеническая оценка питания взрослого населения Республики Хакасия с низкими энерготратами // В мире научных открытий, 2016. № 3(75). С. 10-19. doi:10.12731/wsd-2016-3-1.

Ключевые слова: *продукты питания; калорийность; питательные вещества; витамины; минеральные вещества; рацион питания.*

Dieting is considered to be one of the fundamental factors that should be taken into account for the aims of health maintenance and promotion of the employable age population. According to calculations carried out by economists, doctors as well as nutritionists the daily consumption rate per person in Russia is on average 2200 kcal (in 1990–2590 kcal). Based on the FAO (Food and Agriculture Organization) international classification [7], the dieting energy consumption of 2200 calories is thought to be insufficient and is considered to be an indicator of long-term malnutrition. It should be noted that the last few decades are characterized by a decrease in physical activity of the population of the Russian Federation, which in turn leads to a decrease in energy expenditure. This reduces not only the amount of food consumed, but also the intake of essential nutrients [8, pp. 10–24; 9, pp. 5–8, 11]. Therefore, today the priority should be given to dieting studies of people with low energy expenditure.

The aim of the study: to analyse and assess actual dieting of adult residents of the Khakas republic with low energy expenditure along with working out dieting optimization suggestions.

The object of the study: 400 people of employable age engaged mainly in intellectual labour. The criterion being their profession, all the respondents were divided into 2 groups according to the physical activity coefficient (PAC) up to 1.6 and exceeding 1.6.

Methods of the study: the data on actual dieting were obtained using questionnaires and survey procedures. The hygienic assessment of the respondents' actual dieting was carried out using the method of the daily 24-hour reconstruction in accordance with the guidance notes on the study of actual dieting and health status in relation to the dieting habits as well as the 'The tables of the Russian food products chemical composition' reference book [3, pp. 4–23; 6, pp. 6–274]. The diets were assessed in terms of their quantity and quality, taking into account the energy value and structure (the number of calories replenished at the expense of proteins, fats and carbohydrates), chemical composition, including the amount of food (proteins, fats, carbohydrates) and biologically active substances (vitamins A, B1, C, E, minerals Ca, Mg, P, Fe) [4, pp. 12–44; 10, pp. 11–22].

The findings were then compared to the standards 2.3.1.2432-08 'The physiologic needs for energy and nutrients standards for different groups of the population' [1, pp. 2–4]. The study results were processed using the nonparametric

statistics method along with Microsoft Office Excel 2007 software by calculating the median and interquartile range (Me, Q_{25}-Q_{75}). The differences obtained were considered statistically relevant at the level of significance equal to $p \leq 0.05$.

The results of the study

The data provided by the local agency of the Federal State Statistics Service for the Khakas Republic over the period of 2010–2014 show the residents' reduced consumption of biologically valuable foods (meat and meat products, dairy products, fruit and vegetables), the result being the insufficient intake of complete proteins, polyunsaturated fatty acids, micronutrients and vitamins that might tell on public health due to unbalanced dieting [2, pp. 27–28, 5].

According to the data shown in Table 1, the average per capita consumption of meat and meat products over the period of 2010–2014 in the Khakas Republic remains at a low level compared with the physiological dieting standards (on average 69.4 kg [5].

Over the above-mentioned period consumption of dairy products increased from 250 kg/year in 2010 to 260 kg/year in 2014, that amounted to 81.3% of the required consumption standards.

There is also a shortage of the per capita consumption of vegetable produce. However, it should be noted that in general consumption of vegetables increased from 109 kg/year in 2010 to 118 kg/year in 2014 and amounted to 98.3% of the required consumption standards.

Table 1.

Actual consumption of basic food groups by the residents of the Khakas Republic in 2010–2014 compared to the required consumption standards

No	Foods group	2010, kg/pers. a year	2011, kg/pers. a year	2012, kg/pers. a year	2013, kg/pers. a year	2014, kg/pers. a year	The required consumption standards kg/ pers. a year
1.	Bakery products in terms of flour, flour, cereals, legumes	134	134	135	130	128	95-105
2.	Potatoes	119	119	119	115	115	95-100
3.	Vegetables and gourds	109	110	117	117	118	120-140

End of the Table 1.

4.	Fruit and berries	39	40	45	47	46	90-100
5.	Meat and meat products (total)	66	68	72	73	68	70-75
6.	Milk and dairy products (total)	250	263	267	266	260	320-340
7.	Fish and fish products	14.5	15.2	16.5	-	-	18-22
8.	Sugar	30	31	32	32	32	24-28
9	Vegetable oil	10.3	10.5	11.3	11.2	11.2	10-12
10	Eggs	251 pc	260 pc	265 pc	255 pc	250 pc	260 pc

According to the data obtained from the questionnaires and survey there is insufficient consumption of basic food products in comparison with the relevant data from the Siberian Federal District and the Russian Federation (Table 2).

Table 2.

Actual consumption of basic food groups by the residents of the Khakas Republic according to the data obtained from the questionnaires

No	Foods group	Actual consumption kg/pers. a day		Required consumption standards, kg/pers. a day	Divergence, %		Consumption according to the statistical data in 2014, kg/pers. a day	
		PAC <1.6	PAC >1.6		PAC <1.6	PAC >1.6	SFD	RF
1.	Bakery products in terms of flour, flour, cereals, legumes	0.23	0.29	0.27	85.2	107	0.34	0.32
2.	Potatoes	0.29	0.32	0.27	107	118	0.36	0.3
3.	Vegetables and gourds	0.18	0.21	0.35	51.4	60	0.27	0.3
4.	Fruit and berries	0.12	0.1	0.26	46.2	38.5	0.13	0.17

End of the Table 2.

5.	Meat and meat products (total)	0.102	0.135	0.2	51	67.5	0.2	0.2
6.	Milk and dairy products (total)	0.44	0.56	0.9	48.8	62.2	0.7	0.66
7.	Fish and fish products	0.041	0.049	0.054	75.9	90.7	-	-
8.	Sugar	0.074	0.070	0.071	104.2	98.6	0.09	0.1
9	Vegetable oil	0.029	0.031	0.03	96.6	103	0.03	0.037
10	Eggs	0.25	0.21	1 pc	25	21	0.71	0.73

The average actual energy value of diets intended for men with PAC<1.6 amounts to 1934.80 kcal (Q_{25}-Q_{75}1451.00-2321.80), with PAC>1.6 - 2253.12 kcal (Q_{25}-Q_{75}1913.78-3060.89), which is less compared with the established daily energy needs standards of 2100-2800 kcal (for men with PAC<1.6) and 2950-3300 kcal (for men with PAC>1.6). It is also correct for women who have shown a reduced energy value of their daily diet that amounts to 1595.05 kcal (Q_{25}-Q_{75}1327.60-1825.09) and 1608.70 kcal (Q_{25}-Q_{75}1248.23-1769.85) for women with PAC<1.6 and PAC>1.6 respectively. The differences are statistically relevant ($p \leq 0,05$).

The ratio of proteins, fats and carbohydrates in the diet of men with PAC<1.6 amounts to 1:1.04:3.1, with PAC>1.6 - 1:1:3.7, of women with PAC<1 6 - 1:1.1:3.9, of women with PAC>1.6 - 1:1:3.4.

The content of calcium, phosphorus and magnesium in the daily diet of men with PAC<1.6 amounts to 1:1.8:0.5, of men with PAC> 1.6 - 1:1.6:0.6. Women with PAC<1.6 showed the following ratio of calcium, phosphorus and magnesium - 1:1.4:0.5, with PAC>1.6 - 1:1.5:0.4.

This ratio fails to comply with the physiologically required ratio (1:1.5:0.5), which might negatively affect the absorption of these minerals.

The average vitamins content in the daily diet of men is shown in Table 3.

Table 3.

Vitamins content in the daily diet of men according to the data obtained from the questionnaires

Vitamins	Standard need	Actual content:			
		PAC< 1.6		PAC>16	
		Average value	Divergence	Average value	Divergence
A, mkg (ret. eq.)	900	580	-35.5%	1120	+24%

End of the Table 3.

C, mg	90	45.4	-49.5%	65.2	-27.5%
B_1 mg	1.5	0.69	-46%	0.96	-36%
E, mg (toc. eq.)	15	12.2	-18.6%	15	-

The analysis of men's daily rations vitamin content found out that those with PAC>1.6 had a higher vitamins consumption rate, being relevant from the statistics point of view, compared with those with PAC<1.6. ($p \leq 0.05$).

Table 4.

Vitamins content in the daily diet of women according to the data obtained from the questionnaires

Vitamins	Standard need	Actual content:			
		PAC<1.6		PAC>1.6	
		Average value	Divergence	Average value	Divergence
A, mkg (ret. eq.)	900	590	-34.4%	510	-43.3%
C, mg	90	64	-28.8%	45.3	-49.6%
B_1 mg	1.5	0.63	-42%	0.64	-57.3%
E, mg (toc. eq.)	15	10.2	-32%	11.4	-24%

According to the data obtained, women's diet vitamin composition fails to comply with the physiologically required ratio.

Conclusion

Actual dieting of the adult population with low energy expenditure in the Khakas republic is characterized as being unbalanced in terms of foods themselves, energy adequacy ratio as well as nutrients.

The survey revealed the reduced energy value of the residents' daily ration. The actual ratio of proteins, fats, carbohydrates and minerals is thought to be unbalanced.

To maintain and promote health as well as reduce the risk of alimentary-dependent diseases development a number of measures should be taken aimed at optimizing dieting of the residents with low energy expenditure. The complex of measures that should be implemented with the participation of the government of the republic, as well as health authorities and the Federal Service on Surveillance for Consumer Rights Protection and Human Welfare is as follows:

– in order to handle the issue of micronutrient deficiency fortification of mass consumption foods, especially bread and bakery products, should

be one of the trends of the Khakas Republic regional policy in the sphere of healthy dieting;
- medical staff (especially GPs) should be more aware of alimentary risks leading to the development of diseases and their complications, as well as the link between health indicators and actual dieting, of using food supplements as an additional source of micronutrients;
- residents with low energy expenditure should be more aware of dieting issues including the ones related to age and occupation, ration energy value and chemical composition.

References

1. *Metodicheskie rekomendatsii MR 2.3.1.2432-08 «Normy fiziologicheskikh potrebnostey v energii i pishchevykh veshchestvakh dlya razlichnykh grupp naseleniya Rossiyskoy Federatsii»* [Norms of physiological requirements in energy and nutrients for different population groups of the Russian Federation]. Moscow, 2008, pp. 2–4.
2. *O sostoyanii sanitarno-epidemiologicheskogo blagopoluchiya naseleniya v Respublike Khakasiya v 2014 godu* [On the state of sanitary-epidemiological welfare of the population in the Republic of Khakassia in 2014]. Abakan, 2015. 172 p.
3. Martinchik A.N., Baturin A.K., Feoktistova A.I., Svyakhovskaya I.V. Otsenka kolichestva potreblyaemoy pishchi metodom 24-chasovogo sutochnogo vosproizvedeniya pitaniya [Assessment of the quantity of food consumed by method 24-hour recall]. M.: Minzdrav RF, 1996. 24 p.
4. Shibanova N.Yu., Khorunzhina S.I., Permyakova L.V. et al. *Pitanie i zdorov'e* [Nutrition and health]: methodical book. Kemerovo, 2007. 80 p.
5. *Prikaz Ministerstva zdravookhraneniya i sotsial'nogo razvitiya RF ot 2 avgusta 2010 g. N 593n «Ob utverzhdenii rekomendatsiy po ratsional'nym normam potrebleniya pishchevykh produktov, otvechayushchim sovremennym trebovaniyam zdorovogo pitaniya»* [On approval of recommendations on rational norms of consumption of food products that meet modern requirements of healthy eating]. http://base.garant.ru/12179471/#ixzz41knQ8lsS (accessed January 13, 2016).
6. Skurikhin I.M., Tutel'yan V.A. *Tablitsy khimicheskogo sostava i kaloriynosti rossiyskikh produktov pitaniya* [Table chemical composition and caloric content of the Russian food]: a guidebook. M.: DeLi Print, 2007. 276 p.
7. FAO. FAOSTAT. http://www.fao.org/statistics/ru/ (accessed February, 20, 2016).
8. Shibanova N.Yu., Khorunzhina S.I. *Pitanie dlya zdorov'ya* [Food for health]. Part 1. Kemerovo, 2007. 82 p.

9. Shibanova N.Yu. *Gigienicheskaya otsenka fakticheskogo pitaniya shakhterov Kuzbassa* [Hygienic assessment of actual nutrition in Kuzbass miners]. Kemerovo, 2009. 274 p.
10. Shibanova N.Yu. *Gigienicheskaya otsenka fakticheskogo pitaniya shakhterov Kuzbassa* [Hygienic assessment of actual nutrition in Kuzbass miners]. Kemerovo, 2008. 46 p.
11. Yashina M.L. Zdorovoe pitanie naseleniya Rossii: realii i perspektivy [Healthy food of the population of Russia: realities and prospects]. *Ekonomicheskie issledovaniya,* December, 2013 №4 (13). http://www.erce.ru/internet-magazine/magazine/36/567/ (accessed December 10, 2015).

Список литературы

1. Методические рекомендации МР 2.3.1.2432-08 «Нормы физиологических потребностей в энергии и пищевых веществах для различных групп населения Российской Федерации». М.: Федеральный центр Госсанэпиднадзора Минздрава России, 2008. С. 2–4.
2. О состоянии санитарно-эпидемиологического благополучия населения в Республике Хакасия в 2014 году. Абакан: Управление Роспотребнадзора по Республике Хакасия, 2015. С. 172.
3. Оценка количества потребляемой пищи методом 24-часового суточного воспроизведения питания / А.Н. Мартинчик, А.К. Батурин, А.И. Феоктистова, И.В. Свяховская / утв. Заместителем главного государственного санитарного врача Российской Федерации Г.Г. Онищенко 26.02.1996. №С1-19/14-17. М.: Минздрав РФ, 1996. С. 24.
4. Питание и здоровье: методическое пособие / Н.Ю. Шибанова, С.И. Хорунжина, Л.В. Пермякова и др. Кемерово, 2007. С. 80.
5. Приказ Министерства здравоохранения и социального развития РФ от 2 августа 2010 г. N 593н «Об утверждении рекомендаций по рациональным нормам потребления пищевых продуктов, отвечающим современным требованиям здорового питания» URL: http://base.garant.ru/12179471/#ixzz41knQ8lsS (дата обращения 13.01.2016).
6. Скурихин И.М., Тутельян В.А. Таблицы химического состава и калорийности российских продуктов питания: Справочник. М.: ДеЛи Принт, 2007. С. 276.
7. ФАО. FAOSTAT. URL: http://www.fao.org/statistics/ru/ (дата обращения 20.02.2016)
8. Шибанова Н.Ю. Питание для здоровья/ Н.Ю. Шибанова, С.И. Хорунжина // Как быть здоровым: Пособие для молодежи. Ч.1. Кемерово, 2007. С. 82.

9. Шибанова Н.Ю. Гигиеническая оценка фактического питания шахтеров Кузбасса: Дис. ... д- ра мед. наук. Кемерово, 2009. С. 274.
10. Шибанова Н.Ю. Гигиеническая оценка фактического питания шахтеров Кузбасса: Автореф. дис. … д-ра мед. наук. Кемерово, 2008. С. 46.
11. Яшина М.Л. Здоровое питание населения России: реалии и перспективы // Интернет-журнал «Экономические исследования», декабрь 2013 №4 (13). URL: http://www.erce.ru/internet-magazine/magazine/36/567/ (дата обращения 10.12.2015).

DATA ABOUT THE AUTHOR

Kondrashova Ekaterina Aleksandrovna, Postgraduate Student Department of Hygiene
Kemerovo State Medical Academy
22a, Voroshilova St., Kemerovo, Kemerovo Region, 650029, Russian Federation
kemsma@kemsma.ru
SPIN-code: 8189-3662

ДАННЫЕ ОБ АВТОРЕ

Кондрашова Екатерина Александровна, аспирант кафедры гигиены
Кемеровская государственная медицинская академия
ул. Ворошилова, 22 а, г. Кемерово, Кемеровская область, 650029, Российская Федерация
kemsma@kemsma.ru

DOI: 10.12731/wsd-2017-3-19-24
UDC 613.2

HYGIENIC ASSESSMENT OF FOODS QUALITY AND SAFETY WITHIN THE TERRITORY OF THE KHAKAS REPUBLIC[1]

Kondrashova E.A.

The paper presents the results of the research within the territory of the Khakas Republic of foods in terms of chemical safety indicators. The rate of non-oncogenic risk in relation to food consumption was determined as well as the analysis of alimentary-dependent diseases levels was carried out. A number of suggestions aimed at reducing dietary risk factors were made.

Keywords: *foods; alimentary-dependent pathology rate; nitrates; chemical safety; risk assessment; contaminant exposure; danger coefficient.*

ГИГИЕНИЧЕСКАЯ ОЦЕНКА КАЧЕСТВА И БЕЗОПАСНОСТИ ПРОДУКТОВ ПИТАНИЯ НА ТЕРРИТОРИИ РЕСПУБЛИКИ ХАКАСИЯ

Кондрашова Е.А.

В статье отражены результаты исследований на территории Республики Хакасия продуктов питания по показателям химической безопасности. Установлена величина неканцерогенного риска в связи с потреблением пищевых продуктов. Приведен анализ уровней алиментарнозависимой заболеваемости. Изложены предложения по снижению алиментарных факторов риска.

Ключевые слова: *продукты питания; алиментарно-зависимая заболеваемость; нитраты; химическая безопасность; оценка риска; экспозиция контаминантом; коэффициент опасности.*

[1] Кондрашова Е.А. Гигиеническая оценка качества и безопасности продуктов питания на территории Республики Хакасия // В мире научных открытий, 2016. № 3(75). С. 20–26. doi:10.12731/wsd-2016-3-2.

Environment, diet as well as lifestyle are considered to be significant factors to affect public health. About 30% of the negative factors impact on public health comes from the impact of environmental factors. Foods quality and safety has a serious effect on public health [1, pp. 6–33; 3, pp. 4–10].

In 2010–2014 there was an increase in the alimentary-dependent diseases incidence rate within the territory of the Khakas Republic (Table 1).

Table 1.

The alimentary-dependent diseases track record of all the residents of the Khakas Republic in 2010-2014 ($^0/_{000}$)

Disease classes, disease subclasses, nosological entities	Period of monitoring					Growth rate by 2010 %
	2010	2011	2012	2013	2014	
Endocrine, nutritional and metabolic disorders	57.89	63.83	65.36	75.17	76.91	32.8
Diseases of the blood and blood-forming organs	10.2	10.35	9.9	11.26	14.78	44.9
Diseases of the circulatory system	212.23	212.39	207.63	217.14	212.30	0.03
Neoplasms	33.8	35.41	38.41	38.23	38.50	13.9

The largest increase among the alimentary-dependent pathology rate is observed in diseases of the blood and blood-forming organs (44,9%), endocrine system diseases, nutritional and metabolic disorders (32,8%).

The areas with the biggest number of cases of the blood and blood-forming organs diseases are as follows: Shirinsky district (14.7 per 1000 residents), Bogradsky district (14.8), the cities of Abakan (23.7) and Chernogorsk (16.1), whereas the average rate in the Khakas Republic is estimated within 11 to 14 per 1000 residents.

The following districts are among those that are characterized by a larger number of cases of the endocrine disorders compared to the average rate in the republic (2014: 76.9 per 1000 residents): Shirinsky district (125.5 per 1000 residents), Ordzhonikidzevsky district (99.3), Ust-Abakansky district (77.8), the city of Abakan (99.9) [2, pp. 61–65].

The purpose of the research is to analyse the foods quality within the territory of the republic in terms of the sanitary-chemical indicators in 2010–2014 as well as carry out risk assessment procedures related to foods consumption followed by a number of suggestions aimed at reducing the alimentary factors that affect the Khakas Republic residents.

The object of the research is considered to be foods available at shops and public catering places.

The subject of the research is considered to be the foods safety sanitary-chemical indicators regulated by the unified sanitary, epidemiological and hygienic requirements for goods subject to sanitary and epidemiological supervision (control) approved by the Customs Union commission dated 28.05.2010 No 299 as well as technical guidelines of the Customs Union. The protocols of the tests carried out at the certified testing laboratory centre (Federal State-Funded Healthcare Institution 'Centre for Hygiene and Epidemiology of the Khakas Republic') over the period of 2010-2014 were used to assess the foods. Both the photometric and tetrametric research methods were applied. The statistics data processing was carried out with the use of the Microsoft Office Excel 2007 software. The descriptive statistics of the research results is presented by the relative indicators that include calculation of 95% confidence intervals. The calculation of foods contamination exposure in terms of the number of the residents was carried out using the median as well as the 90^{th} percentile of foods contamination rate [4, p. 3–20].

Research results

Having analysed the chemical contamination level in the foods, we have observed its fall by half over the period of 2012–2014 (3.4% to 1.7%). But despite the decrease, the contamination annual average rate in the Khakas Republic for 2014 is higher than the one in the whole territory of the Russian Federation, which amounted to 0.64%.

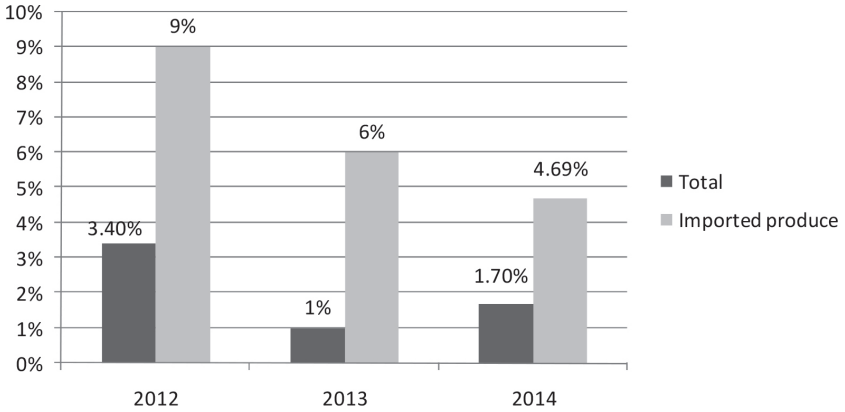
The average chemical contamination rate for the period of 2012–2014 in the Khakas Republic amounts to 2.42(1.6–3.5)%. The share of off-standard production samples for the above-mentioned period decreased from 9% to 4.69%, the average rate being 4.62% (0.7–15.7) (Pic. 1).

The increase in the share of the samples that do not meet the above-mentioned requirements was observed in the produce group, including vegetables (1.82% in 2010 to 3.99% in 2014).

The off-standard samples were found in the 6 administrative territories of the Khakas Republic, namely, in the cities of Chernogorsk and Sorsk as well as in Bogradsky, Ust-Abakansky, Tashtypsky, Ordzhonikidzevsky districts.

The main chemical contaminants are still thought to be nitrates, the average off-standard samples over the period of 5 years (2010–2014) being 9.2%, while the average content rate of pesticides, arsenic, cadmium amounts to 0.2%, the content of lead – 0.6%, antibiotics – 2.6%, whereas no mer-

cury content was found in both foods and other type of produce over the above-mentioned period.



Pic. 1. Variation in the share of off-standard food samples that do not meet the hygienic requirements in terms of the sanitary-chemical-indicators for the period of 2012–2014

Both domestic and imported produce fails to meet the standards in terms of nitrates content.

It is due to the fact that in the Khakas Republic the basic chemical contaminants in foods are nitrates found in fruit and vegetables, that the exposure assessment of these chemicals was made.

The contaminant exposure of the foods was made according to the formula:

$$Exp = \frac{\overset{N}{\underset{i=1}{\text{SUM}}} (C_i \times M_i)}{BW}, \quad (1)$$

Exp – the contaminant exposure value, mg/kg of the body weight /day (mg/kg of the body weight/week, mg/kg of the body weight/month);

C_i – contaminant content in i-product, mg/kg;

M_i – *i*-product consumption, kg/day (kg/week, kg/year);

BW – human body weight, kg (standard value – 70 kg);

N – total amount of the products used for the purposes of the research.

To calculate the risk of non-oncogenic impacts development the danger coefficient (HQ) was taken into consideration; the latter is expressed as the ratio between the assessed contaminant dose and permissible one according to the formulas:

$$HQ_{med} = \frac{C_{med}}{ADI} \quad (2)$$

$$HQ_{90\%} = \frac{Exp_{90\%}}{ADI} \quad (3)$$

The produce consumption rate was established according to the budget-funded research activities.

While calculating the foods contaminant exposure the data used were as follows: the standard human weight value (70 kg), median, 90th percentile of nitrates content in the produce over the period of 2010–2014.

Table 2.

Exposure value and danger coefficient (HQ) for the residents of the Khakas Republic as nitrates are consumed orally along with the produce

	Contaminant exposure value (Exp), mg/kg of the body weight/day	Danger coefficient value (HQ)
Me	0,69	0,18
90th percentile	4,92	1,32

Conclusion

Taking into consideration the research results obtained, the issue of providing the residents of the Khakas republic with high quality and contaminant-free foods seems to be one of the most pressing ones.

In order to ensure good nutrition of the residents of the Khakas republic in terms of its compliance with both sanitary and epidemiological standards, as well as to prevent contaminated and potentially off-standard foods being available on sale, it seems advisable to enhance the foods laboratory monitoring in research of contaminants.

For the aims of health maintenance and promotion, it is necessary to carry out an awareness-raising activities campaign among the residents of the republic providing information on healthy dieting, taking vitamin and mineral supplements to prevent alimentary-dependant disorders.

References

1. *O sostoyanii sanitarno-epidemiologicheskogo blagopoluchiya naseleniya v Rossiyskoy Federatsii v 2014 godu* [About the state sanitary-epidemiological welfare of the population in the Russian Federation in 2014]. Moscow, 2015. 206 p.
2. *O sostoyanii sanitarno-epidemiologicheskogo blagopoluchiya naseleniya v Respublike Khakasiya v 2014 godu [On the state of sanitary-epidemiological*

welfare of the population in the Republic of Khakassia in 2014]. Abakan, 2015. 172 p.
3. Onishchenko G.G. O sanitarno-epidemiologicheskom sostoyanii okruzhayushchey sredy [The sanitary and epidemiological state of the environment]. *Gigiena i sanitariya* [Hygiene and sanitation], 2013. no 2, pp. 4-10.
4. *Opredelenie ekspozitsii i otsenka riska vozdeystviya khimicheskikh kontaminantov pishchevykh produktov na naselenie. Metodicheskie ukazaniya. MU 2.3.7.2519-09* [Determination of exposure and assessment of risks of exposure to chemical contaminants in food products to the population]. 21 p.

Список литературы

1. О состоянии санитарно-эпидемиологического благополучия населения в Российской Федерации в 2014 году. М.: Федеральная служба по надзору в сфере защиты прав потребителей и благополучия человека, 2015. 206 с.
2. О состоянии санитарно-эпидемиологического благополучия населения в Республике Хакасия в 2014 году. Абакан: Управление Роспотребнадзора по Республике Хакасия, 2015. 172 с.
3. Онищенко Г.Г. О санитарно-эпидемиологическом состоянии окружающей среды // Гигиена и санитария. 2013. № 2. С. 4–10.
4. «Определение экспозиции и оценка риска воздействия химических контаминантов пищевых продуктов на население. Методические указания. МУ 2.3.7.2519-09» (утв. Роспотребнадзором 05.06.2009) 21 с.

DATA ABOUT THE AUTHOR

Kondrashova Ekaterina Aleksandrovna, Postgraduate Student, Department of Hygiene
Kemerovo State Medical Academy
22a, Voroshilova St., Kemerovo, Kemerovo Region, 650029, Russian Federation
kemsma@kemsma.ru
SPIN-code: 8189-3662

ДАННЫЕ ОБ АВТОРЕ

Кондрашова Екатерина Александровна, аспирант кафедры гигиены
Кемеровская государственная медицинская академия
ул. Ворошилова, 22 а, г. Кемерово, Кемеровская область, 650029, Российская Федерация
kemsma@kemsma.ru

DOI: 10.12731/wsd-2017-3-25-38
UDC 599.323.4:578.833.29(571.63)

ASSESSMENT OF EPIZOOTIC ACTIVITY AND EPIDEMIC RISK IN HEMORRHAGIC FEVER WITH RENAL SYNDROME FOREST FOCI OF PRIMORSKY KRAI[1]

Kushnareva T.V., Kumaksheva E.V.

In forest foci of hemorrhagic fever with renal syndrome (HFRS) of Primorsky Krai Amur and Hokkaido hantaviruses are circulated in the natural host population, i.e. Apodemus peninsulae and Myodes rufocanus. The indicators of epizootic activity and their threshold values in rodent population dynamics were determined in order to forecast HFRS outbreaks. The material for the research was obtained throughout 2001–2013. The number of trap-nights was 33890. 2737 of A. peninsulae and 1643 of M. rufocanus were investigated. ELISA, RT-PCR, IFA were used for the detection of hantavirus antigen, RNA, antibodies/avidity. The parameters of epizootic activity per 100 TN (N – population, n_i – infected rodents, n_{ai} – individuals with acute infection) were proposed. The results showed that the active foci of Amur viral infection are located on the slopes of the Sikhote-Alin ridge. The epizootic activity in A. peninsulae populations is characterized by the expressed cyclicity: phase I is rise, phase II is high activity, phase III is recession/low activity. Phases I and II are valid up to a year, whereas phase III is valid within a few years, determining the whole epizootic cycle. In phase I the number of rodents with an acute infection increased from summer to late autumn. In phase II the number of rodents with acute infection was considerable in spring/summer and decreased in autumn more than 3 times. In all phases of the cycle the threshold values were considerably higher for A. peninsulae, than for M. rufocanus, thus showing the former's epidemiological role in forest ecosystems. HFRS infection rate in phases I/II of the epizootic cycle in A. peninsulae populations had two peaks: during late autumn – winter (≥ 37% of cases) and spring – first half of summer (≥ 55% of cases).

[1] Кушнарева Т.В., Кумакшева Е.В. Оценка эпизоотической активности и эпидемического риска в лесных очагах геморрагической лихорадки с почечным синдромом Приморского края // В мире научных открытий, 2016. № 6(78). С. 92–108. doi:10.12731/wsd-2016-6-6.

The obtained threshold values of Amur hantavirus active circulation in population dynamics of the natural host allows to predict the periods of the increased risk of infection in HFRS forest foci for humans.

Keywords: *hantaviruses; rodents; hemorrhagic fever with renal syndrome (HFRS); natural foci; Primorsky Krai.*

ОЦЕНКА ЭПИЗООТИЧЕСКОЙ АКТИВНОСТИ И ЭПИДЕМИЧЕСКОГО РИСКА В ЛЕСНЫХ ОЧАГАХ ГЕМОРРАГИЧЕСКОЙ ЛИХОРАДКИ С ПОЧЕЧНЫМ СИНДРОМОМ ПРИМОРСКОГО КРАЯ

Кушнарева Т.В., Кумакшева Е.В.

В лесных очагах геморрагической лихорадки с почечным синдромом (ГЛПС) Приморского края циркулируют хантавирусы Amur и Hokkaido в популяциях природных хозяев – Apodemus peninsulae и Myodes rufocanus. С целью прогноза подъемов заболеваемости ГЛПС определены индикаторные показатели эпизоотической активности и их пороговые значения в динамике популяций грызунов. Материал получен в 2001–2013 гг. Выставлено 33890 ловушко-ночей (л-н). Исследовано 2737 A. peninsulae и 1643 M. rufocanus. Антиген, РНК хантавируса, специфические антитела / авидность выявляли в ИФА, ОТ-ПЦР, НМФА. Предложены показатели эпизоотической активности на 100 л-н: N – вся популяция; $n_и$ – все инфицированные; $n_{ои}$ – все особи с острой инфекцией. Результаты показали, что активные очаги Amur-вирусной инфекции расположены на склонах хребта Сихотэ-Алинь. Эпизоотическая активность в популяциях A. peninsulae имеет выраженную цикличность: I фаза – подъем, II – высокая, III – спад / низкая активность. I и II фазы длятся не более года, III фаза длится несколько лет, определяя период всего эпизоотического цикла. В I фазу число зверьков с острой инфекцией увеличивалось от лета к поздней осени. Во II число зверьков с острой инфекцией было значительно выше весной/летом, снижаясь осенью более чем в 3 раза. Значения показателей во все фазы цикла были значительно выше у A. peninsulae, чем у M. rufocanus, указывая на ее эпидемическую значимость в лесных экосистемах. В период I и II фаз эпизоотического цикла в популяциях A. peninsulae заболеваемость ГЛПС в крае имела два пика: осенне-зимний (≥ 37% случаев) и весенне-летний (≥ 55% случаев).

Полученные пороговые показатели активной циркуляции вируса Amur в динамике популяций природного хозяина дают возможность прогнозировать периоды повышенного риска заражения людей в лесных очагах ГЛПС.

Ключевые слова: *хантавирусы; грызуны; геморрагическая лихорадка с почечным синдромом (ГЛПС); природные очаги; Приморский край.*

Introduction

Currently, over 40 genetically and immunologically distinct hantavirus species in the genus *Hantavirus* of the *Bunyaviridae* family have been discovered. Each of them, with few exceptions, is strongly associated with a unique host species, having passed a long way of co-evolution. 22 species of hantaviruses are considered pathogenic to humans, their natural hosts being defined as the rodents of the three families, i.e. *Murinae*, *Cricetinae*, *Sigmodontinae* [1, 2]. Hantaviruses are capable of causing serious diseases in humans, i.e. the so-called hantavirus fevers [3] that are defined as natural focus nontransmissible viral zoonoses. Hemorrhagic fever with renal syndrome (HFRS) is quite widespread in Eurasia, whereas hantavirus pulmonary syndrome (HPS) can be found in both North and South America. Geographic distribution and epidemiology of cases caused by hantaviruses are seen as the consequence of distribution and natural history of their natural hosts [4]. The problem with HFRS, associated with immunologically distinct hantaviruses, seems to be particularly acute on the foci where two or more of its causative agents are present at the same time. In the European part of Russia, the following hantaviruses are HFRS etiologic agents: *Puumala* (reservoir – the *Myodes glareolus* bank vole) and *Dobrava* (the *Kurkino* genetic subtype, the reservoir being a subspecies of the *Apodemus agrarius* field mouse and the *Sochi* genetic subtype, its reservoir being the Caucasian forest mouse *A. ponticus*) [3, 5, 6]. In the Asian part of Russia, the following hantaviruses are HFRS etiologic agents: *Hantaan* (Far East genovariant), *Amur* (Amursk, Khabarovsk, Primorye, and Primorye1-China genovariants) and *Seoul* (VDV genovariant). The natural hosts of *Hantaan*, *Amur* and *Seoul* viruses are the eastern subtype of the *A. agrarius* field mouse, *A. peninsulae* forest Asian mouse and *Rattus norvegicus* gray rat, respectively [7–9]. The forest ecosystems are dominated by *A. peninsulae* – the natural host of the *Amur* pathogenic virus and the source of infection to humans, its co-dominant being the *Myodes rufocanus* gray-sided vole – natural host of the *Hokkaido* hantavirus with an unknown virulence level to humans. Studying of the areas being endemic to HFRS is aimed at establishing biocenotic structures of ecosystems, function and reservoir potential peculiarities of hantavirus natural foci [10, 11]. However, quite a few urgent issues

related to natural foci of hantavirus zoonoses have not been thoroughly studied so far, one of them being the mechanism of epizootic activity in the dynamics of rodent population as well as epidemic manifestations of different types of hantavirus infection natural foci within a particular spatial-temporal framework. The purpose of the study was to determine the indicators of epizootic activity and their threshold values in the population dynamics of rodents, being the carriers of the forest areas hantaviruses, in order to predict HFRS incidence rise on the forested territory of Primorsky Krai.

Material and Research methods

For the purposes of the study the research material was obtained during field and stationary research activities (2001–2013) on the HFRS endemic areas in the belt of mixed coniferous-deciduous and deciduous forests in central and southern parts of Primorsky Krai. The epizootological observation and collection of the material was carried out yearly in spring, summer and autumn. During the observation period, 33890 trap-nights (TN) were worked over. 4594 rodents were caught, 2737 of those were identified as *A. peninsulae*, 214 – *A. agrarius*, 1505 – *M. rufocanus*, 114 – *Myodes rutilus* red voles and 24 – *Microtus fortis* reed voles.

Table 1.

Immunological and molecular genetic research techniques

Research techniques	Hantavirus and infection identification in rodents
ELISA (enzyme-linked immunosorbent assay) Hantagnost commercial test-system manufactured by Federal State Unitary Enterprise on Manufacture of Bacterial and Viral Preparations of Chumakov Institute of Poliomyelitis and Viral Encephalitides	**Viral antigen** in 10–20% of the rodents' lungs and excretory organs suspension
RT-PCR (Reverse transcription polymerase chain reaction) RNA extraction, RT and PCR formulation, visual indication of amplification products by gel electrophoresis in agarose gel in the presence of ethidium bromide. Vector-Best, AmpliSens Hantavirus sets.	Hantavirus **RNA** in the animals' organs on ambient substrata
IFAT (Indirect fluorescent antibody technique). Anti-species FITC conjugates manufactured by N.F. Gamaleya Research Institute of Epidemiology and Microbiology. Antibody avidity in seropositive animals by the Hedman technique (1991).	**Antibodies** to culture antigens of hantaviruses Antibodies *avidity*: high, transitional, low.

The animals' hantavirus infection was detected by the presence of antigen/RNA in lungs/excretory organs and/or the presence of specific antibodies in their blood. Hantavirus antigen was identified using the ELISA, whereas viral RNA was identified using the RT-PCR; specific antibodies and their avidity were identified using the indirect fluorescence technique (Table 1).

To characterize hantavirus infection in individuals as well as on the population level of rodents, being hantavirus carriers, the following parameters and indicators were proposed: infection rate; acute infection; relative abundance / infection rate; epizootic activity (Table 2).

Table 2.

Main parameters and indicators of hantavirus infection

Parameters and values	Hantavirus infection in animals and population
Infection rate in rodents	Hantavirus antigen in lungs/organs, specific antibodies in blood.
Acute infection in rodents (hantavirus shedding with the natural host's saliva, urine, faeces into ambient environment).	Hantavirus antigen/RNA in lungs/ secretory and excretory organs, antibodies of low/transitional avidity.
Relative abundance of the species – Relative infection rate – Relatively acute infection –	number of all individuals per 100 TN number of all infected individuals per 100 TN number of all individuals with acute infection per 100 TN
Epizootic activity	Relatively acute infection in population

Research results and discussion

Forest ecosystems occupy about 70% of Primorsky Krai. *Amur* viral infection endemic areas were identified in the parts of the region with mixed coniferous-deciduous forests with a high proportion of cedar and oak, and a well-developed lower tier, being a favorable habitat for the large Japanese field mouse. *Amur* viral infection active natural foci are located on the western and eastern slopes of the Sikhote-Alin ridge occupied by coniferous-deciduous forests that are preferred by the *A. peninsulae*. Long-time average annual values for various rodent species, being hantavirus carriers, in forest communities are shown in Table 3, which proves the fact that all the values obtained are much higher in the *A. peninsulae* species.

According to the obtained data the dynamics of epizootic activity in *A. peninsulae* populations has an expressed cyclic recurrence. Rise and high activity are valid up to a year, from autumn of the current year till autumn of the subsequent

year, followed by recession. The phase of recession/low activity lasts for several years, determining the duration of the cycle. Table 4 presents the characteristic of the rodents, being hantaviruses carriers in forest ecosystems, within the phases of rise, high and low epizootic activity in *A. peninsulae* populations.

Table 3.

Long-time average annual values for rodents, being hantavirus carriers, in HFRS forest natural foci

Species of rodents as hantaviruses carriers	Values			
	Species proportion in the trapping (%)	Species proportion of the infected animals in the trapping (%)	Species population (per 100 TN)	The infection rate of the species (per 100 TN)
Apodemus peninsulae	59,6±0,7	**65,5**±1,8	**8,1**	**1,4**
Apodemus agrarius	4,7±0,2	2,5±0,2	0,6	<0,1
Myodes rufocanus	32,7±0,7	29,6±0,5	4,4	0,6
Microtus fortis	0,5±0,1	1,1±0, 4	<0,1	<0,1
Myodes rutilus	2,5±0,2	1,3±0, 4	0,3	<0,1

Table 4.

The characteristic of rodents, being hantaviruses carriers in forest ecosystems, within different phases of the epizootic activity in *A. peninsulae* populations

Phases of the *A. peninsulae* epizootic cycle	Species of rodents as hantaviruses carriers	Values of the species			
		Proportion in the trapping (%)	Proportion of the infected animals in the trapping (%)	Population (per 100 TN)	The infection rate (per 100 TN)
Phase I – activity rise	***A. peninsulae***	**78,3**	**78,9**	**7,45**	1,**58**
	A. agrarius	8,0	5,3	0,76	0,10
	M. rufocanus	13,4	15,8	1,28	1,31
	Microtus fortis	0,0	0,0	0,00	0,00
	M. rutilus	0,4	0,0	0,04	0,00
Phase II– high activity	***A. peninsulae***	**65,2**	**75,6**	**20,52**	**5,62**
	A. agrarius	3,3	1,8	1,04	0,14
	M. rufocanus	31,2	22,3	9,82	1,66
	Microtus fortis	0,2	0,3	0,07	0,02
	M. rutilus	0,1	0,0	0,02	0,00

End of the Table 4.

Phase III–low activity	***A. peninsulae***	**82,5**	**65,4**	**5,35**	**0,31**
	A. agrarius	1,0	0,0	0,06	0,00
	M. rufocanus	13,5	26,9	0,88	0,15
	Microtus fortis	0,3	3,8	0,02	0,02
	M. rutilus	2,6	3,8	0,17	0,02

During a year characterized by the activity rise the relative abundance of mice with acute infection in populations of *A. peninsulae* increased from summer to late autumn to an average value of 2. Within the high activity phase the number of mice with acute infection during a spring and summer season was more than 5 individuals per 100 TN, decreasing to more than 3 times in autumn at a fairly high population rate. Within the phase of low epizootic activity individuals with acute infection were found during all seasons, their number not exceeding the value of 0.3.

As a result of HFRS forest foci long-term monitoring, the parameters of hantaviruses active circulation were determined as well as their threshold values at different phases of the epizootic cycle in populations of rodents, being virus carriers, were defined. As seen in Table 5, within all the cycle phases the epizootic activity values tend to be much higher in *A. peninsulae*, compared to *M. rufocanus*, that proves the epidemiological importance of this species in forest ecosystems of Primorsky Krai.

Table 5

Threshold values of the population parameters within different phases of the *Apodemus peninsulae* and *Myodes rufocanus* epizootic cycle

Parameters	Phases of the cycle		***Apodemus peninsulae***	*Myodes rufocanus*
Relative abundance of the natural host (number of individuals per 100 TN): **N** – whole population $\mathbf{n}_{и}$ – all infected animals $\mathbf{n}_{ои}$ – animals with acute infection	**Rise** of the epizootic activity	**N**	≥ 8,0	≥ 1,5
		$\mathbf{n}_{и}$	≥ 1,8	≥ 0,3
		$\mathbf{n}_{ои}$	**≥ 1,5**	≥ 0,2
	High epizootic activity	**N**	≥ 20,0	≥ 9,0
		$\mathbf{n}_{и}$	≥ 7,0	≥ 1,7
		$\mathbf{n}_{ои}$	**≥ 5,0**	≥ 0,8
	Low epizootic activity	**N**	≤ 6,0	≤ 1,0
		$\mathbf{n}_{и}$	≤ 0.5	≤ 0,2
		$\mathbf{n}_{ои}$	**≤ 0,3**	≤ 0,1

For the observed period, in forest natural foci of hantavirus infection 39.6% of HFRS cases were reported from May to June. During the years of high epizo-

otic activity in the populations of the large Asian field mouse the bulk of HFRS cases were reported in spring and summer (68.6% of annual incidence). When comparing the long-time annual dynamic pattern of the epizootic activity in populations of rodents, being hantavirus carriers, to HFRS incidence in humans, the following dynamics conjugation was noted, the one of the epizootic process in populations of *A. peninsulae* and the annual and seasonal dynamics of HFRS cases registration. During the rise/high stage of the epizootic activity in populations of *A. peninsulae* two incidence peaks were determined: autumn to winter (≥ 37,5% of cases during a year), and spring to summer (≥ 55,2% of cases).

Another research activity was conducted within the frame of the study regarding the possibility to preserve natural foci of HFRS hantaviruses in the ambient environment, the ones excreted by the infected rodents with urine, saliva, faeces. Environmental substrata samples were taken on forested areas, being enzootic to hantavirus infections (Table 6).

Table 6.

Detection of hantavirus RNA, being external to its natural host, in the ambient environment of HFRS forest foci

Area / Time of sample collection	Research objects	Number of substrara samples	Sample characteristics	RT-PCR results
Kavalerovsky district, June to October	Trap lines in coniferous and cone-bearing forest on a stationary plot	20	Soil with plant litter	4+ RNA assays
Chuguyevsky district, October	Rodents' natural refuges	10	Soil with litter	2+ RNA assays
Olginsky district, Jyne. *HFRS group cases*	Trap lines in coniferous and cone-bearing forest around gamekeepers' dwelling	8	Soil with plant litter	2+ RNA assays

A specific RNA was found in the samples containing soil with plant litter on trap lines as well as in places, where HFRS group cases had been detected, and a certain number of *A. peninsulae* with acute hantavirus infection had been caught as well as traces of their activity detected.

Conclusion

To date, the Eurasian countries have seen the increase in both the amplitude and number of HFRS outbreaks. The risk determinants include reservoir ecology, ecology of the virus and antropogenous factors [12, 13]. Every year,

hundreds of thousands of people, who live in the endemic territories or temporarily stay there while at work or having time off, get in contact with HFRS natural foci. Both temporary protection of an individual or a group of people from a pathogen is required, as well as preventive measures aimed at reducing infection rate on specific HFRS endemic territories. HFRS, having all the features of the emerging infection, can lead to a complicated epidemic situation. In some HFRS and HPS outbreaks the mortality rate can reach 12% and 60% respectively [14]. WHO estimates that each year there are between 150000 and 200000 hantavirus disease cases, of which 70 to 90% are detected in parts of China, adjoining the north-eastern border of Primorsky Krai. More and more HFRS cases are reported in Europe [15]. In order to improve the prevention of hantavirus infections, the cooperation of international organizations is required, just as it is done concerning other widespread viral diseases [16].

According to the hypothesis (Vorontsov, 1974), causative agents of viral infections, by integrating fragments of their genome into their natural host's genome, play an important role in their evolution. The strategy to prevent natural foci infection should be aimed at preserving the role of the pathogen in the ecosystem, along with the unconditional protection of humans from infections caused by pathogens, rather than at the elimination of the pathogen [17].

In order to develop effective methods of HFRS protection and prevention, in our opinion, it is necessary to obtain quantitative parameters of hantaviruses circulation in different phases of the epizootic cycle in different types of the natural foci. After long-term monitoring of HFRS forest foci in Primorsky Krai, certain epidemic-significant indicators and their thresholds values were identified that reflect the activity of the epizootic process in its different development phases in populations of *A. peninsulae* and *M. rufocanus*, being natural hosts to *Amur* and *Hokkaido* hantaviruses. It is important to note that the rise, high and low epizootic activity values obtained were significantly higher in *A. peninsulae* compared to *M. rufocanus*, that proves the former's epidemic significance. Within the periods of rise and high epizootic activity in populations of *A. peninsulae* the two HFRS incidence peaks were observed as follows: autumn to winter and spring to summer ($\geq 37\%$ and $\geq 55\%$ of the annual incidence). The epizootic activity in populations of *A. peninsulae*, being cyclical, leads to years to year and seasonal differences in the HFRS cases distribution [18, 19]. Detection of hantavirus RNA in ambient environment substrata of HFRS forest natural foci shows the possibility of *Amur* virus survival within a considerably long period, while being external of its natural host organism, which is consistent with the data obtained for *Puumala* hantavirus [20]. Considering the 'hantavirus – rodent' binomial par-

asitic system the study on the detection of hantavirus in the medium between the natural host and human being seems to be quite significant in determining the factors, time, and areas of HFRS high infection rate concerning humans.

The proposed indicators for assessing the epizootic activity and their threshold values in the population dynamics of the natural host of *Amur* virus makes it possible to predict high-risk periods of human infection in HFRS forest foci within a particular spatial-temporal framework.

References

1. Mir M. Hantaviruses. *Clin. Lab. Med.,* 2010, vol. 30, no. 1, pp. 67–91.
2. Castel G., Razzauti M., Jousselin E., Kergoat G.J., Cosson G.F. Changes in diversification patterns and signatures of selection during the evolution of murinae-associated hantaviruses. *Viruses,* 2014, vol. 10, no. 6 (3), pp.1112–34.
3. Tkachenko E.A., Bernshtejn A.D., Dzagurova T.K., Morozov V.G., Slonova R.A., Ivanov L.I., Trankvilevskij D.V., Krjuger D. Aktual'nye problemy sovremennogo jetapa izuchenija gemorragicheskoj lihoradkoj s pochechnym sindromom v Rossii [Actual issues of hemorrhagic fever with renal syndrome]. *Zh. Mikrobiol., jepidemiol., immunobiol.* [Zh. Microbiol. (Moscow)], 2013, no 1, pp. 51–58.
4. Plyusnin A., Morzunov S. Virus evolution and genetic diversity of hantaviruses rodent hosts. *Curr. Top. Microbiol. Immuno*l., 2001, vol. 256, pp. 47–75.
5. Dzagurova T.K. *Gemorragicheskaja lihoradka s pochechnym sindromom (jetiologija, specificheskaja laboratornaja diagnostika, razrabotka diagnosticheskih i vakcinnyh preparatov)* [Hemorrhagic fever with renal syndrome (etiology, specific laboratory diagnostics, development of diagnostic and vaccinic preparations)]: Avtoref. dis. … d-ra med. nauk. Moscow, 2014. 47 p.
6. Klempa B., Avsic-Zupanc T., Clement J., Dzagurova T.K., Henttonen H., Jakab F., Kruger D.H., Maes P., PapaA., Tkachenko E.A., Ulrich L.G., Vapalahti O., Vaheri A. Complex evolution and epidemiology of Dobrava-Belgrade hantavirus: definition of genotipes and their characteristics. *Arch Virology.,* 2013, vol. 158, no. 3, pp. 521–529.
7. Slonova R.A., Kushnareva T.V., Kompanec G.G., MaksemaI.G., Simonova T.L., Simonov S.B. Hantavirusnaja infekcija v Primorskom krae – jepidemiologicheskaja situacija v ochagah cirkuljacii raznyh serotipov virusa [Hantavirus infection in Primorye – epidemiologic conditions in the nidi of circulation of different serotypes of virus]. *Zh. Mikrobiol., jepidemiol. i immunobiol.* [Zh. Microbiol. (Moscow)], 2006, no3, pp. 74–77.
8. Jashina L.N. *Geneticheskoe raznoobrazie hantavirusov v populjacijah gryzunov i nasekomojadnyh aziatskoj chasti Rossii* [Genetic diversity of Hantaviruses

in Rodent and Insectivora populations of Russia Asiatic part]: Avtoref. dis. … d-ra biol. nauk: Novosibirsk, 2012. 49 p.
9. Kushnareva T.V. New aspects of ecology of hantaviruses and hantaviral infections. *Eastern European Scientific J.*, 2016, no. 1, pp. 21–26.
10. Nafeev A.A., Shemjatihina G.B. Jekologo-jepidemiologicheskie podhody k nadzoru za gemorragicheskoj lihoradkoj s pochechnym sindromom [Ecological and epidemiological approaches to the control of hemorrhagic fever with renal syndrome]. *Jepidemiologija i infekcionnye bolezni* [Epidemiol. Infect. Dis. (Moscow)], 2011, no 1, pp. 49–50.
11. Tersago K., Verhagen R., Leirs H. Temporal variation in individual factors associated with hantavirus infection in bank voles during an epizootic: implications for Puumala virus transmission dynamics. *Vector Borne Zoonotic Dis.,* 2011, vol. 11, pp. 715–721.
12. Dearing M., Dizney L. Ecology of hantavirus in a changing world. *Ann. Ny. Acad. Sci.,* 2010, vol. 1195, pp. 99–112.
13. Zhigal'skij O.A., Bernshtejn A.D., Kshnjasev I.A., Apekina N.S. Jekologicheskie mehanizmy funkcionirovanija aktivnyh evropejskih ochagov GLPS [Ecological mechanisms of function of active European HFRS foci]. *Jekologija* [Ecology (Moscow)], 2013, no 3, pp. 237–240.
14. Jonsson C.B., Figueiredo L.T.M., Vapalahti O.A. Global Perspective on Hantavirus Ecology, Epidemiology and Disease. *Clin. Microbiol. Rev.,* 2010, vol. 23, no. 2, pp. 412–441.
15. Manigold T., Vial P. Human hantavirus infections: epidemiology, clinical features, pathogenesis and immunology. *Swiss Medical Weekly,* 2014, vol. 144, w. 13937.
16. Mamaev T.M., Zholdoshev S.T., Durusbekov A.D., Mamadzhanov A.N. Strategija profilaktiki VICh-infekcii v Oshskoj oblasti Kyrgyzskoj respubliki [Strategy of prevention of HIV in the Osh region of the Kyrgyz republic]. *V mire nauchnyh otkrytij* [In the world of Scientific Discoveries], 2016, no. 2 (74), pp. 120–130.
17. Korenberg Je.I. Prirodnaja ochagovost' infekcij: sovremennye problemy i perspektivy issledovanija [Natural focality of infections: current problems and prospects of investigations]. *Zoologicheskij Zh.* [Zoological J. (Moscow)], 2010, vol. 89, no. 1, pp. 5–17.
18. Slonova R.A., Kushnareva T.V., Kompanec G.G., Maksema I.G., Iunihina O.V., Kushnarev E.L. Svjaz' jepidemicheskogo processa hantavirusnoj infekcii s jepizooticheskim processom v populjacijah myshej roda Apodemus [Relationship of epidemic of hantavirus infection with epizootic process in mice populations of genus Apodemus]. *Tihookeanskij medicinskij Zh.* [Pasific Medical J.], 2010, no. 3, pp. 34–37.

19. Kushnareva T.V., Slonova R.A. Rezervuarnyj potencial prirodnyh hozjaev hantavirusov v dinamike jepizooticheskogo processa v jekosistemah Primorskogo kraja [Reservoir potential of hantavirus natural hosts in the epizootic process dynamic in the ecosystems of Primorskii Krai]. *Sibirskij jekologicheskij Zh.* [Siberian Ecological J.], 2014, no. 1, pp. 27–34. [Kushnareva T.V., Slonova R.A. The Natural Host Range of Hantaviruses and Their Reservoir Potential in the Dynamic of the Epizootic Process within the Ecosystems of Primorskii Krai . *Contemporary Problems of Ecology*, 2014, vol. 7, iss. 1, pp. 19–25].
20. Kallio E.R., Klingstrum J., Gustafsson E., Manni T., Vaheri A., Henttonen H., Vapalahti O., Lundkvist A. Prolonget survival of Puumala hantavirus outside the host: evidence for indirect transmission via the environment. *J. Gen. Virol.,* 2006, vol. 87, no. 8, pp. 2127–2134.

Список литературы

1. Mir M. Hantaviruses // Clin. Lab. Med. 2010. Vol. 30. N. 1, pp. 67–91.
2. Changes in diversification patterns and signatures of selection during the evolution of murinae-associated hantaviruses / G. Castel, M. Razzauti, E. Jousselin, G.J. Kergoat, J.F. Cosson // Viruses. 2014. Vol. 10. N 6 (3), pp. 1112–1134.
3. Актуальные проблемы современного этапа изучения геморрагической лихорадкой с почечным синдромом в России / Е.А. Ткаченко, А.Д. Бернштейн, Т.К. Дзагурова, В.Г. Морозов, Р.А. Слонова, Л.И. Иванов, Д.В. Транквилевский, Д. Крюгер // Ж. микробиол., эпидемиол. и иммунобиол., 2013. № 1. С. 51–58.
4. Plyusnin A., Morzunov S. Virus evolution and genetic diversity of hantaviruses rodent hosts // Curr. Top. Microbiol. Immunol. 2001. Vol. 256, pp. 47–75.
5. Дзагурова Т.К. Геморрагическая лихорадка с почечным синдромом (этиология, специфическая лабораторная диагностика, разработка диагностических и вакцинных препаратов): автореф. дис. … д-ра мед. наук. М., 2014. 47 с.
6. Complex evolution and epidemiology of Dobrava-Belgrade hantavirus: definition of genotipes and their characteristics / B. Klempa, T. Avsic-Zupanc, J. Clement, T.K. Dzagurova, H. Henttonen, F. Jakab, D.H. Kruger, P. Maes, A. Papa, E.A. Tkachenko, L.G. Ulrich, O. Vapalahti, A. Vaheri // Arch Virology. 2013. Vol. 158. N. 3, pp. 521–529.
7. Хантавирусная инфекция в Приморском крае – эпидемиологическая ситуация в очагах циркуляции разных серотипов вируса / Р.А. Слонова, Т.В. Кушнарева, Г.Г. Компанец, И.Г. Максема, Т.Л. Симонова, С.Б. Симонов // Ж. микробиол., эпидемиол. и иммунобиол., 2006. № 3. С. 74–77.
8. Яшина Л.Н. Генетическое разнообразие хантавирусов в популяциях грызунов и насекомоядных азиатской части России: автореф. дис. … д-ра биол. наук. Новосибирск, 2012. 49.

9. Kushnareva T.V. New aspects of ecology of hantaviruses and hantaviral infections // Eastern European Scientific J. 2016. N.1, pp. 21–26.
10. Нафеев А.А., Шемятихина Г.Б. Эколого-эпидемиологические подходы к надзору за геморрагической лихорадкой с почечным синдромом // Эпидемиология и инфекционные болезни. 2011. № 1. С. 49–50.
11. Tersago K., Verhagen R., Leirs H. Temporal variation in individual factors associated with hantavirus infection in bank voles during an epizootic: implications for Puumala virus transmission dynamics // Vector Borne Zoonotic Dis. 2011. Vol. 11, pp. 715–721.
12. Dearing M., Dizney L. Ecology of hantavirus in a changing world // Ann. Ny. Acad. Sci. 2010. Vol. 1195, pp. 99–112.
13. Экологические механизмы функционирования активных европейских очагов ГЛПС / О.А. Жигальский, А.Д. Бернштейн, И.А. Кшнясев, Н.С. Апекина // Экология. 2013. № 3. С. 237–240.
14. Jonsson C.B., Figueiredo L.T.M., Vapalahti O.A. Global Perspective on Hantavirus Ecology, Epidemiology and Disease // Clin. Microbiol. Rev. 2010. Vol. 23. N 2, pp. 412–441.
15. Manigold T., Vial P. Human hantavirus infections: epidemiology, clinical features, pathogenesis and immunology // Swiss Medical Weekly. 2014. Vol. 144. W. 13937.
16. Стратегия профилактики ВИЧ-инфекции в Ошской области Кыргызской республики / Т.М. Мамаев, С.Т. Жолдошев, А.Д. Дурусбеков, А.Н. Мамаджанов // В мире научных открытий. 2016. 2 (74). С. 120–130.
17. Коренберг Э.И. Природная очаговость инфекций: современные проблемы и перспективы исследования // Зоологич. Ж. 2010. Т. 89. № 1. С. 5–17.
18. Связь эпидемического процесса хантавирусной инфекции с эпизоотическим процессом в популяциях мышей рода Apodemus / Р.А. Слонова, Т.В. Кушнарева, Г.Г. Компанец, И.Г. Максема, О.В. Иунихина, Е.Л. Кушнарев // Тихоокеанский Медицинский Ж. 2010. № 3. С. 34–37.
19. Кушнарева Т.В., Слонова Р.А. Резервуарный потенциал природных хозяев хантавирусов в динамике эпизоотического процесса в экосистемах Приморского края // Сибирский Экологический Ж. 2014. № 1. С. 27–34. [Kushnareva T.V., Slonova R.A. The Natural Host Range of Hantaviruses and Their Reservoir Potential in the Dynamic of the Epizootic Process within the Ecosystems of Primorskii Krai // Contemporary Problems of Ecology. 2014. Vol. 7. Iss. 1, pp. 19–25]. (http://link.springer.com/article/10.1134/S1995425514010090).
20. Prolonget survival of Puumala hantavirus outside the host: evidence for indirect transmission via the environment / T.R. Kallio, J. Klingstrum, E. Gustafs-

son, T. Manni, A. Vaheri, H. Henttonen, O. Vapalahti, A. Lundkvist // J. Gen. Virol. 2006. Vol. 87. N. 8, pp. 2127–2134.

DATA ABOUT THE AUTHORS

Kushnareva Tatyana Valerevna, Leading Scientist of Hantaviral Infections Laboratory, Candidate of Biology Science
Institution of Epidemiology and Microbiology name of G.P. Somov; Pacific State Medical University
1, Selskaya Str., Vladivostok, Primorskii Krai, 690087, Russian Federation; 2, Ostryakova av., Vladivostok, 690002, Russian Federation
tatyana.kushnareva@inbox.ru
SPIN-code: 2345-7935
ORCID: 0000-0002-9629-1281
ResearcherID: I-8451-2016

Kumaksheva Elizaveta Vladimirovna, Junior Scientist of Hantaviral Infections Laboratory
Institution of Epidemiology and Microbiology name of G.P. Somov
1, Selskaya Str., Vladivostok, Primorskii Krai, 690087, Russian Federation
liza_kumaksheva@mail.ru

ДАННЫЕ ОБ АВТОРАХ

Кушнарева Татьяна Валерьевна, ведущий научный сотрудник лаборатории хантавирусных инфекций, кандидат биологических наук
НИИ эпидемиологии и микробиологии имени Г.П. Сомова; Тихоокеанский государственный медицинский университет
ул. Сельская, 1, г. Владивосток, Приморский край, 690087, Российская Федерация; пр. Острякова, 2, г. Владивосток, приморский край, 690002, Российская Федерация
tatyana.kushnareva@inbox.ru

Кумакшева Елизавета Владимировна, младший научный сотрудник лаборатории ХВИ
НИИ эпидемиологии и микробиологии имени Г.П. Сомова
ул. Сельская, 1, г. Владивосток, Приморский край, 690087, Российская Федерация
liza_kumaksheva@mail.ru

СЕЛЬСКОХОЗЯЙСТВЕННЫЕ НАУКИ
AGRICULTURAL SCIENCES

DOI: 10.12731/wsd-2017-3-39-46
UDC 547.455.647

PH AND TEMPERATURE EFFECT ON WHEAT GERM CAKE CATALASE ACTIVITY AND RIGOR[1]

Alekseeva T.V., Rodionov A.A., Kalgina Y.O., Vesnina A.A., Zyablov M.M.

The paper presents the results of the study considering the role of catalase as the governing factor at wheat germ storage. The pH and temperature effect on wheat germ cake catalase activity and rigor has been considered and analyzed.

Keywords: *catalase; wheat germ cake.*

ВЛИЯНИЕ РН И ТЕМПЕРАТУРЫ НА АКТИВНОСТЬ И УСТОЙЧИВОСТЬ КАТАЛАЗЫ ЖМЫХА ЗАРОДЫШЕЙ ПШЕНИЦЫ

Алексеева Т.В., Родионов А.А., Калгина Ю.О., Веснина А.А., Зяблов М.М.

Представлены результаты исследований касательно роли каталазы как определяющего фактора при хранении жмыха зародышей пшеницы. Рассмотрено и проанализировано влияние pH среды и температуры на активность каталазы жмыха зародышей пшеницы.

Ключевые слова: *каталаза; жмых зародышей пшеницы.*

[1] Алексеева Т.В. Влияние pH и температуры на активность и устойчивость каталазы жмыха зародышей пшеницы / Т.В. Алексеева, А.А. Родионов, Ю.О. Калгина, А.А. Веснина, М.М. Зяблов // В мире научных открытий, 2016. № 10(82). С. 139-147. doi:10.12731/wsd-2016-2-10.

Introduction

In the Russian Federation there is a number of state-run programs aimed at developing production of foods enriched with essential components, functional use products, distribution of advanced processing of agricultural raw materials on the principles of non-waste production, sustainable use of secondary products, as well as food industry waste reduction. The above-mentioned programs are as follows: the comprehensive program of biotechnologies development in the Russian Federation, health nutrition state policy in the period through to 2020, state program of agriculture development and agricultural commodities, raw materials and foods market regulation.

From this point of view, wheat germ cake (WGC), being the product of advanced wheat processing, seems to be of great interest. WGC is a native plant component that has high nutritional and biological value. It contains vitamins A and E, vitamin B complex as well as 20 macro- and microelements. Thanks to its rich biochemical composition and high functional and technological properties WGC can be widely used in food, confectionery, perfumery and medical industry. However, WGC has low storage stability as it is characterized by a high level of lipids (8-10%), which contain up to 80% of polyunsaturated fatty acids (including ω-3, ω-6 fatty acids) [1, 2].

Catalase (EC 1.11.1.6) is an enzyme of the oxidoreductase group that catalyses a reduction-oxidation reaction; it is within this type of reaction that two molecules of hydrogen peroxide are transformed into water and oxygen. When storing and processing WGC it is catalase that has a negative effect. Lipase starts a process of WGC fats getting rancid (EC 3.1.1.3) as it triggers lipids hydrolysis alongside with free fatty acids formation as well as their further oxidation. Lipoxygenase (EC 1.13.11.12) affects the parallel process as fatty acids hydroperoxides are decomposed to acidic products. As it takes part in the reaction, catalase leads to oxygen evolution; the latter intensifies the oxidation processes in the product. The result of the chain reaction leading to hydroperoxides formation in WGC as well as other advanced types of oxidation products and lipid decomposition is objectionable odour and rancid taste of the product [3, 5].

The aim of the paper is to study the way pH and temperature affect WGC catalase activity and rigor as these are significant factors influencing the storage parameters.

Materials and study methods

For the aims of the study the following type of wheat germ (WG) was used, namely, the one industrially produced (TS 9295-010-00932732-08 ‘ed-

ible wheat germ flakes'). The authors studied batches of WG obtained as a result of processing wheat grain of various types coming from Belgorod, Lipetsk and Voronezh oblasts (Starooskolsky bread and cereal products factory JSC, Buturlinovsky flourmill factory JSC, Tonex JSC, Lipetsk bread and cereal products JSC). WG processing was performed using a cold pressing technique at Tonex JSC (Belgorod oblast). WGC, being the product of WG advanced processing met all the requirements of the relevant technical specifications (TS 9295-014-18062042-06 'VITAZAR edible wheat germ flour').

A WGC specimen was obtained by mechanical grinding in a laboratory mill and its further homogenization with phosphate-citrate buffer (pH 7.4). The first purification step involved the precipitation of the enzyme specimen using 96.5% ethanol at a temperature of 2–4°C. The precipitate was separated using a cold centrifuge at 5000 g and then it was vacuum dried. The ballast proteins were eliminated from the enzyme by fractionation with the use of ammonium sulfate. The precipitate was obtained at the level of ammonium sulfate saturation of 60–80%. The latter was dissolved in a minimum amount of buffer. Low-molecular impurities were removed from the enzyme solution using gel-filtration on Sephadex G-25. The final purification step involved gel-filtration on Sephadex G-100 (Pharmacia, Sweden). Finally, the enzyme specimen was obtained, being characterized by 80-fold purity and specific activity of 545.2 units/1 mg protein.

An activity unit was thought to be the amount of mm hydrogen peroxide being decomposed during the incubation process to 1 ml of the enzyme specimen at 37°C and pH = 7.4 [3, 4].

Results of the study and their discussion

Temperature and pH are considered to be the two most important factors that must be taken into consideration when catalase inactivation takes place for the purpose of WGC long-term storage, as well as when making specimen (Fig. 1 and 2). The enzyme activity was determined within pH 4–9 at the optimum temperature and was expressed as a percentage of the maximum (Fig. 1). The catalase optimum pH is thought to be within the area of 7.3–7.8.

With the optimum pH being found, the temperature effect on the enzyme activity was determined, the optimum temperature being 37 ± 2°C.

The study of thermal and pH stability of the enzyme is of considerable interest as these indications are considered to be important criteria when selecting WGC storage conditions as well as processing conditions of food products that contain WGC. When studying WGC catalase inactivation kinetics,

samples were taken from the incubation medium regularly after certain time intervals, then the residual activity of the enzyme was determined.

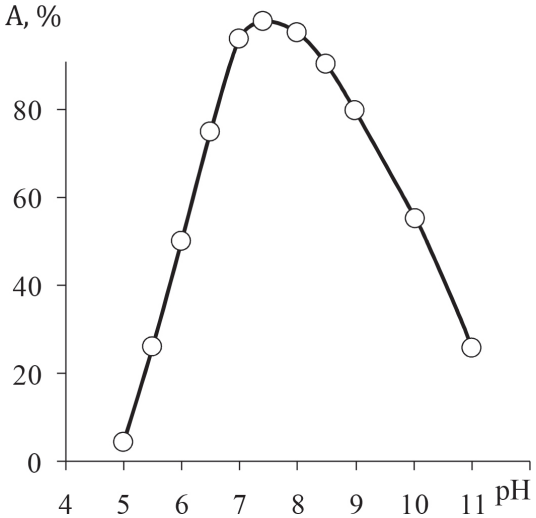


Fig. 1. WGC catalase activity dependence on the medium pH at the temperature of 37°C

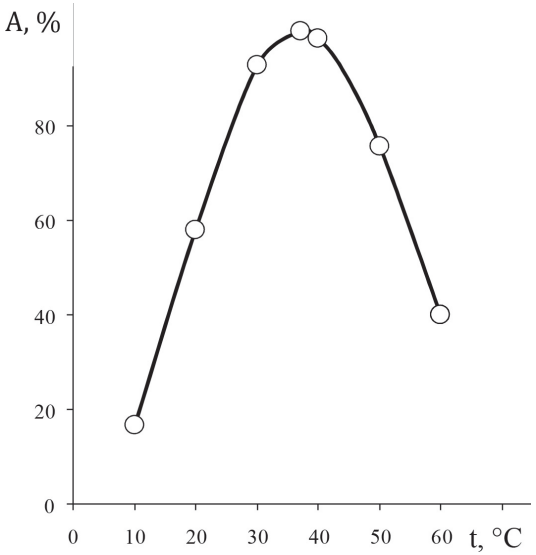


Fig. 2. WGC catalase activity dependence on temperature at the medium pH 7.4

With the use of the inactivation dynamics data we calculated the inactivation rate invariables. The greatest stability of the enzyme was recorded at pH 8.0 and the temperature of 20°C (Table 1).

Increase of temperature resulted in a significant increase of the average rate, which increased more dramatically at hydrogen ions higher concentrations level and the temperature increase up to 40°C and above. We calculated the entropy variation in $\Delta S^{\neq}$ of the enzyme transition state from the active form to the inactivated one.

Table 1.

WGC catalase inactivation rate invariables

Temperature, °C	$K \cdot 10^2$, hr^{-1}				
	pH 4	pH 5	pH 6	pH 7	pH 8
20	4,1	3,3	2,4	1,9	1,4
40	95,9	41,8	27,1	19,6	12,9
60	630,9	524,8	409,3	344,4	289,1

The data obtained show that at low temperatures the high concentration of H^+ ions leads to the enzyme protein globule intensive transition to a chaotic tangle; apparently, it is due to the active destruction of the electrostatic bonds (Table 2).

Table 2.

Temperature effect on pH and entropy value ($\Delta S^{\neq}$) of the WGC catalase transition state

Temperature range, °C	pH	$\Delta S^{\neq}$, J · degree · mol^{-1}
20-40	4,0	170,079
40-60		40,943
20-40	8,0	33,965
40-60		190,717

The opposite situation is observed at pH 8.0. At high temperatures, one can see an intensive destruction of the protein globule. It can be a result of the process in which the hydrophobic interactions of molecule non-polar parts are destroyed.

Conclusion

Based on the data obtained it can be concluded that it is the H^+ ions that greatly affect the WGC catalase inactivation process at low temperatures,

whereas it is heat that affects the same way at high temperatures. The enzyme has a low acid and thermal rigor, which makes it possible to use these characteristics to suppress the enzyme activity at WGC storage as well as find proper technological parameters for processing foods that contain WGC.

References

1. Alekseeva T.V. *Biotekhnologicheskiy potentsial fraktsiy glubokoy pererabotki nizkomaslichnogo syr'ya: balansirovanie PNZhK – sostava, prognozirovanie kachestva, novye tekhnologii* [Biotechnological potential fractions of deep processing of low oilseeds: balancing PUFA – structure, forecasting quality, new technologies]. 2015. V. 1. 332 p.
2. Alekseeva T.V., Rodionov A.A., Vesnina A.A. *Vestnik VGUIT.* 2015. № 3 (65), pp. 127–131.
3. Becker D.J., Lowe J.B. *Glycobiology*. 2003. V. 13(7), pp. 41–53.
4. Zherebtsov N.A., Grigorov V.S., Korneeva O.S., Spivakova L.V. *Laboratornyy praktikum po biokhimii* [Laboratory workshop on Biochemistry]. Voronezh, 2000. 138 p.
5. Rodionova N.S., Alekseeva T.V. *Teoreticheskie aspekty razrabotki tekhnologiy i komponentnogo sostava rastitel'noy kompleksnoy pishchevoy sistemy na osnove produktov glubokoy pererabotki nizkomaslichnogo syr'ya* [Theoretical aspects of technology development and component composition of plant food complex systems based on deep-processing products nizkomaslichnogo raw materials]. Voronezh: VGUIT, 2014. 224 p.

Список литературы

1. Алексеева Т.В. Биотехнологический потенциал фракций глубокой переработки низкомасличного сырья: балансирование ПНЖК – состава, прогнозирование качества, новые технологии: Диссертация доктора технических наук. 2015. Т. 1. 332 с.
2. Алексеева Т.В. Управление качеством пищевых систем с прогнозируемым биопотенциалом на основе продуктов переработки отечественного низкомасличного сырья / Т.В. Алексеева, А.А. Родионов, А.А. Веснина // Вестник ВГУИТ. 2015. № 3 (65). С. 127–131.
3. Becker D.J., Lowe J.B. Fucose: biosynthesis and biological function in mammals by Catalase // Glycobiology. 2003. V. 13(7), pp. 41–53.
4. Жеребцов Н. А. Лабораторный практикум по биохимии: учебное пособие / Н.А. Жеребцов, В.С. Григоров, О.С. Корнеева, Л.В. Спивакова. Воронеж, 2000. 138 с.

5. Родионова Н.С., Алексеева Т.В. Теоретические аспекты разработки технологий и компонентного состава растительной комплексной пищевой системы на основе продуктов глубокой переработки низкомасличного сырья: монография. Воронеж: Изд-во «ВГУИТ», 2014. 224 с.

DATA ABOUT THE AUTHORS

Alekseeva Tatyana Vasilievna, Dr.Sci.Tech., Professor Chair of Service and Catering Business
Voronezh State University of Engineering Technology
19, Revolution Avenue, Voronezh, 394036, Russian Federation
zyablova@mail.ru

Rodionov Alexaner Anatolievich, Undergraduate, Chair of Service and Catering Business
Voronezh State University of Engineering Technology
19, Revolution Avenue, Voronezh, 394036, Russian Federation
syperintellect@mail.ru

Kalgina Yuliya Olegovna, Undergraduate, Chair of Service and Catering Business
Voronezh State University of Engineering Technology
19, Revolution Avenue, Voronezh, 394036, Russian Federation
kalgina@mail.ru

Vesnina Anna Alexandrovna, Undergraduate, Chair of Service and Catering Business
Voronezh State University of Engineering Technology
19, Revolution Avenue, Voronezh, 394036, Russian Federation
vesninaaa@mail.ru

Zyablov Maxim Mihaylovich, Undergraduate, Chair of Service and Catering Business
Voronezh State University of Engineering Technology
19, Revolution Avenue, Voronezh, 394036, Russian Federation
makson1993@mail.ru

ДАННЫЕ ОБ АВТОРАХ

Алексеева Татьяна Васильевна, д.т.н., профессор кафедры сервиса и ресторанного бизнеса

Воронежский государственный университет инженерных технологий
проспект Революции, 19, г. Воронеж, 394036, Российская Федерация
zyablova@mail.ru

Родионов Александр Анатольевич, студент кафедры сервиса и ресторанного бизнеса
Воронежский государственный университет инженерных технологий
проспект Революции, 19, г. Воронеж, 394036, Российская Федерация
syperintellect@mail.ru

Калгина Юлия Олеговна, студент кафедры сервиса и ресторанного бизнеса
Воронежский государственный университет инженерных технологий
проспект Революции, 19, г. Воронеж, 394036, Российская Федерация
kalgina@mail.ru

Веснина Анна Александровна, студент кафедры сервиса и ресторанного бизнеса
Воронежский государственный университет инженерных технологий
проспект Революции, 19, г. Воронеж, 394036, Российская Федерация
vesninaaa@mail.ru

Зяблов Максим Михайлович, студент кафедры сервиса и ресторанного бизнеса
Воронежский государственный университет инженерных технологий
проспект Революции, 19, г. Воронеж, 394036, Российская Федерация
makson1993@mail.ru

DOI: 10.12731/wsd-2017-3-47-61
UDC 631.41

FEATURES OF HUMUS AND NITROGEN ECOLOGICAL STATUS FOR STEPPE ZONE CHERNOZEMS OF THE NORTH CAUCASUS[1]

Novikov A.A.

The purpose of the paper presented is to determine tendency and intensity for quantitative and qualitative changes in humus and nitrogen status of chernozems. The system approach to study natural objects is assumed as the basis for research methodology of humus and nitrogen status of soils.

It is established that the depth typical values of chernozem humus horizons in the North Caucasus are 120–180 cm for South European facies of leached chernozems, 100–170 cm for modal chernozems, 70–160 cm for common chernozems, 70–120 cm for southern chernozems; for East European facies of southern chernozems the value is 55–70 cm. A distinctive ecological feature of the soils is thought to be a low humus content in the arable layer, its deep distribution along the profile and slight variability among each subtype.

Nitrogen quantity in chernozems of the region variates within a comparatively wide range: 0.20–0.35% in South European facies of leached, modal and common chernozems, 0.22–0.30% in East European facies of southern chernozems. Southern chernozems of South European facies contain least of all nitrogen, i.e., 0.18–0.22%. Total nitrogen composition is mainly presented by non-hydrolysable facies, making 74.2–78.9%.

The research materials are intended to design farming systems on the landscape basis for specialists dealing with the issues of soil preservation, increasing soil fertility as well as environment protection. The results of the research may contribute to making a purposeful impact on decision making to control humus and nitrogen status of soils, thus serving as the basis for preservation of bioecological potential of chernozems.

Keywords: *soil; soil fertility; chernozems; humus; nitrogen.*

[1] Новиков А.А. Особенности экологического состояния гумуса и азота чернозёмов степной зоны Северного Кавказа // В мире научных открытий, 2016. № 12(84). С. 144-160. doi:10.12731/wsd-2016-12-144-160.

ОСОБЕННОСТИ ЭКОЛОГИЧЕСКОГО СОСТОЯНИЯ ГУМУСА И АЗОТА ЧЕРНОЗЁМОВ СТЕПНОЙ ЗОНЫ СЕВЕРНОГО КАВКАЗА

Новиков А.А.

Цель представленной работы установить направленность и интенсивность количественных и качественных изменений гумусного и азотного состояний чернозёмов. В основу методологии исследований гумусного и азотного состояния почв положен системный подход к изучению объектов природы.

Установлено, что типичные значения мощности гумусовых горизонтов чернозёмов Северного Кавказа составляют: южно-европейской фации выщелоченных 120–180, типичных 100–170, обыкновенных 70–160, южных 70–120, восточно-европейской фации южных 55–70 см. Отличительная экологическая особенность почв – низкое содержание гумуса в пахотном слое, глубокое распределение его по профилю, малая вариабельность среди каждого подтипа.

Количество азота в чернозёмах региона колеблется сравнительно в широких пределах: в южно-европейской фации выщелоченных, типичных, обыкновенных 0,20-0,35%; восточно-европейской фации южных 0,22–0,30. Меньше всего азота содержат чернозёмы южные южно-европейской фации – 0,18–0,22%. Состав валового азота в основном представлен негидролизуемой фракцией – 74,2–78,9%.

Материалы исследования предназначены для проектирования систем земледелия на агроландшафтной основе, специалистам занимающимся вопросами сохранения и повышения плодородия почв, охраны окружающей среды. Результаты исследования позволяют осуществлять целенаправленное воздействие на принятие решений по регулированию гумусного и азотного состояния почв, что послужит основой сохранения биоэкологического потенциала чернозёмов.

Ключевые слова: *почва; плодородие почв; чернозёмы; гумус; азот.*

Introduction

V.V. Dokuchaev, a prominent soil analyst and natural scientist, repeatedly noted that chernozem is the basis of Russia's wealth and prosperity. However, for a long period of time, we have, especially recently, been facing a number

of significant problems concerning chernozems fertility, namely, progressive degradation of the soil, dehumification, loss of organic and readily available mineral forms of nitrogen, which have resulted in development of other negative processes and are mainly responsible for the current decline in productivity and sustainability of the agroecosystem.

It is the ecological problem of fertility preservation along with its main indicators, i.e., humus and nitrogen in the chernozems of the North Caucasus, being among the most fertile soils both in Russia and all over the globe, that is becoming increasingly urgent. Thus, both generalization and monitoring the humus and nitrogen status of the chernozems in the region are required.

Purpose

To establish the direction and intensity of both quantitative and qualitative changes in the humus and nitrogen status of the chernozems of the North Caucasus.

Study data and methodology

The methodology of the research concerning the humus and nitrogen status of soils is based on a systematic approach to the study of objects of nature that points out the necessity not to isolate an object or phenomenon, but to consider it in its interrelation and interdependence with the surrounding systems and processes.

The following components constitute the basis of the methodology for studying the humus and nitrogen status of chernozems that determine the level of soil fertility, its bioenergy potential, sustainable ecological functioning of the agroecosystem, as well as land protection:

- integrated approach to biological objects, i.e., soil derivatives and abiotic environment;
- profile-genetic and comparative-geographical assessment of soil status;
- taking into account spatial and temporal variability of soil properties;
- consistency of author's research methods.

The research activities were carried out as the fieldwork on common and southern chernozems at the three stations of the Don Zonal Research Institute of Agriculture. Soil crossovers were made at the stations and allocated lots to be used to take soil samples according to GOST (All-Union State Standard) 28168-89. Following "The general sampling procedure requirements" (GOST 29269-91), the samples were used to determine common humus (GOST 26213-91), total nitrogen (GOST 26107-84), as well as fraction-group composition of humus using the method by I.V. Tyurin as modified by V.V. Ponomaryova and

T.A. Plotnikova. The mathematic treatment of the findings was carried out using a technique developed by B.A. Dospekhov.

Results of the study and their discussion

Organic matter performs an enormous number of functions. It serves as a direct source of nutrients for plants, affects nutrients accessibility and behavior, regulates soil structure formation, its hydrophysical properties, thermal parameters, redox and ion exchange reactions [1, 2].

Considering the environmental aspect, it is especially important that humus substances are characterized by their high absorption capacity, thus (as well as other colloid substances) contributing to one of the most remarkable properties of the soil, i.e., its buffering capacity, the ability to withstand the harmful effects of acidic and alkaline solutions [3].

Soil, once it is enriched with organic matter, becomes more resistant to contamination due to a high content of various functional groups in humic acids, including carboxyl, amine, phenolic, hydroxyl groups, involved in the formation of simple and complex organo-mineral compounds [4].

Organic matter is characterized by having general significance for the globe as it constitutes "humosphere" which is thought to be the most important natural storage of energy, being essential to help plants obtain mineral nutrition elements out of inaccessible forms, i.e., nitrogen out of air, ash constituents out of minerals of soil-forming materials [5].

At present, bioenergetics issues are becoming increasingly relevant, which is due to both general environmental problems and specific practical tasks of preserving and improving soil fertility and productivity of crops [6, 7].

Sources of soil organic matter and energy it contains are the remains of plants, animals, microorganisms and their products that are subjected to complex, sometimes opposite, transformations [8, 9, 10, 11].

During the decomposition process of organic substances in the soil, processes of mineralization and the so-called "aging" of both newly formed humus substances and previously accumulated ones are observed. As a result of mineralization of the "destructive" (i.e. annually decomposing) humus, as well as decomposition of decaying plans and other organic compounds, a certain amount of substances enters the soil. Their level depends not only and not so much on the total amount of humus as on the amount of the humus part and total organic matter that dissolve.

New portions of humification products enter into exchange reactions with the already existing humic acids, as well as with the exchangeable and non-ex-

changeable occluded mineral part of the soil, participate in the completion and fragmentation of the renewed humus substances, perform the protective function of the "old" humus as it were. Along with plant and animal remains, soil receives energy fixed by photosynthesis [12].

It is the loss of the main property of natural soils, i.e. the rhythm of destruction of a part of humus and formation of a new part within the same year, that is the main ecological criterion for the deterioration of the humus status of plowed soils.

According to G. Reuter, the loss of humus in soils as a result of long-term use amounts to 13–25% of the original content [13]. In Canada, the humus content in the arable land has decreased by an average of 45% within the past 50 years, including chernozems by 48.2%; in soils of the south of the USA the humus content has decreased to 60%.

Over the last 70–80 years, the loss of humus in the arable soils of the USSR amounted to 40–50%, different subtypes of chernozems annually lost 0.5–1.8 tons per hectare [14, 15].

Most studies of the humus status of the North Caucasus chernozems were carried out in the areas of the warm Southern European facies, while the others were conducted in the areas of the warm-temperate Eastern European facies.

The study of the humus status of soils of the Southern Russia showed that its formation was determined by a complex of natural historical prerequisites, the most important being rank motley grass and fescue-feather grass vegetation with well-developed root system. The remains of the latter were humified for a long time in warm and warm-temperate climate.

It was established that the greatest thickness of the humus horizon characterizes chernozems of the leached Southern European facies, reaching 180 cm. Lesser A+B thickness of 100–170 cm characterizes modal chernozems, common chernozems have even lesser value of 70–160 cm, while southern chernozems are characterized by the value of 70–120 cm thickness of the humus horizon. The least thickness was found in the South Eastern European facies, being 55–70 cm [16, 17].

The typical values of humus of each subtype varies within a just small range. A somewhat larger content of organic matter is characteristic of modal chernozems.

According to the average content of humus and typical values fluctuations modal chernozems are characterized as being low-humic. The scarcely-humic variants of these chernozems are rare, being determined by the lowest values lying beyond the scale of typicality. The extensive area of common and leached

chernozems of the South European facies is less homogeneous in terms of the humus accumulation intensity.

The southern chernozems of the Southern European and East European facies are mainly low-humic, being considerably different from other soils in the region. The coefficient of variation amounts to 10–28%.

The study of the humus content and its fraction-group composition that we carried out in the common chernozems of the South European facies at the Don Zonal Research Institute of Agriculture as well as southern chernozems of the East European facies at the Severo-Donetsk experimental station showed that common chernozems are characterized by having a considerable thickness of the humus horizon (84 cm) compared to southern chernozems (62 cm) [18, 19]. Higher value of carbon content and less sharp decrease along the soil profile was also found in common chernozem.

The carbon percentage in the arable horizon of common chernozems amounted to 2.38, while in southern chernozem the value was 2.19; the one in BC horizon was 0.91 and 0.80; in C it was 0.53 and 0.32. The amount of humic acid groups in these chernozem subtypes, being equal to A_{arable} 0.98 and 0.94%, shows a considerable decrease to 0.09 and 0.05% in C horizon. The groups of fulvic acids in the A_{arable} common and southern chernozems were also approximately equal, i.e. 0.48 and 0.46%, whereas the amount decreased in the lower horizons of the southern chernozem.

The humus type of A_{arable} chernozem horizon was found as being humate-fulvic: $R_{ha} : R_{fa} = 2.0$. The degree of humification, estimated as the proportion of humic acids in the total amount of carbon, being equal to 41–43%, indicates a "high" conversion degree of organic substances into humic compounds.

As the ratio $R_{ha} : R_{fa}$ in the lower horizons narrowed, humus in BC as well as C horizons acquired properties of the humate-fulvic type.

In the arable horizons of both subtypes of chernozems, the main amount of humic acids is attributed to fraction 2 bonded with calcium in complex forms of compounds, being 0.72–0.69%, whereas southern non-carbonate chernozems are characterized by a slightly lower value. The content value of this fraction in (A+B) humus horizon was 0.57 and 0.47%, in C horizon – 0.04–0.02. The absolute value of fraction 3, bonded with clay minerals and stable sesquioxides, was 0.21 0.20% in A_{arable} of the profile of these soils, while decreasing to 0.05–0.03 in C horizon.

The content of free humic acids and humic acids bound with movable sesquioxides of fraction 1 in the arable horizon of common and southern chernozems is quite small (0.05%), being even lower along the soil profile, in particular, in B_2

horizon – 0.01; and the fraction was not found at all in C horizon, which determines the low formation rate of humus substances in the soil profile.

The fulvic part of humus is characterized by approximately similar amount of fraction 2 and 3 fulvic acids in A_{arable}, i.e., 0.21–0.18 and 0.20–0.17%, bonded in a complex polymer compound with the corresponding fractions of humic acids. In the lower layers, the percentage of these fractions drops to 0.03–0.06% in C horizon, the drop being especially significant in southern chernozems.

The content of fraction 1_a, i.e. free humic acids and humic acids bound with movable sesquioxides, as well as fraction 1 is insignificant, amounting to 0.05–0.04% in A_{arable}, 0.01 in C horizon, which indicates the stability of the chernozems organic matter. The amount of insoluble residue in A_{arable} and A_1 common chernozem horizons is 0.92–0.80 absolute percent, decreasing to 0.31 in C horizon; concerning southern chernozems the values are 0.79–0.62 and 0.20%, respectively. The relative groups and fractions content values while a part of carbon compositions correspond to their percentage in soils, being characteristic of these subtypes of chernozems.

The proportion of humic acids in the total amount of carbon in the upper horizon is slightly lower in common chernozems (41%) compared to southern chernozems (43%), in the humus horizon it amounts to 38.2 and 37.5% respectively, while in C horizon the proportion is 17–15.6%.

The relative content of the fulvic acids group amounts to 20.2–21.0% in A_{arable}, 20.8 and 22.2% in the humus horizon, i.e. the content value is somewhat larger in southern chernozems, whereas in C horizon, on the contrary, the value is slightly less in southern chernozems (22%) compared to common chernozems (24.5%), which indicates a large migratory capacity of fulvic acids in this type of chernozem.

As a part of their humic acids in (A + B) humus horizon, southern chernozems contain 68.3% of fraction 2, whereas common chernozems contain 73% of fraction 2. The proportion of other fractions, especially fraction 1, is relatively small.

Concerning the fulvic part, the relative content of fractions 2 and 3 in A_{arable} is the same in both subtypes, namely, 8.8–7.6 and 9.1–7.8%, their amount increasing along the profile in common chernozems, especially in BC horizon (fraction 2) and C horizon (fraction 3). The same phenomenon can be observed in southern chernozems, except for BC horizon, which contains less fraction 2 compared to A_{arable}.

The relative percentage of fraction 1_a and fraction 1 is low. No significant changes in the content of these fractions along the profile of common cher-

nozems were observed, their amount increasing in southern chernozems, for example, the one of fraction 1increased from 1.8% in A_{arable} to 3.1 in C.

The percentage of insoluble residue, amounting to 38.6% in A_{arable} of common chernozems, increases to 58.5% in C horizon, from 36.1% in A_{arable} to 62.5% in C horizon, which proves the lesser mobility degree of the organic matter of this type of chernozem [20].

Nitrogen is the biogenic element, its transformation being entirely determined by the processes of humus formation and mineralization, as well as the biochemical activity of the soil. This clearly affects the nature of nitrogen compounds of the soil, that mainly consists of organic forms (93–97%), most of them being a part of humus [21, 22, 23].

Formation of the nitrogen bulk of the main subtypes of the chernozems in the South of Russia is determined by a complex of soil formation conditions, the main components being a deeply penetrating vegetation root system and favorable climatic conditions.

Typical values of the total nitrogen content in the arable horizon of leached chernozems are 0.20–0.35%. Common chernozems, as well as modal and southern of Eastern European facies are characterized by somewhat narrower fluctuations ranges of these values. In southern chernozems of the Southern European facies, when compared to other soils, the nitrogen content proves to be lower, while its fluctuations range is also narrower, the variation coefficient being 18–26% [24].

Specific data on particular soil crossovers of the North Caucasus show their regional specific features and differences from chernozems in the European part of Russia, i.e., a relatively low content of both nitrogen and humus in the arable layer, as well as its deep and gradual decrease along the genetic horizons.

Both leached and modal chernozems of Krasnodar Krai contain approximately the same amount of total nitrogen, i.e., in 0.23–0.21% in A_{arable}, 0.14–0.13% in AB_1 horizon at a depth of 75–80 cm, 0.09% in B_1 horizon at a depth 125–130 cm. In common chernozem crossovers, the amount of nitrogen in the soil layer 0-10 cm is slightly larger than in leached and modal chernozems, being 0.28%. The decrease of nitrogen down along the soil profile is proportional, but its distribution is deeper in comparison to leached chernozems; thus, the nitrogen content in the layer of 70–80 cm was 0.18%, 120–130 cm – 0.13%, 150–160 cm – 0.08%.

Modal chernozems of Stavropol Krai are characterized by the same values of total nitrogen content in the upper horizon, just as leached and modal cher-

nozems of the region do. Down along the soil profile, the amount of nitrogen also gradually decreased, being 0.13% in AB_1 horizon at a depth of 80–90 cm. In common chernozems, within the layer of 0–20 cm there is more nitrogen than in modal chernozems, though its distribution along the soil layers is the same.

The amount of nitrogen in the arable layer of common and southern chernozems of Rostov Oblast was found as being 0.25–0.24% and 0.12–0.08% in BC horizon.

The analysis of particular crossovers fractional composition of the North Caucasus region chernozems showed that leached chernozems of the Southern European facies of Krasnodar Krai that contain 0.149% total nitrogen in A_{arable} were characterized as having mere 7 mg mineral forms (N-NH4 ++ N-NO3-) per 100 g of soil, i.e., just 0.4% of total content. The share of more accessible organic forms as represented by easily hydrolysable fraction (amines, a certain part of the amides) was 16.1 mg per 100 g of soil, i.e., 8.3% of N_{total}.

It was found that there is twice as much hardly hydrolysable form of nitrogen, being a secondary reserve for plants nutrition, than easily hydrolysable in both absolute and relative values. The major part of nitrogen (145.3 mg per 100 g, i.e., 74.9% of N_{total}) is represented by a non-hydrolysable fraction, which only slightly participates in the biological cycle.

As compared to A_{arable}, the amount of mineral nitrogen slightly increased in A_1 horizon, whereas it dropped in B_1 horizon to 0.5 mg per 100 g of soil and to 0.3 mg per 100 g of soil in B_2 and C. Its share in the total nitrogen amount increased insignificantly in A_1 horizon, whereas it decreased slightly in deeper horizons, having the same value, except for C horizon.

The amount of the easily hydrolysable nitrogen fraction in the lower part of the humus horizon (B_2) was found as 5.5 mg per 100 g of soil and 2.3 in C horizon. The relative value of this form in the lower horizons also decreased, though less sharply than the absolute one.

The content of hardly hydrolysable and non-hydrolysable nitrogen in their absolute value, as well as easily hydrolysable nitrogen, decreased along the soil profile, but more gradually. The percentage of these fractions in N_{total} had an increasing tendency, except for hardly hydrolysable nitrogen in BC horizon, its share being the same as in A_{arable}, and non-hydrolysable nitrogen in the upper part of A_1, its amount being somewhat less than in A_{arable}.

In common chernozems of Stavropol Krai, the content of total nitrogen within the layer of 0–30 cm was 0.250% along with a low share of mineral nitrogen (4.2% of total) and easily hydrolysable nitrogen (7.1%), while the

content of hardly hydrolysable nitrogen (14.2%) and non-hydrolysable nitrogen (74.4%) was high.

The absolute amount of total, mineral, easily hydrolysable and hardly hydrolysable nitrogen decreased in lower soil layers, except for mineral nitrogen in the layer of 30–40 cm that contains a bit more of this fraction compared to the layer of 0–30 cm. The amount of non-hydrolysable nitrogen decreased in its absolute value along the soil layers from 0–30 cm to 40–50 cm, while the relative value increased in layers of 30–40 cm and 40–50 cm.

The amount of total nitrogen in A_{arable} of chernozems obtained at the stations of the Don Zonal Research Institute of Agriculture was found as 0.250%, which is just the same as the one found for common chernozems of Stavropol Krai, whereas the amount of mineral nitrogen is less, being 2.4 mg per 100 g of soil. Along the soil profile, the amount of total nitrogen in C horizon drops to 0.080%, while the amount of mineral nitrogen decreases to 0.8 mg per 100 g of soil. The share of the mineral nitrogen fraction in N_{total} hardly varied along the horizons.

The fractions of easily hydrolysable, hardly hydrolysable and non-hydrolysable nitrogen varied along the soil profile the same way as total and mineral nitrogen did. As a percentage of total nitrogen, the content of non-hydrolysable fractions increased, while the one of easily hydrolysable fraction decreased, the hardly hydrolysable fraction changing but a little.

A_{arable} of southern chernozems contained 0.220% of total nitrogen, 13.3 mg per 100 g of soil of easily hydrolysable nitrogen and 29.6 mg per 100 g of soil of hardly hydrolysable nitrogen, which is less than in common chernozem, while the share of mineral nitrogen was higher. The absolute and relative amounts of mineral nitrogen fraction along the soil layers increased, being more noticeable in B_1 horizon compared to A_1.

In deeper soil horizons, organic fractions underwent certain changes just the way they did in common chernozems, though their quantitative characteristics being more significant. Their share in N_{total} along the depth of the soil is approximately of the same value. The content of non-hydrolysable nitrogen, as well as other fractions, compared to common chernozems is lower in A_{arable} (173.2 mg per 100 g of soil), higher in B_1 (168.2 mg) and B_2 (148.4 mg per 100 g of soil).

Conclusion

Thus, both common and southern chernozems, though having certain differences in the total carbon content in the arable layer, are characterized by roughly the same (absolute and relative) composition. The lower horizons con-

tain a greater absolute quantity of humic and fulvic acids of fractions 2 and 3 as well as insoluble residue in common chernozems compared to southern chernozems, which indicates a more intensive degree of both humus formation and humus compounds fixation.

A study of the nitrogen fractional composition of certain chernozems subtypes of the North Caucasus showed that its composition includes little mineral (0.4–4.2%) and easily hydrolysable (6.0–8.3%) fractions, though twice as much hardly hydrolysable fraction (13.4–16.4%). The major part of the nitrogen bulk (74.4–78.9%) is represented by a non-hydrolysable fraction, which only slightly participates in agricultural crops nutrition.

References

1. Orlov D.S. *Khimiya pochv* [Soil chemistry]. Moscow: MGU Publ, 1985, 376 p.
2. Grishina L.A. *Gumusoobrazovanie i gumusnoe sostoyanie pochv* [Humus formation and humus status of soils]. Moscow: MGU Publ, 1986, 240 p.
3. Mineev V.G. *Khimizatsiya zemledeliya i prirodnaya sreda* [Farming chemization and the environment]. Moscow: Agropromizdat Publ, 1990, 288 p.
4. Aleksandrova L.N. *Organicheskoe veshchestvo pochvy i protsessy ego transformatsii* [Soil organic matter and processes of its transformation]. Moscow: Nauka Publ, 1980, 287 p.
5. Orlov D.S., Biryukova O.N., Sukhanova N.I. *Organicheskoe veshchestvo pochv Rossiyskoy Federatsii* [Organic matter of the Russian Federation soils]. Moscow: Nauka Publ, 1996, 256 p.
6. Volodin V.M., Masyutenko N.P. Energeticheskie pokazateli chernozemnykh pochv [Energy indices of chernozem soils]. *Doklady Rossel'khozakademii*, 1993, no. 6, pp. 12–15.
7. Volodin V.M., Shcherbakov A.P., Masyutenko N.P. Energeticheskoe sostoyanie chernozemov TsChZ [Energy status of chernozems in the Central Chernozem Zone]. *Antropogennaya evolyutsiya chernozemov* [Anthropogenic evolution of chernozems]. Voronezh: 2000, pp. 101–119.
8. Flaiq W., Beutelspacher H., Rietz E. Chemicalcompoition and physical properties of humic substance. In J. E. Giesekibq (ed.), *Soil Components*. 1975. 1, pp. 1–211. Sprinqer Verlaq, New York.
9. Verma L., Martin J.P. Decomposition of algal cells and compontnts and their stabilization through complexing with model humic acid-tepe phenolic polymers. *Soil Biol. Biochem*. 1976. 8, pp. 85–90.
10. Shaposhnikova I.M., Novikov A.A. Posleuborochnye ostatki polevykh kul'tur v zernoparopropashnom sevooborote [Post-harvest residues of field crops in

grain fallow tilled crop rotation]. *Agrokhimiya* [Agricultural Chemistry], 1985, no. 1, pp. 48–51.

11. Novikov A.A., Kisarov O.P. Obosnovanie roli kornevykh i pozhnivnykh ostatkov v agrotsenozakh [Substantation of the role of root and cover residues in agrocenoses]. *Nauchnyy zhurnal KubGAU : elektron. nauch. zhurnal*. 2012, no. 78(04), pp. 643–652. http://ej.kubagro.ru/2012/04/pdf/36.pdf. (accessed December 12, 2016).
12. R.Teyt III. *Organicheskoe veshchestvo pochvy* [Soil organic matter]. Moscow: Mir Publ, 1991, 400 p.
13. Reyter G. Zwanzig Jahre Rostocker Dauersuche zur Humusbildung im Boden. *Archiv-Acktr und Pflanzenbau und Bodenkunde.* 1981. Bd 25. № 5, pp. 277–285.
14. Shcherbakov A.P., Vasenev I.I. Russkiy chernozem na rubezhe vekov [Russian chernozem at the border of ages]. *Antropogennaya evolyutsiya chernozemov* [Anthropogenic evolution of chernozems]. Voronezh: 2000, pp. 32–67.
15. Babushkin V.M., Krivokoneva E.Yu., Novikov A.A. *Prirodnye resursy chernozemov obyknovennykh Yuga Rossii i ikh ratsional'noe ispol'zovanie* [Natural resources of common chernozems in the South of Russia and their efficient use]. Novocherkassk: Lik Publ, 2013, 170 p.
16. Novikov A.A. *Ekologicheskoe sostoyanie gumusa i azota v chernozemakh Severnogo Kavkaza* [Ecological status of humus and nitrogen in chernozems of the North Caucasus]. NGMA. Novocherkassk, 2001, 181 p.
17. Novikov A.A. Gumusnoe sostoyanie pochv v sevooborotakh razlichnoy konstruktsii na chernozemakh obyknovennykh [Humus status of soils in crop rotations of difftrent constructions in common chernozems]. *Nauchnyy zhurnal KubGAU elek-tron. nauch. zhurnal*. 2012, no. 78(04), pp. 555–564. URL: http: //ej.kubagro.ru/2012/ 04/pdf/34 (accessed December 12, 2016).
18. Shaposhnikova I.M., Novikov A.A., Ignat'ev D.S., Medvedeva V.I. Gumusnoe sostoyanie i azotnyy fond chernozema obyknovennogo [Humus status and and nitrogen bulk of common chernozems]. *Agrokhimiya* [Agricultural Chemistry]. 2005, no. 5, pp. 15–20.
19. Novikov A.A. *Sovremennoe sostoyanie i puti sokhraneniya gumusnogo i azotnogo fonda chernozemov Severnogo Kavkaza* [Modern status and ways for conservation of humus and nitrogen funds of chernozems in the North Caucasus]. Novocherkassk, 2002. 317 p.
20. Novikov A.A. *Ekologo-meliorativnoe sostoyanie chernozemnykh pochv yuzhnogo regiona Rossii* [Ecological and reclamation status of chernozems in the southern region of Russia]. LAP LAMBERT Academic Publishinq Publ, 2015, 103 p.

21. Menqel K. Ernahrunq und Stoffwechsel der Pflanze. Jena. 1972, pp. 140–153.
22. Aderikhin P.G., Shcherbakov A.P. *Azot v pochvakh Tsentral'no-Chernozemnoy polosy* [Nitrogen in soils of the Central Chernozem Zone]. Voronezh, 1974, 170 p.
23. Parton W.J., Stewart J.W., Cole C.V. Dynamics of C, N, P, and S in grassland soil. *A model. Bioqeochem*. 1988. 5, pp. 109–131.
24. Novikov A.A. Formirovanie azotnogo fonda osnovnykh podtipov chernozemov Yuga Rossii [Nitrogen bulk formation for the subtypes of chernozems in the South of Russia]. *Nauchnyy zhurnal KubGAU elektron. nauch. zhurn*. 2012, no. 78(04), pp. 620–630. http: //ej.kubagro.ru/2012/04/pdf/35.pdf (accessed December 12, 2016).

Список литературы

1. Орлов Д.С. Химия почв. М.: МГУ, 1985. 376 с.
2. Гришина Л.А. Гумусообразование и гумусное состояние почв. М.: МГУ, 1986. 240 с.
3. Минеев В.Г. Химизация земледелия и природная среда. М.: ВО Агропромиздат, 1990. 288 с.
4. Александрова Л.Н. Органическое вещество почвы и процессы его трансформации. М.: Наука, 1980. 287 с.
5. Орлов Д.С., Бирюкова О.Н., Суханова Н.И. Органическое вещество почв Российской Федерации. М.: Наука, 1996. 256 с.
6. Володин В.М., Масютенко Н.П. Энергетические показатели черноземных почв // Доклады Рос. академии сельскохозяйственных наук. 1993. № 6. С. 12–15.
7. Володин В.М., Щербаков А.П., Масютенко Н.П. Энергетическое состояние чернозёмов ЦЧЗ // Антропогенная эволюция чернозёмов. Воронеж: 2000. С. 101–119.
8. Flaiq W., Beutelspacher H., Rietz E. Chemicalcompoition and physical properties of humic substance // In J. E. Giesekibq (ed.), Soil Components. 1975. 1, pp. 1–211. Sprinqer Verlaq, New York.
9. Verma L., Martin J.P. Decomposition of algal cells and compontnts and their stabilization through complexing with model humic acid-tepe phenolic polymers // Soil Biol. Biochem. 1976. 8, pp. 85–90.
10. Шапошникова И.М., Новиков А.А. Послеуборочные остатки полевых культур в зернопаропропашном севообороте // Агрохимия. 1985. № 1. С. 48–51.
11. Новиков А.А., Кисаров О.П. Обоснование роли корневых и пожнивных остатков в агроценозах // Научный журнал КубГАУ: электрон. науч. жур-

нал. 2012. № 78(04). С. 643–652. URL: http: //ej.kubagro.ru/2012/04/pdf/36.pdf. (дата обращения: 12.12.2016).
12. Р. Тейт III. Органическое вещество почвы. М.: Мир, 1991. 400 с.
13. Reyter G. Zwanzig Jahre Rostocker Dauersuche zur Humusbildung im Boden // Archiv-Acktr und Pflanzenbau und Bodenkunde. 1981. Bd 25. № 5. S. 277–285.
14. Щербаков А.П., Васенев И.И. Русский чернозём на рубеже веков // Антропогенная эволюция чернозёмов. Воронеж: 2000. С. 32–67.
15. Бабушкин В.М., Кривоконева Е.Ю., Новиков А.А. Природные ресурсы чернозёмов обыкновенных Юга России и их рациональное использование. Новочеркасск: Лик, 2013. 170 с.
16. Новиков А.А. Экологическое состояние гумуса и азота в чернозёмах Северного Кавказа. НГМА. Новочеркасск: 2001. 181 с.
17. Новиков А.А. Гумусное состояние почв в севооборотах различной конструкции на чернозёмах обыкновенных // Научный журнал КубГАУ: электрон. науч. журнал. 2012. № 78(04). С. 555–564. URL: http: //ej.kubagro.ru/2012/ 04/pdf/34. (дата обращения: 12.12.2016).
18. Шапошникова И.М., Новиков А.А., Игнатьев Д.С., Медведева В.И. Гумусное состояние и азотный фонд чернозёма обыкновенного // Агрохимия. 2005. № 5. С. 15–20.
19. Новиков А.А. Современное состояние и пути сохранения гумусного и азотного фонда чернозёмов Северного Кавказа: Дис. … д-ра с.-х. наук. Новочеркасск, 2002. 317 с.
20. Новиков А.А. Эколого-мелиоративное состояние чернозёмных почв южного региона России. LAP LAMBERT Academic Publishinq, 2015. 103 с.
21. Menqel K. Ernahrunq und Stoffwechsel der Pflanze // Jena. 1972, pp. 140–153.
22. Адерихин П.Г., Щербаков А.П. Азот в почвах Центрально-Черноземной полосы. Воронеж, 1974. 170 с.
23. Parton W.J., Stewart J.W., Cole C.V. Dynamics of C, N, P, and S in qrassland soil // A model. Bioqeochem. 1988. 5, pp. 109–131.
24. Новиков А.А. Формирование азотного фонда основных подтипов чернозёмов Юга России // Научный журнал КубГАУ: электрон. науч. журнал. 2012. № 78(04). С. 620–630. URL: http: //ej.kubagro.ru/2012/04/pdf/35.pdf. (дата обращения: 12.12.2016).

DATA ABOUT THE AUTHOR

Novikov Aleksei Alekseevich, Doctor of Agriculture, Professor at the Chair of Cadastre and Monitoring of Lands

Novocherkassk Institute of Reclamation Engineering after A.K. Kortunov, Donskoi State Agrarian University
111, Pushkinskaya Str., Novocherkassk, Rostov region, 346428, Russian Federation
al.al.novikov@gmail.com
SPIN-code: 6731-7692
ORCID: 0000-0001-9013-2629

ДАННЫЕ ОБ АВТОРЕ

Новиков Алексей Алексеевич, доктор сельскохозяйственных наук, профессор кафедры кадастра и мониторинга земель
Новочеркасский инженерно-мелиоративный институт имени А.К. Кортунова – филиал федерального государственного бюджетного образовательного учреждения высшего образования «Донской государственный аграрный университет»
ул. Пушкинская, 111, г. Новочеркасск, Ростовская область, 346428, Российская Федерация
al.al.novikov@gmail.com

DOI: 10.12731/wsd-2017-3-62-75
UDC 619:616.995.42:615

MULTIPLE-FUNCTION ACTIVITY OF THE PREPARATION ARTAFIDIN[1]

Shamanskaya L.D., Butakov E.I.

The article presents testresults of the preparation Artafidinthat fightsparasitic fauna of plants, animals and birds. Artafidin effectiveness against various kinds of aphids has been estimated 96.5–100%on horticultural crops, 97.4–98%on melons and 100% on vegetable crops. The preparation has proved to be highly selective towards the beneficial fauna. No resistance to Artafidin against Aphis pomiDeg.was foundat its check studiesat a long-term apple station.

Artafidin has shown 100% effectiveness against the ixodicticks Dermacentor marginatus Sulzerat a concentration of 4% while performing treatment with spray material and at a concentration of 3% while using foam. High sensitivity to Artafidin in the menoponidae Menacanthus stramineus (Nitzsch, 1818), being parasites on chickens, has been found. Ovicide effect of the preparation against the parasite ensures a prolonged protective effect.

The use of Artafidin against various kinds of parasitic fauna removes a number of restrictions on the use of protection products, contributes to ecologically friendly agricultural production and cattle breeding as well as provides ecological security.

Keywords: *exophytes; plants; animals; chitosan preparation; effectiveness; aftereffect.*

ПОЛИФУНКЦИОНАЛЬНАЯ АКТИВНОСТЬ ХИТОЗАНОВОГО ПРЕПАРАТА АРТАФИДИН

Шаманская Л.Д., Бутаков Е.И.

В статье приводятся результаты испытаний хитозанового препарата Артафидин против паразитарной фауны растений, животных и

[1] Шаманская Л.Д., Бутаков Е.И. Полифункциональная активность хитозанового препарата Артафидин // В мире научных открытий, 2016. № 10(82). С. 93–109. doi:10.12731/wsd-2016-10-93-109.

птиц. Эффективность Артафидина против различных видов тлей на садовых культурах составила 96,5–100, на бахчевых 97,4–98,0, на овощных – 100%. Препарат показал высокую избирательную активность в отношении полезной фауны. Не отмечено появление устойчивости к препарату Артафидин при его испытании в многолетнем стационаре яблони против AphispomiDeg.

Артафидин показал 100%-ю эффективность против иксодового клеща Dermacentor marginatus Sulzer в концентрации 4% при обработке рабочим раствором и 3% при обработке пеной.

Выявлена высокая чувствительность к Артафидину у пухопероеда Menacanthus stramineus Nitzsch, 1818 паразитирующего на курах. Овицидное действие препарата в отношении этого паразита обеспечивает длительный защитный эффект.

Использование Артафидина против различных представителей паразитарной фауны снимает целый ряд ограничений по применению средств защиты, способствует получению экологически чистой продукции растениеводства и животноводства и обеспечивает безопасность окружающей среды.

Ключевые слова: *экзопаразиты; растения; животные;хитозановый препарат; эффективность; последействие.*

Introduction

Among numerous negative aftereffects of the use of chemical plant protection products, the following are considered the most significant: environmental and crops pollution with toxic residues, beneficial fauna extermination as well as pestsresistance development. In this regard, organic farming is getting more widespread on a global scale, which has heightened the interest in learning and putting into practice methods of crops cultivation that reduceand exclude pollution of both the produce and environment with harmful substances, especially pesticides and agrochemicals [1]. Non-chemical protection techniques are being the choice as they neither pollute the environment nor produce any toxic residues; they also contribute to the beneficial fauna preservation.

For a long time, the chemical pesticides used in crop production were widely used in cattle breeding as well. It was for animals and birdsprotection against exophytesthat Malathion, Sevin, DDT and other types of pesticideswere applied. These chemical preparations are characterized by their hypertoxicity and cumulative properties. Their use in cattle breeding is severely restricted.

Thus, it is of great importance to come up with new preparations that have the same broad spectrum as chemical pesticides, but, unlike them, are safe for humans and the environment [2].

One promising area of research is to develop preparations based on natural biologically active substances [3]. Of theseones, the most widely used are now certain preparations based on chitosan, such as Fitohit, Zolushka, Agro-Hit, Mikosan, Narciss and Ecogel. Several of these preparations were developed in Russia. Of these, Narcissus and Ecogel are the ones being most widely used in crop farming.

Chitosan and preparations based on chitosan are neither toxic to humans and the environment nor cause resistance in pathogenic microorganisms. Chitosan has fungicide [4], antibacterial [5] and anti-viral [6] effects as well as is capable of inducing a nonspecific wide spectrum disease resistance in plants and can be used to protect plants from diseases of different etiology.

One of the unique biological activities of chitosan is considered to be its ability to induce resistance to plant viral diseases, as well as inhibit viral infection in animals [7].

Chitosan contributes to reducing nematode population density [8, 9]. Concerning other types of pests, chitosan effectiveness has been insufficiently studied so far.

The purpose of the study is to examine the biological activity of the chitosan preparation Artafidin against parasitic fauna of plants, animals and birds.

Materials and methods of research

Main research activitieswere carried out atthe Siberian Horticultural Research Institute named after M.A. Lisavenko.

Artafidin testing against aphids, being horticultural crops pests, was performed in apple, black currant, sweet viburnum and raspberry industrial plantations of the Horticultural Research Institute experimental field, against aphids, being vegetables and melonspests, at garden plots, against scales – on houseplants. Experiments on the spraying of these crops were carried out in four repetition stages using a Kwazar backpack sprayer. Liquid insecticidal soap was tested as the experimental reference standard. The control plants were not treated.

Dead pests count was performed 1 day after treatment using an MBS-9 microscope to scan ten damaged leaves in each replicate while calculating the number of live and dead individuals according to the technique by K. Gar [1963] [10]. The population density of the colonies was taken into account.

The colonies numbering up to 30 individuals were referred to as lowly-populated, whereas those numbering up to over 250 as highly-populated ones.

The three-factor experiment to test Artafidin on horticultural crops includedFactor A factor as the preparation, Factor B – aphid species, Factor C – population density of the colonies.

The way Artafidin treatment affects protected plants was tested at a long-term apple station on the Zhar-Ptitsa apple variety. The way plants develop under different treatment conditions was analyzed by measuring growth of all plants at the end of the vegetation season; crop yield was measured on two plants in each replicate. The fruit biochemical analysis was carried out at the biochemistry laboratory of the Horticultural Research Institute using the conventional techniques.

The statistical data processing was done by the analysis-of-variance method [11].

The testing of Artafidina caricide activity against ixodicticks *Dermacentor marginatus* (Sulzer, 1776) was conducted in the Altai Research and Development Institute of Cattle Breeding Technology using the standard technique [12], against menoponidae *Menacanthus stramineus* (Nitzsch, 1818) it was the technique by D.I. Blagoveshchensky that was used [1972] [13].

Results and discussion

The chitosan preparation Artafidin was developed atthe Siberian Horticultural Research Institute named after M.A. Lisavenko. Liquid insecticidal soap and organic-mineral fertilizer Artemia obtained from cysts of Artemia sp., found in salt lakes of the AltaiTerritory, were used as raw materials. The structure of the Artemia sp. hydrolysatecontains 35% solid matter (proteins and amino acids, fats and fatty acids, chitin and chitosan), 0.5% total nitrogen, 12% total phosphorus and traces of Cu, Zn, Co, Mn [14]. The Artemia sp.hydrolysate also contains 35 fatty acids, including arachidonic acid [15], which is characterized as having a growth stimulating effect.

Artafidinwas tested against the most common group of sap-sucking pests of horticultural crops, i.e., the following species of aphids: green apple (*Aphis pomi* Deg, 1773), gooseberry (*Aphis grossulariae* Kalt, 1843), black sweet viburnum (*Aphis viburni* Giovanni Antonio Scopoli, 1763) and raspberry (*Aphis idaiei* Goot., 1912).

Numerous colonies of these species of aphids live in the tops of the growing shoots, slowing their growth and development, reducing winter hardiness of the plants. The harmfulness of aphids is exacerbated by the fact that they can be carriers of dangerous viral diseases.

The preliminary tests of the Artemia sphydrolysate in pure form as well as at a concentration of 0.3–1% showed its weak insecticidal activity against aphids of various species due to poor wettability of the latter. Insecticidal soap, tested as the experimental reference standard, causes death of the pests in lowly-populated colonies at 95.4–100% due to its plasmatic andskin dehydrating effect. In highly-populated colonies the insecticidal soap treatment effectiveness against *A.grossulariae* decreased to 29.3%, while against *A.idaiei* it decreased to 5.7%.

It is the content of the Artemia sp. hydrolysate in Artafidin that enhances theinsecticidal soap toxic effect, probably as it contains arachidonic acid, the one that has insecticidal properties [16]. In case 0.5% Artafidin was applied, the aphids exterminationrate failed to exceed 90% (Table 1).

Table 1.

The preparations effectiveness against various species of aphids onhorticultural crops

Preparation	Concentration, %	Population density of the colonies	Aphids extermination rate, %			
			A. pomi	*A. grossulariae*	*A. viburni*	*A. idaiei*
No treatment - control	–	low	0.10	0.20	0.15	0.20
		high	0.30	6.90	2.50	3.50
Liquid soap (reference standard)	1	low	100	95.4	100	97.0
		high	90.8	29.3	97.3	5.7
Artafidin	0.5	low	87.4	85.6	90.0	63.2
		high	85.4	74.5	88.9	41.8
	1	low	100	100	100	100
		high	99.7	97.7	96.9	96.5
	1.5	low	100	100	100	100
		high	99.3	98.4	97.3	98.6
	2	low	100	100	100	100
		high	99.2	99.3	97.8	99.1
HCP_{05} for thefactors	–	–	A – 0.13; B – 0.1; C – 0.07; AB – 0.15; AC – 0.18; BC – 0.25; ABC – 0.36			

As the concentration of the spray material was increased to 1%, it enhanced the treatment effectiveness up to 100% in lowly-populated colonies and to 96.5–99.7%in highly-populated ones. Further increase in the concentration of

Artafidinseems to be impractical as it fails to significantly affect the treatment effectiveness.

According to the results of the statistical data processing the maximum share of Factor A was 82.8%, Factors AB – 5.2%, Factors AC– 4.1%, Factors ABC – 3.5%, other Factors – 0.07 – 2.1%.

Further Artafidin effectiveness testing was performed at a long-term apple station, the plant shoots being densely populated by the green apple aphid.

The insecticidal soap entry-level effectiveness was 93.1%, the one of Artafidin being 95.8%. In the latter case, individuals, that stayed alive, failed to feed, and were not observed on the plants within 16 days after the treatment was performed. Re-colonization of the plants was observed 21 days after the spraying, the pest population being relatively small (6 individuals per leaf), while the population density on the leavesthat had been treated with insecticidal soap over this period of time increased to 45 individuals per leaf, further population density rate decreasing significantly due to predatory insects' vigorous activity. The long-term protective effect of Artafidin can reliably protect apple trees against the green apple aphid after a single spraying.

The apple trees treatment with Artafidin contributed to the shoots quick growth. By the end of the vegetation season, the growth increase was estimated 2.8 times as highcompared with the control sample and 1.5 times higher compared with the shoots that had been treated with insecticidal soap. The analysis of variance results showed that this difference is statistically valid. We believe that the stimulatory effect of Artafidinis related to the fact that the Artemia sp. hydrolysatecontains elements of plant nutrition and growth promoters, i.e. chitin, succinic acid and arachidonic acid.

Upon treating the plants with Artafidin the fruit quality improvement was observed (as compared with the control sample) that include increase in the sugar content, content of vitamin C and pectin.

The sugar-acid ratio, which characterizes fruit palatability traits, was estimated as 23.8 in the first case and 14.1 in the second one. The lowest sugar-acid ratio of 10.0 was observed upon treating the apple trres with insecticidal soap.

The use of Artafidinto protect apple trees from *A. pomi* allows growing ecologically friendly produce, which is considered an advantage in comparison with the chemical protection products.

The test results of the chitosan preparation effectiveness against various species of aphids on vegetable and melon crops have shown that when 1% Artafidin was applied, the extermination rate of the *Brevicoryne brassicae* L., 1758 increased from 82.4 to 100% in comparison with the experimental refer-

ence standard. Liquid insecticidal soap ensured 100% extermination rate of the pests provided the spray material concentration was increased to 2%.

The effectiveness of liquid insecticidal soap at a concentration of 1% against *Aphis gossypii* Glov., 1877 being sprayed over cucumbers and watermelons amounted to 70.4–74.2%. It reached 92.4–94.6% only once the spray material concentration had been doubled. Artafidin provided high treatment effectiveness (97.4–98.0%) against these kinds of aphids when the 1% spray material was applied.

The effectiveness testing of the chitosan preparation Artafidin (1%) showed its ability to be used not only against various kinds of aphids, but also against scales on the house plants with 99% effectiveness. Insecticidal soap (2%) provided 73.3% extermination rate of this kind pests. The tests have shown that Artafidin can be used for protection against scales on virtually all house plants-due to its high wetting activity.

High sensitivity to Artafidinhas been found in black-veined white caterpillars (*Aporiacrataegi* L., 1758) of the 1st age. Their extermination rate, once 1% and 2% spray material had been applied, was 98.2% and 100%, respectively. Artafidin effectiveness decreased to 70.3-82.4% when the caterpillars had come of the 2nd age during the stage of winter nests formation.

According to the test results, Artafidin has proved to be highly selective towards the beneficial entomofauna and acarofauna. Thus, predatory ticks on apple trees as well as larvae of various species of predatory gall midges on fruit, berry, vegetable and melon crops fully retain their viability as the Artafidin recommended concentration of 1% is applied, while the use of insecticidal soap at an effective concentration of 2% caused death of 35.8% of predatory gall midge larvae.

The tests, carried out at the long-term experimental field, failed to reveal any resistance to Artafidinin *A. pomi*.

Further studies included the chitosan preparation Artafidin testing against ixodic (pasture) ticks, being temporary external parasites of the vertebrates. Ixodic ticks are the only carriers of pathogens that cause piroplasmosis, theileriosis, babesiosis, nuttaliosis, tick paralysis, tick bite fever, leptospirosis, spring-summer encephalitis in humans [17, 18, 19, 20]. In Russia, this type of ticks is involved in the spread of 20 animal diseases that result in significantly reduced milk productivity of livestock, whereas the mortality rate can reach up to 60–90%.

Dermacentormarginatus (Sulzer, 1776) was used as an experimental object. The tests were carried out in a laboratory environment.

Absolute (100%) effectiveness of Artafidin against this species was obtained by treatmentwith the 4% spray material (Table 2).

Table 2.

Artafidin effectiveness against *D. marginatus*

Variant	Ticks extermination rate, %			
	spray material treatment		foam treatment	
	in 24 hrs	in 48 hrs	in 24 hrs	in 48 hrs
No treatment - control	0.1	0.2	0.2	0.1
Artafidin – 1%	20.6	75.8	53.3	86.6
Artafidin – 2%	15.0	82.5	26.0	82.6
Artafidin – 3%	36.5	93.5	77.5	100
Artafidin – 4%	72.0	100	90.0	100
$НСР_{05}$	0.53	0.55	0.61	0.36

While the ticks were treated with foam, the 100% extermination rate was obtained at a lower concentration of Artafidin (3%).

At further stages of Artafidin effectiveness testing, along with other products based on natural biologically active substances, it was tested against menoponidae *M. stramineus* (Nitzsch, 1818), being parasites on chickens. The presence of this ectoparasite on birdscauses mallophagosis that results in a significant economic damage to the poultry industry in many countries [21]. Currently, in Russia various sorts of powders, solutions or shampoos containing synthetic pyrethroids and carbamate insecticides are used to protect the poultry from menoponidae. They fail to exhibit ovicidal action, as well as repeated treatments are required. After the treatment is performed, the eggs and poultry meat should be excluded from consumption for 1 month.

Artafidin effectiveness testing against *M. stramineus* in a laboratory environment has shown high sensitivity of this type of pests to Artafidin and other preparations based on natural biologically active substances. At both high (1–4%) andextremely low concentrations (0.001–0.0005%) the treatment effectiveness was 100% (Table 3).

M. stramineus high sensitivity to the treatment is due to the fact that once their ritating agents get inside the respiratory chambers, they affect the peripheral nervous system and damage the respiratory muscles, which leads to the death of the parasite. The chemical preparation Neostomasan, tested at a concentration of 0.001%, has also provided 100% mortality of the pest.

Artafidin effectiveness in stationary conditions was tested at the Blagoveshchenskaya poultry farm of the Altai Territory. Prior to the treatment the

massive clusters of adult parasites around the chickens' abdomen areahad been found. The chickens were treated by immersing the whole body (head up), followed by a vigorous manual handling of the head and other body parts. The treatment of the birds neither had negative effect on their condition nor affected the egg-laying intensity or the main parameters of the blood composition.

Table 3.

Effectiveness of preparations based on natural biologically active substances against *M. stramineus*

Preparation	*M. stramineus* extermination rate, % at a preparation concentration, %								
	4-1	0.5	0.25	0.1	0.05	0.025	0.01	0.001	0.0005
Afidin	100	100	100	100	100	100	100	100	100
Artafidin	100	100	100	100	100	100	100	100	100
Vita-Start	100	100	100	100	100	100	100	100	100
Fos	100	100	100	100	100	100	100	100	100
Neo	100	100	100	100	100	100	100	100	–
Formicide	100	100	100	100	100	100	100	100	100
Neostomasan (reference standard)	–	–	–	–	–	–	–	100	–
No treatment - control	0.09-0.4								

The birds were then periodically inspected for the presence of live parasites and their larvae during the post-treatment period. Ovicidal action of the preparations was not specifically taken into account, but all the pests' eggs seem to have died after the treatment had been effected, since the protective effect period of the preparation was 1.5 months long and neither larvae nor adult insects were found on the treated poultry. We assume that death of the eggs is related to the waxy coatingdestruction, the one being required for the egg to be able to attach itself to the feather.

The preparation Artafidin, that has proved to be effective against *M. stramineus*, contains notoxic ingredients, which seems to be an advantage compared withthe chemical preparation Neostomasan. Ovicidal action of Artafidin provides long-term protection. Its use allows to lift restrictions on the eggs and poultry meat consumption after treatment.

Conclusion

The chitosan preparation Artafidin, developed on the basis of liquid insecticidal soaps and organic-mineral fertilizer Artemia, is characterized by

a multiple-function activity against various representatives of the parasitic fauna.

1% Artafidin is 96.5-100% effective against aphids, being a common group of sap-sucking pests on horticultural crops, it is 97.4–98.0% effective against a phids on melons, is 100% effective against *B. brassicae*, and is 82.4–100% effective against *A. crataegi* caterpillars at early ages. In addition, this preparation has proved to be highly selective towards the beneficial fauna.

The long-term protective effect of Artafidin contributes to a good phytosanitary condition of the plants after a single spraying against *A. pomi*.

No formation of *A. pomi* stable populations at the long-term apple station was observed after Artafidin had been applied.

Treating apple trees with Artafidinpromotes active plant growth and improves the produce quality.

Artafidin provesto be 100% effective against *D. marginatus* once either 4% spray material or 3% foam is used.

High sensitivity to Artafidin in *M. stramineus* and its ovicidal activity providesa long-term protective effect. Its use allows to lift restrictions on the eggs and poultry meat consumption after treatment.

Artafidin fights against the parasitic fauna of plants and animals as well as helps to ensure ecologically friendly crops and livestock production, providing a safe environment.

References

1. Zakharenko V.A. *Zashchita i karantin rasteniy*. 2015. № 11, pp. 3–6.
2. International Code of Conduct of the Distribution and Use of Pesticides (Amended version). FAO – Food and agriculture organization of the United Nations, Rome, 1990. 20 p.
3. Shamanskaya L.D. *Sibirskiy vestnik sel'skokhozyaystvennoy nauki*. 2012. № 1, pp. 53–60.
4. Park K. et al. Variation of antifungal activities of chitosans on plant pathogens. *Journal of Microbiology and Biotechnology.* 2002. № 12, pp. 84–88.
5. Raafat D., Bargen K., Haas A., Sahl H.G. Insights into the mode of action of chitosan as an antibacterial compound. *Applied and Environmental Microbiology.* 2008. Jun. № 74 (12), pp. 3764–3773.
6. Pestov A.V., Bondar' Yu.A., Mirsaev T.D., Skorik Yu.A., Yatluk Yu.G. *Sovremennye perspektivy v issledovanii khitina i khitozana: materialy Vos'moy Mezhdunarodnoy konferentsii. Kazan', 13-17 iyunya 2006* [Current perspectives

in the study of Chitin and Chitosan: ma-rials Eighth International Conference. Kazan, on June 13–17, 2006]. Moscow, 2006, pp. 233–235.
7. Chirkov S.N. *Novye dostizheniya v issledovanii khitina i khitozana: materi-aly Shestoy Mezhdunarodnoy konferentsii* [New achievements in the study of Chitin and Chitosan: Proceedings of the Sixth International conference]. M.: VNIRO, 2001, pp. 120–123.
8. Kozhushko I.B. *Zashchita i karantin rasteniy*. 2003. № 8. P. 29.
9. Penf M.A. Biological pesticidae based on chitosan and entomopathogenic nematodes / Patent EP 1 332676 (Bl). FR. Publication date 21.07.2004.
10. Gar K.A. *Metody ispytaniya toksichnosti i effektivnosti pestitsidov* [Methods for testing the toxicity and efficacy of pesticides]. M., 1963. 286 p.
11. Dospekhov B.A. *Metodika polevogo opyta* [Methods of field experience]. M.: Kolos, 1986. 502 p.
12. Dezinsektsiya. *Metody opredeleniya effektivnosti insektitsidov, akari-tsidov, regulyatorov razvitiya irepellentov, ispol'zuemykh v meditsinskoy dezinsektsii. NMU 3.5.2. 1759-03. P. 4.18. Metody otsenkieffektivnosti sredstv (skabitsidov) dlya unichtozheniya chesotochnykh kleshchey. 28 sentyabrya 2003 g* [Pest. Methods for determining the effectiveness of insecticides, Akari-cides, the development of regulators and repellents used in medical disinfestation. NMU 3.5.2. 1759-03. P. 4.18. Methods of assessment of the effectiveness of (skabitsidov) to kill scabies mites. September 28, 2003]. 87 p.
13. Blagoveshchenskiy D.I. *Metody issledovaniy vshey (Siphunculata)* [Research Methods lice (Siphunculata)]. Leningrad: Nauka. 1972. 87 p.
14. Vereshchagin A.L., Prishchenko Yu.E., Bryukhanov V.A., Kuz'menko I.A., Antonova O.I. *Proizvodnye khitozana i stimulyatory rosta v sel'skom khozyay-stve: Materialy 3-ey mezhregional'noy nauchno-prakticheskoy konferentsii* [Derivatives of chitosan and growth promoters in agriculture: Proceedings of the 3rd inter-regional scientific-practical conference]. Biysk: Izd. Alt. gos. tekh. un-ta, 2005, pp. 5–8.
15. Batashov E.S. *Proizvodnye khitozana v stimulyatory rosta v sel'skom khozyay-stve: Materialy 5-y Mezhregional'noy nauch.-prakt. konferentsii 25 marta 2008 goda* [Derivatives of chitosan in the sti-pack for growth in agriculture. Proceedings of the 5th Inter-regional scientific-practical. Conference March 25, 2008]. Biysk. 2008, pp. 10–13.
16. Il'inskaya L.I., Ozertsovskaya O.L. *Prikladnaya biokhimiya i mikrobiologiya.* 1998. V. 34, № 5, pp. 467–479.
17. Hartung, Thomas, Rauter, Carolin. Prevalence of Borrelia burgdorferi sensu lato genospecies in Ixodesricinus ticks in Europe. A metaanalysis American

Society for Microbiology. *Applied and Environmental Microbiology. Biological sciences*. Vol. 71. No. 11 (November 2005), pp. 7203–7216.
18. Grey J.S., Kahl O.In. Ticks as vectors of zoonotic pathogens in Europe. Halliday R.B., Walter D.E., Proctor H.C., Norton R.A., Colloff M.J., editors. Acarology: Proceedings of the 10th International Congress. Melbourne: CSIRO Publishing; 2001, pp. 547–51.
19. Ruiz-Fons F., Fernández-de-Mera I.G., Acevedo P. et al. Ixodid ticks parasitizing Iberian red deer (Cervus elaphus hispanicus) and European wild boar (Susscrofa) from Spain: geographical and temporal distribution. *Journal Article, Re-search Support*, Non-U.S. Gov't Vet. Parasitol. Aug 31. 2006. 140 (1–2):133–42.
20. Yano Y., Saito-Ito A., Anchalee D., Takada N. Japanese. Babesia microti cytologically detected in salivary glands of naturally infected tick Ixodesovatus. *Journal Article. Microbiol Immunol* 49(10), 2005, pp. 12–36.
21. Frolov B.A. *Veterinariya*. 1985. №11, pp. 48–49.

Список литературы

1. Захаренко В.А. Биотехнология и защита растений // Защита и карантин растений. 2015. № 11. С. 3–6.
2. International Code of Conduct of the Distribution and Use of Pesticides (Amended version). FAO – Food and agriculture organization of the United Nations, Rome, 1990. 20 p.
3. Шаманская Л.Д. Полифункциональная активность препаратов, полученных на основе природных биологически активных веществ // Сибирский вестник сельскохозяйственной науки. 2012. № 1. С. 53–60.
4. Park K. et al. Variation of antifungal activities of chitosans on plant pathogens // Journal of Microbiology and Biotechnology. 2002. № 12, pp. 84–88.
5. Raafat D., Bargen K., Haas A., Sahl H.G. Insights into the mode of action of chitosan as an antibacterial compound // Applied and Environmental Microbiology. 2008. Jun. № 74 (12), pp. 3764–3773.
6. Пестов А.В. Стоматологические материалы на базехитозана и карбоксиэтилхитозана / Пестов А.В., Бондарь Ю.А., Мирсаев Т.Д., Скорик Ю.А., Ятлук Ю.Г. // Современные перспективы в исследовании хитина и хитозана: материалы Восьмой Международной конференции. Казань, 13–17 июня 2006. Москва, 2006. С. 233–235.
7. Чирков С.Н. Противовирусные свойства хитозана // Новые достижения в исследовании хитина и хитозана: материалы Шестой Международной конференции. М.: ВНИРО, 2001. С. 120–123.

8. Кожушко И.Б. Действие хитозана на соевую цистообразующую нематоду // Защита и карантин растений. 2003. № 8. С. 29.
9. Penf M.A. Biological pesticidae based on chitosan and entomopathogenic nematodes / Patent EP 1 332676 (Bl). FR. Publicationdate 21.07.2004.
10. Гар К.А. Методы испытания токсичности и эффективности пестицидов. М., 1963. 286 с.
11. Доспехов Б.А. Методика полевого опыта. М.: Колос, 1986. 502 с.
12. Дезинсекция. Методы определения эффективности инсектицидов, акарицидов, регуляторов развития и репеллентов, используемых в медицинской дезинсекции. NMУ 3.5.2. 1759-03. П. 4.18. Методы оценки эффективности средств (скабицидов) для уничтожения чесоточных клещей. 28 сентября 2003 г. 87 с.
13. Благовещенский Д.И. Методы исследований вшей (Siphunculata). Ленинград: Наука. 1972. 87 с.
14. Верещагин А.Л. Органо-минеральное хитозановое удобрение артемия / Верещагин А.Л., Прищенко Ю.Е., Брюханов В.А., Кузьменко И.А., Антонова О.И. // Производные хитозана и стимуляторы роста в сельском хозяйстве: Материалы 3-ей межрегиональной научно-практической конференции. Бийск: Изд. Алт. гос. тех. ун-та, 2005. С. 5–8.
15. Баташов Е.С. Изучение жирнокислотного состава цист Artemia sp., обитающих в соленых озерах Алтайского края // Производные хитозана в стимуляторы роста в сельском хозяйстве: Материалы 5-й Межрегиональной науч.-практ. конференции 25 марта 2008 года. Бийск. 2008. С. 10–13.
16. Ильинская Л.И., Озерцовская О.Л. Продукты липоксигепазного окисления жирных кислот как сигнальные молекулы в индуцировании устойчивости растений // Прикладная биохимия и микробиология. 1998. Т. 34, № 5. С. 467-479.
17. Hartung, Thomas, Rauter, Carolin. Prevalence of Borrelia burgdorferi sensu lato genospecies in Ixodesricinus ticks in Europe. A metaanalysis American Society for Microbiology. Applied and Environmental Microbiology. Biological sciences. Vol. 71. No. 11 (November 2005), pp. 7203–7216.
18. Grey J.S., Kahl O.In. Ticks as vectors of zoonotic pathogens in Europe. Halliday R.B., Walter D.E., Proctor H.C., Norton R.A., Colloff M.J., editors. Acarology: Proceedings of the 10th International Congress. Melbourne: CSIRO Publishing; 2001, pp. 547–51.
19. Ruiz-Fons F., Fernández-de-Mera I.G., Acevedo P. et al. Ixodid ticks parasitizing Iberian red deer (Cervus elaphus hispanicus) and European wild boar

(Susscrofa) from Spain: geographical and temporal distribution // Journal Article, Research Support, Non-U.S. Gov'tVet. Parasitol. Aug 31. 2006. 140 (1–2):133–42.
20. Yano Y., Saito-Ito A., Anchalee D., Takada N. Japanese. Babesia microti cytologically detected in salivary glands of naturally infected tick Ixodesovatus // Journal Article. Microbiol Immunol 49(10), 2005, pp. 12–36.
21. Фролов Б.А. Борьба с эктопаразитами в птицеводческих хозяйствах // Ветеринария. 1985. №11. С. 48–49.

DATA ABOUT THE AUTHORS

Shamanskaya Lubov Demianovna, Senior Research Officer, Doctor of Agronomical Sciences
Scientifically Research Institute Gardening of Siberia Regional Compartment by name M.A. Lisavenko
49, Zmeinogorskii fas., Barnaul, Russian Federation
niilisavenko@hotbox.ru

Butakov Evgenii Ivanovich, Research Officer
Altai Research Institute of Agriculture
35, Scientific Village, Barnaul, Russian Federation
aniizis@mail.ru
SPIN-code: 9496-7944

ДАННЫЕОБАВТОРАХ

Шаманская Любовь Демьяновна, старший научный сотрудник, д. с.-х. н.
Федеральное государственное бюджетное научное учреждение Научно-исследовательский институт садоводства Сибири М.А. Лисавенко
Змеиногорский тракт, 49, г. Барнаул, Российская Федерация
niilisavenko@hotbox.ru

Бутаков Евгений Иванович, научный сотрудник
Федеральное государственное бюджетное научное учреждение Алтайский научно-исследовательский институт сельского хозяйства
Научный городок, 35, г. Барнаул, Российская Федерация
aniizis@mail.ru

НАУЧНЫЕ ОБЗОРЫ И СООБЩЕНИЯ

SCIENTIFIC REVIEWS AND REPORTS

DOI: 10.12731/wsd-2017-3-76-86
UDC 615.451.16:633.888.271

EVALUATION OF CRITERIA FOR THE EFFICIENCY OF THE EXTRACTION PROCESS OF ROOT AND RHIZOMES OF TURKESTAN VALERIAN

Sermukhamedova O.V., Gladukh E.V., Sakipova Z.B., Ibragimova L.N., Tleshova G.B., Maulen Zh.N., Nasyr A.S.

The goal is to calculate the efficiency criteria of the technological process of percolation of Turkestan valerian roots and rhizomes, to work out an optimal technology for obtaining a thick extract of Turkestan valerian.

Materials and methods. *In the experiment used roots and rhizomes of Turkestan valerian, purified water and ethanol of 96% pharmacopoeial quality.*

When determining the optimum extraction conditions 70% ethyl alcohol was used as the extractant. The extraction method is percolation. Each extract fraction was taken at a DER 1:1 step, the amount of dry residue in each fraction was estimated and the main indices of the process dynamics were calculated.

Results. *The total yield of extractives from 100 g of the raw materials was 10.79 g, which is more than 12.44%. The maximum number of stages of extraction for obtaining a thick extract is 7, a further increase in portions of the extractant does not lead to a significant increase in the yield of the finished product, which indicates the depletion of the raw material.*

The optimal technology for getting a thick extract consists of the following classical steps: grinding raw materials, preparing the extractant, preparing herbal raw materials, infusion, percolation, settling, filtration, evaporation, packaging and marking.

Conclusion. *Based on the conducted research, a technology for obtaining a thick extract from the roots and rhizomes of Turkestan valerian has been tested and experimentally substantiated, a laboratory regulation and methods for its standardization have been developed.*

Keywords: *Turkestan valerian (V. turkestanica Sumn.); thick extract; efficiency criteria; ethyl alcohol; temperature; speed.*

ОЦЕНКА КРИТЕРИЕВ ЭФФЕКТИВНОСТИ ПРОЦЕССА ЭКСТРАКЦИИ КОРНЕЙ И КОРНЕВИЩ ВАЛЕРИАНЫ ТУРКЕСТАНСКОЙ

Сермухамедова О.В., Гладух Е.В., Сакипова З.Б., Ибрагимова Л.Н., Тлешова Г.Б., Маулен Ж.Н., Насыр А.С.

Целью работы является проведение расчетов критериев эффективности технологического процесса перколяции корней и корневищ валерианы туркестанской, отработать оптимальную технологию получения густого экстракта валерианы туркестанской.

Материалы и методы. *В эксперименте использовали корни и корневища валерианы туркестанской, воду очищенную и спирт этиловый 96% фармакопейного качества.*

При определении оптимальных условий экстрагирования использовали в качестве экстрагента спирт этиловый 70 %. Метод экстракции – перколяция. Каждая фракция экстракта отбирали с шагом DER 1:1, оценивали количество сухого остатка в каждой фракции и рассчитывали основные показатели динамики процесса.

Результаты. *Общий выход экстрактивных веществ из 100 г сырья составил 10,79 г, что составляет более 12,44%. Максимальное количество ступеней экстракции для получения густого экстракта равно 7, дальнейшее увеличение порций экстрагента не приводит к значительному увеличению выхода готового продукта, что свидетельствует об истощении исследуемого сырья.*

Оптимальная технология получения экстракта густого состоит из следующих классических стадий: измельчение сырья, приготовление экстрагента, подготовка лекарственного растительного сырья, настаивание, перколяция, отстаивание, фильтрация, упаривание, упаковка и маркировка.

Заключение. *Таким образом на основании проведенного исследования отработана и экспериментально обоснована технология получения гу-*

стого экстракта из корней и корневищ валерианы туркестанской, разработан лабораторный регламент и разработаны методики для его стандартизации.

Ключевые слова: *валериана туркестанская (V. turkestanica Sumn); густой экстракт; критерии эффективности; спирт этиловый; температура; скорость.*

Turkestan valerian (V. turkestanica Sumn.) is a perennial herbaceous plant with a straight or at the bottom short rising stem of 30–80 (100) cm in height and a shortened rhizome with numerous dark brown cord-like lobes 1–2 mm thick. Basal leaves are lyrate-pinnately-dissected, with 3–5 pairs of lateral, entire marginal, ovate-lanceolate segments, 25–30 mm long and 4–11 mm wide; terminal portion is slightly larger than lateral segments, round or oblong-ovate, 30–40 mm long and 10–20 mm wide. Inflorescence is at first capitate, flowers are lilac, up to 7 mm in length; fruits are 4 mm long and 1.5 mm wide, elongated, brown. It blossoms in June, the fruits are ripen in July-August. It grows on subalpine and alpine meadows, in spruce forests, on forest and flood meadows, grassy slopes of gorges up to 2000–4000 m in height [1].

Turkestan valerian is characterized by the Central Asian type of area. In Kazakhstan it is found in the Dzungarian Alatau, the Zailiysky and Kungei Alatau, Ketmen, the Terskey Alatau, the Chu-Ili mountains, the Kirghiz Alatau, the Karatau [2, 3]. Although this species is widely distributed on the territory of Kazakhstan, the cultivation of the species is of practical importance for maintaining the consistency of the composition of biologically active substances and the manifestation of their pharmacological activity [4].

The goal is to calculate the efficiency criteria of the technological process of percolation of Turkestan valerian roots and rhizomes, to work out an optimal technology for obtaining a thick extract of Turkestan valerian.

Materials and methods

Roots and rhizomes of Turkestan valerian were collected in the mountains of the Zailiysky Alatau in late August, 2016 and represent a whole dried raw material. The following ingredients were used in the preparation of the extractant: purified water and ethanol of 96% pharmacopoeial quality.

When determining the optimum extraction conditions 70% ethyl alcohol was used as the extractant. Each extract fraction was taken at a DER 1:1 step, the amount of dry residue in each fraction was estimated and the main indices of the process dynamics were calculated.

Percolation was carried out using a laboratory filtration extractor. 100 g of crushed (3–5 mm) roots and rhizomes of Turkestan valerian were loaded into the extractor, 70% ethanol was poured in and infused for 24 hours. Then the percolation process was carried out; the speed was approximately 3–4 ml/min. Samples of the extract were collected separately with a DER 1:1 step. The extraction process was carried out until a total extract of DER 1:10 was obtained. For each sample of the extract a dry residue was determined and the basic physicochemical characteristics were fixed.

The content of the dry residue A_n in individual portions of the extracts V_n obtained by a certain extractant at a certain ratio of raw material: extract was calculated by the formula, g [5]:

$$A_n = \frac{\omega_n \times V_n}{100} \quad (1)$$

where: V_n – is the volume of a separately collected portion of the liquid extract obtained by a certain extractant at a raw material: extract (1:1) ratio, ml;

ω_n – is the dry residue in a separately collected portion of extract n,%.

The content of the dry residue B_n in the total extracts V_{n+1} obtained by a certain extractant at a certain ratio of raw material: extract was calculated by the formula, g [5]:

$$B_n = \sum_{n=1}^{n} A_n \quad (2)$$

where: A_n – the dry residue in a separately collected portion of the extract V_n, g.

The content of the dry residue C_n in the total extracts V_{n+1}, obtained by a certain extractant at a certain ratio of raw materials: extract at the stage, was calculated by the formula, % [5]:

$$C_n = \frac{B_n}{V_{n+1}} * 100\% \quad (3)$$

where: V_{n+1} – the volume of the total extract in the stage, ml;

B_n – the content of the dry residue in the total extracts V_{n+1}, g.

The yield of extractive substances (absolutely dry extract) D_n of each fraction by a certain extractant at a certain raw material: extract ratio was calculated by the formula,% [5]:

$$D_n = \frac{B_n}{m_c} * 100\% \quad (4)$$

where: m_c is the mass of the raw material loaded into the extractor, g;

B_n – the content of the dry residue in the total extracts V_{n+1}, g.

Results of the study

Table 1 presents the data of the experiments and calculated data of the main parameters of the dynamics of the percolation process of Turkestan valerian fragmented roots and rhizomes by 70% ethanol at a certain ratio of raw material: extractant. The total yield of extractives from 100 g of the raw materials was 10.79 g, which is more than 12.44%.

Table 1.

Calculated data of the main indicators of the dynamics of the Turkestan valerian percolation process

№	Volume of a separate portion of extract, V_n	Volume of the total extract V_{n+1} in the stage, ml	Content of dry residue, ω_n, g/100 ml	Content of dry residue, A_n, g	Content of dry residue, B_n, g	Content of dry residue, C_n, %	Dry extract yield D_n, %
1	100	100	2,45	2,45	2,45	2,45	2,45
2	100	200	2,25	2,25	4,70	2,35	4,70
3	100	300	1,79	1,79	6,49	2,16	6,49
4	100	400	1,91	1,91	8,40	2,10	8,40
5	100	500	1,00	1,00	9,40	1,88	9,40
6	100	600	0,71	0,71	10,11	1,69	10,11
7	100	700	0,54	0,54	10,65	1,52	10,65
8	100	800	0,05	0,05	10,70	1,34	10,70
9	100	900	0,05	0,05	10,75	1,19	10,75
10	100	1000	0,05	0,05	10,80	1,08	10,80

In order to determine the optimum conditions for extraction of raw materials, diagrams of the dependence of the main criteria of extraction process efficiency on the change in the ratio «raw material: extract» were constructed for each of the experiments.

The nature of the change in the process evaluation criteria under study in the dynamics of the «raw material: extract» ratio change is shown in Figures 1–2.

The maximum number of stages of extraction for obtaining a thick extract is 7, a further increase in portions of the extractant does not lead to a significant increase in the yield of the finished product, which indicates the depletion of the raw material.

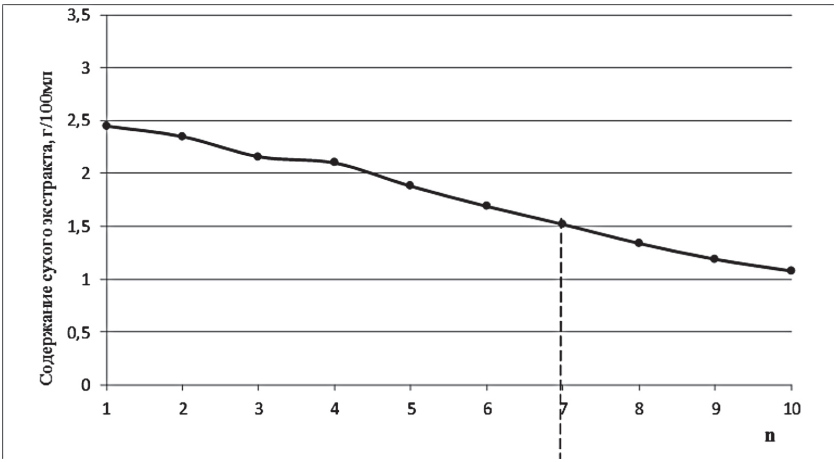


Fig. 1. Diagram of the dry residue content in the n-sample of liquid extracts

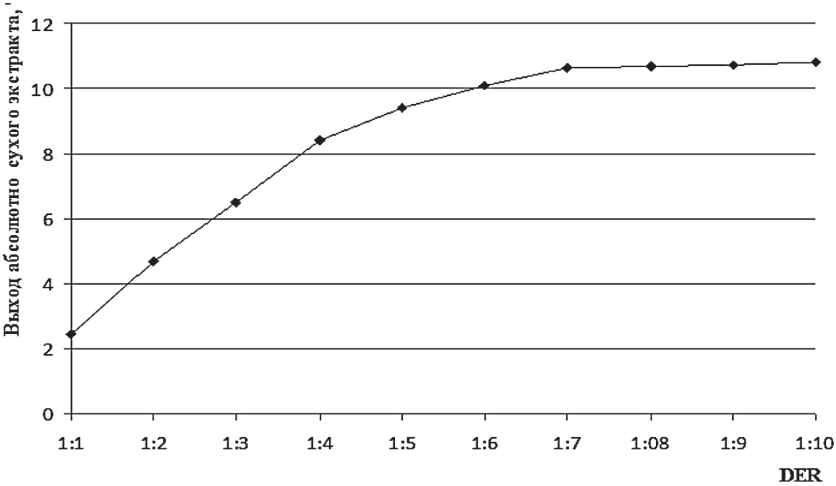


Fig. 2. Diagram of the yield of an absolutely dry extract, depending on DER

Based on the data obtained the optimal technology for getting a thick extract has been worked out, which consists of the following classical steps: grinding raw materials, preparing the extractant, preparing herbal raw materials (HRM), infusion, percolation, settling, filtration, evaporation, packaging and marking (Figure 3).

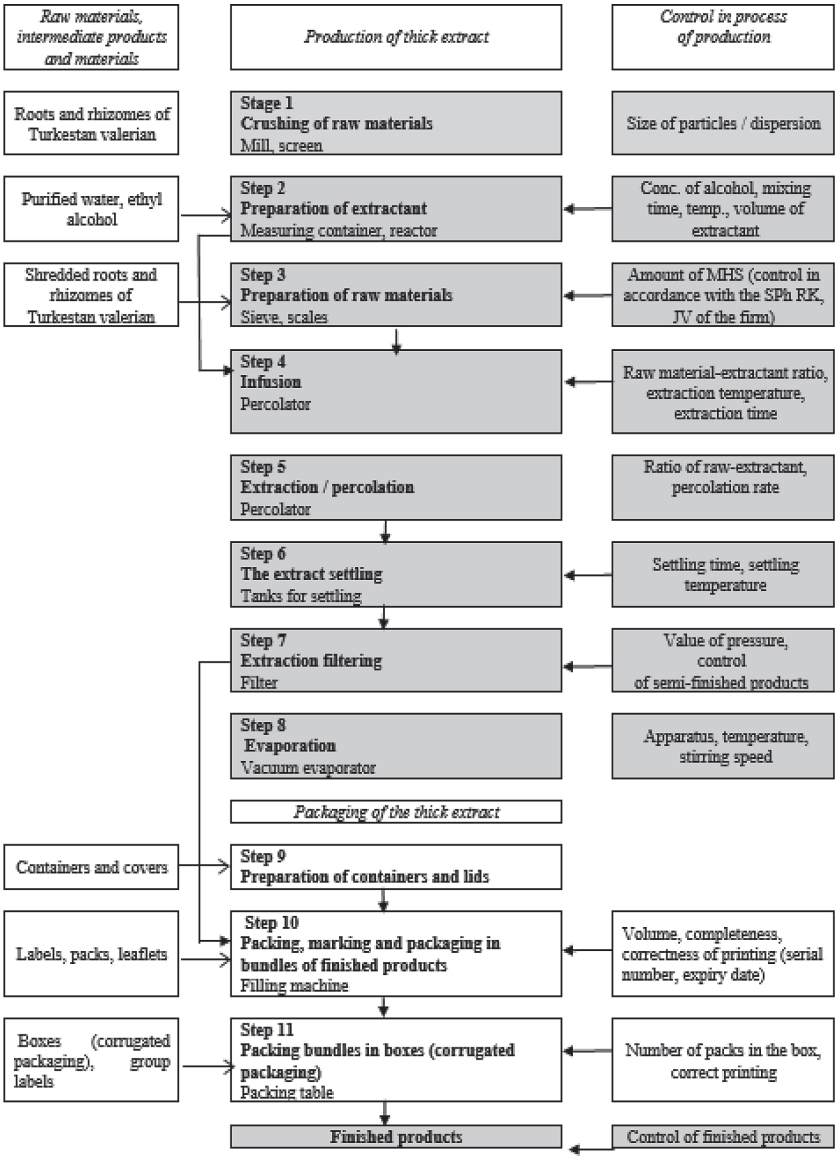


Fig. 3. Technological scheme for producing a thick extract from roots and rhizomes of Turkestan valerian

Roots and rhizomes of Turkestan valerian are crushed on a grass cutter to a size of 3–5 mm. A regulated amount of the crushed raw material is loaded into the percolator with a false bottom, filled with the calculated amount of ethyl alcohol 70% taking into account the absorption coefficient and infused for 24 hours. Then the process of extraction (percolation), draining of the percolate and simultaneous feeding of the extractant is carried out at a speed of 3–4 mils/min. The resulting semi-finished product is left to settle at a temperature of no higher than 8°C for 24 hours. The settled extract is separated from the ballast mass, subjected to a three-stage filtration (the filter pore size: 1.0 μm, 0.5 μm, 0.65/0.45 μm), evaporated in a rotary vacuum evaporator at the specified parameters (temperature 40±1°C, rotation speed 80–100 rpm, vacuum 0.08 mPa), packed in containers of orange glass for pharmaceutical use, and marked in accordance with the requirements of order No. 227 of 04/16/2015 [4].

Thus, based on the conducted research, a technology for obtaining a thick extract from the roots and rhizomes of Turkestan valerian has been tested and experimentally substantiated, a laboratory regulation and methods for its standardization have been developed.

References

1. Valeriana dubia Bunge, Valeriana proximata Sumn., Valeriana turkestanica Sumn. http://innature.kz/articles.php?article_id=886
2. *Flora Kazakhstana* [Flora of Kazakhstan]. V.8. Alma-Ata: NAUKA Publishing House, 1965, pp. 247–252.
3. Lekarstva iz rasteniy [Medicines from plants] / N.D. Beklemishev (ed.). Almaty: Mektep, 2002, pp. 53–57.
4. Sermukhamedova O.V., Sakipova Z.B., Basargina Yu.G. Vnedrenie nadlezhashchikh printsipov kul'tivirovaniya i sbora lekarstvennogo rastitel'nogo syr'ya pustyrnika turkestanskogo i valeriany turkestanskoy v Respublike Kazakhstan [Introduction of proper principles of cultivation and collection of medicinal plant raw material of Turkestan motherwort and Turkestan valerian in the Republic of Kazakhstan]. *Bulletin of Almaty Technological University*. 2017. N1, pp. 78–83.
5. Chueshov V.I. [et al.] The Industrial Technology of Drugs. Kharkov, National Pharmaceutical University. 2010. 208 p.

Список литературы

1. Валериана сомнительная, Валериана туркестанская, (Valeriana dubia Bunge, Valeriana proximata Sumn., Valeriana turkestanica Sumn.) [Электронный ресурс]. URL: http://innature.kz/articles.php?article_id=886

2. Флора Казахстана. Т.8. Алма-Ата: Издательство «НАУКА», 1965. С. 247–252.
3. Лекарства из растений / Под ред. Акад. АН РК Н.Д. Беклемишева. Алматы: «Мектеп», 2002. С. 53–57.
4. Сермухамедова О.В., Сакипова З.Б., Басаргина Ю.Г. Внедрение надлежащих принципов культивирования и сбора лекарственного растительного сырья пустырника туркестанского и валерианы туркестанской в Республике Казахстан // Алматы технологиялық университетінің хабаршысы. 2017. N 1. С. 78–83.
5. Chueshov V.I. [et al.] The Industrial Technology of Drugs. Kharkov, National Pharmaceutical University. 2010. 208 p.

DATA ABOUT THE AUTHORS

Sermukhamedova Ol'ga Vladimirovna, PhD Doctoral Student
Asfendiyarov Kazakh National Medical University
94, Tole Bi Str., Almaty, 050000, Kazakhstan
olesia_156@mail.ru

Gladukh Evgeniy Vladimirovich, Doctor of Pharmacy, Professor, Head of the Department of Industrial Pharmacy
National University of Pharmacy
53, Pushkinska Str., Kharkiv, 61002, Ukraine
olesia_156@mail.ru

Sakipova Zuriyadda Bektemirovna, Doctor of Pharmacy, Professor, Dean of the Faculty of Pharmacy and Pharmaceutical Technology
Asfendiyarov Kazakh National Medical University
94, Tole Bi Str., Almaty, 050000, Kazakhstan
olesia_156@mail.ru

Ibragimova Liliya Nikolaevna, Ph.D. of Pharmaceutical Sciences, Assistant Professor
Asfendiyarov Kazakh National Medical University
94, Tole Bi Str., Almaty, 050000, Kazakhstan
pln_19@mail.ru

Tleshova Gayni Baygazykyzy, Bachelor
Asfendiyarov Kazakh National Medical University

94, Tole Bi Str., Almaty, 050000, Kazakhstan
pln_19@mail.ru

Maulen Zhanna Nurgabylovna, Bachelor
Asfendiyarov Kazakh National Medical University
94, Tole Bi Str., Almaty, 050000, Kazakhstan
pln_19@mail.ru

Nasyr Arzgul' Sonvarovna, Bachelor
Asfendiyarov Kazakh National Medical University
94, Tole Bi Str., Almaty, 050000, Kazakhstan
pln_19@mail.ru

ДАННЫЕ ОБ АВТОРАХ

Сермухамедова Ольга Владимировна, PhD докторант
Казахский Национальный Медицинский Университет имени С.Д. Асфендиярова
Толе-би 94, г. Алматы, 050000, Казахстан
olesia_156@mail.ru

Гладух Евгений Владимирович, д-р фарм. наук, профессор, зав. кафедрой промышленной фармации
Национальный фармацевтический университет
ул. Пушкинская, 53, г. Харьков, 61002, Украина
olesia_156@mail.ru

Сакипова Зуриядда Бектемировна, д-р фарм. наук, профессор, декан факультета фармации и технологии фармацевтического производства
Казахский Национальный Медицинский Университет имени С.Д. Асфендиярова
Толе-би 94, г. Алматы, 050000, Казахстан
olesia_156@mail.ru

Ибрагимова Лилия Николаевна, к. фарм. н., доцент
Казахский Национальный Медицинский Университет имени С.Д. Асфендиярова
Толе-би 94, г. Алматы, 050000, Казахстан
pln_19@mail.ru

Тлешова Гайни Байгазыкызы, бакалавр
Казахский Национальный Медицинский Университет имени С.Д. Асфендиярова
Толе-би 94, г. Алматы, 050000, Казахстан
pln_19@mail.ru

Маулен Жанна Нургабыловна, бакалавр
Казахский Национальный Медицинский Университет имени С.Д. Асфендиярова
Толе-би 94, г. Алматы, 050000, Казахстан
pln_19@mail.ru

Насыр Арзгуль Сонваровна, бакалавр
Казахский Национальный Медицинский Университет имени С.Д. Асфендиярова
Толе-би 94, г. Алматы, 050000, Казахстан
pln_19@mail.ru

ПРАВИЛА ДЛЯ АВТОРОВ

(http://discover-journal.ru/guidelines.html)

В журнале публикуются статьи, научные обзоры и сообщения проблемного и научно-практического характера, представляющие собой результаты завершенных исследований о важнейших достижениях в основных разделах фундаментальных и прикладных исследований, обладающие новизной и представляющие интерес для широкого круга читателей журнала, а также передовой опыт в области клинической, профилактической медицины, биологии и сельского хозяйства.

Требования к оформлению статей

Объем рукописи	7-24 страницы формата А4, включая таблицы, иллюстрации, список литературы; для аспирантов и соискателей ученой степени кандидата наук – 7-10.
Поля	все поля – по 20 мм
Шрифт основного текста	Times New Roman
Размер шрифта основного текста	14 пт
Межстрочный интервал	полуторный
Отступ первой строки абзаца	1,25 см
Выравнивание текста	по ширине
Автоматическая расстановка переносов	включена
Нумерация страниц	не ведется
Формулы	в редакторе формул MS Equation 3.0
Рисунки	по тексту
Ссылки на формулу	(1)
Ссылки на литературу	[2, с.5], цитируемая литература приводится общим списком в конце статьи в порядке упоминания
	ЗАПРЕЩАЕТСЯ ИСПОЛЬЗОВАТЬ ССЫЛКИ-СНОСКИ ДЛЯ УКАЗАНИЯ ИСТОЧНИКОВ

Обязательная структура статьи

УДК

ЗАГЛАВИЕ (на русском языке)

Автор(ы): фамилия и инициалы (на русском языке)

Аннотация (на русском языке)
Ключевые слова: отделяются друг от друга точкой с запятой (на русском языке)

ЗАГЛАВИЕ (на английском языке)

Автор(ы): фамилия и инициалы (на английском языке)

Аннотация (на английском языке)
Ключевые слова: отделяются друг от друга точкой с запятой (на английском языке)

Текст статьи (на русском языке)

1. Введение.
2. Цель работы.
3. Материалы и методы исследования.
4. Результаты исследования и их обсуждение.
5. Заключение.
6. Информация о конфликте интересов.
7. Информация о спонсорстве.
8. Благодарности.

Список литературы
Библиографический список по ГОСТ Р 7.05-2008

References
Библиографическое описание согласно требованиям журнала

ДАННЫЕ ОБ АВТОРАХ

Фамилия, имя, отчество полностью, должность, ученая степень, ученое звание

Полное название организации – место работы (учебы) в именительном падеже без составных частей названий организаций, полный юридический адрес организации в следующей последовательности: улица, дом, город, индекс, страна (на русском языке)

Электронный адрес

SPIN-код в SCIENCE INDEX:

DATA ABOUT THE AUTHORS

Фамилия, имя, отчество полностью, должность, ученая степень, ученое звание

Полное название организации – место работы (учебы) в именительном падеже без составных частей названий организаций, полный юридический адрес организации в следующей последовательности: дом, улица, город, индекс, страна (на английском языке)

Электронный адрес

AUTHOR GUIDELINES

(http://discover-journal.ru/en/guidelines.html)

In the World of Scientific Discoveries publishes papers of problematic nature, as well as scientific reviews that reflect the most important achievements in the main fields of both the fundamental and applied research in medicine, biology and agricultural sciences.

Requirements for the articles to be published

Volume of the manuscript	7-24 pages A4 format, including tables, figures, references; for post-graduates pursuing degrees of candidate and doctor of sciences – 7–10.
Margins	all margins –20 mm each
Main text font	Times New Roman
Main text size	14 pt
Line spacing	1.5 interval
First line indent	1,25 cm
Text align	justify
Automatic hyphenation	turned on
Page numbering	turned off
Formulas	in formula processor MS Equation 3.0
Figures	in the text
References to a formula	(1)
References to the sources	[2, p.5], references are given in a single list at the end of the manuscript in the order in which they appear in the text

DO NOT USE FOOTNOTES
AS REFERENCES

Article structure requirements

TITLE (in English)

Author(s): surname and initials (in English)

Abstract (in English)
Keywords: separated with semicolon (in English)

Text of the article (in English)

1. Introduction.
2. Objective.
3. Materials and methods.
4. Results of the research and Discussion.
5. Conclusion.
6. Conflict of interest information.
7. Sponsorship information.
8. Acknowledgments.

References
References text type should be Chicago Manual of Style

DATA ABOUT THE AUTHORS

Surname, first name (and patronymic) in full, job title, academic degree, academic title

Full name of the organization – place of employment (or study) without compound parts of the organizations' names, full registered address of the organization in the following sequence: street, building, city, postcode, country

E-mail address

SPIN-code in SCIENCE INDEX:

СОДЕРЖАНИЕ

ПРОФИЛАКТИЧЕСКАЯ МЕДИЦИНА

СЕЛЬСКОХОЗЯЙСТВЕННЫЕ НАУКИ

НАУЧНЫЕ ОБЗОРЫ И СООБЩЕНИЯ

CONTENTS

PREVENTIVE MEDICINE

AGRICULTURAL SCIENCES

SCIENTIFIC REVIEWS AND REPORTS

Отпечатано с готового оригинал-макета
в типографии «ЛитераПринт»
г. Красноярск, ул. Гладкова, 6, офис 0-10
Подписано в печать и дата выхода: 30.06.2017.
Заказ ВМНО32017.
Тираж 5000. Усл. печ. л. 10. Формат 60×84/16