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ИНТЕНСИВНАЯ ТЕХНОЛОГИЯ ПЕРЕРАБОТКИ ПТИЧЬЕГО ПОМЕТА В ОРГАНОМИНЕРАЛЬНЫЕ УДОБРЕНИЯ

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В данной работе приведены состав и свойства птичьего помета, некондиционных фосфоритов Центральных Кызылкумов - минерализованной массы и шламового фосфорита, результаты получения органоминеральных удобрений путем подкисления птичьего помета 30% азотной кислотой от 7 до 4 pH с последующим разложением некондиционных фосфоритов подкисленным азотной кислотой птичьим пометом. Показано, что при переработке некондиционных фосфоритов подкисленным 30 % азотной кислотой птичьим пометом за счет взаимодействия органических кислот и остаточной азотной кислоты с некондиционными фосфоритами усвояемая форма P_2O_5, содержащаяся в некондиционных фосфоритах, увеличивается в 6,5-7,0 раз, подкисление птичьего помета азотной кислотой и добавление к нему некондиционных фосфоритов приводит к резкому снижению выделения в газовую фазу азотсодержащих и различных легколетучих органических веществ, негативно влияющих на окружающую среду. Приведены оптимальные условия и принципиальная технологическая схема получения органоминеральных удобрений на основе птичьего помета и некондиционных фосфоритов. При обработке минерализованной массы с подкисленным азотной кислотой до значения pH = 5 пометом и соотношении птичий помет: минерализованная масса = 1 : 0,10 получается удобрение состава $P_2O_{5общ.}$ 5,04 %; $P_2O_{5усв.}$: $P_2O_{5общ.}$ = 62,38 %, $CaO_{общ.}$ = 11,79%, N 3,86%, органические вещества 44,20% и гумусовые вещества 14,20%. При переработке шламового фосфорита, взятого в том же соотношении и pH удобрение содержит $P_2O_{5общ.}$ 4,42 %; $P_2O_{5усв}$: $P_2O_{5общ.}$ = 69,64 %, $CaO_{общ.}$ = 10,51%, N 3,89%, органические вещества 44,43% и гумумусовые вещества 14,30 %.

Ключевые слова: птичьий помет, азотная кислота, шламовые фосфориты, минерализованная масса, гуминовые кислоты, органоминеральные удобрения

INTENSIVE TECHNOLOGY FOR PROCESSING BIRD LITTER IN ORGANOMINERAL FERTILIZERS

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This paper presents the composition and properties of bird droppings, substandard phosphorites of Central Kyzylkum - mineralized mass and slurry phosphorite, the results of obtaining organomineral fertilizers by acidifying bird droppings with 30% nitric acid from 7 to 4 pH, followed by decomposition of substandard phosphorites by acidified bird droppings with nitric acid. It is shown that when processing substandard phosphorites with acidified bird droppings with 30% nitric acid due to the interaction of organic acids and residual nitric acid with substandard phosphorites, the assimilable form of P_2O_5 contained in substandard phosphorites increases by 6.5-7.0 times, acidification of bird droppings with nitric acid and addition of substandard phosphorites leads to a sharp decrease in the release of nitrogen-containing and various volatile organic substances into the gas phase affecting the environment. The optimal conditions and the basic technological scheme for obtaining organomineral fertilizers based on bird droppings and substandard phosphorites are given. When processing the mineralized mass with acidified droppings with nitric acid to the pH value = 5 and the ratio of bird droppings: mineralized mass = 1: 0.10, a fertilizer of the composition $P_2O_{5total.}$ 5.04%, $P_2O_5 : P_2O_{5total}$ = 62.38%, CaO_{total} = 11.79%, N 3.86%, organic substances 44.20% and humic substances 14.20% is obtained. When processing slurry phosphorite taken in the same ratio and pH, the fertilizer contains $P_2O_{5total.}$ 4.42 %; $P_2O_5 : P_2O_{5total}$ = 69.64%, CaO_{total} = 10.51%, N 3.89%, organic substances 44.43% and humus substances 14.30%.

Key words: bird droppings, nitric acid, sludge phosphorites, mineralized mass, humic acids, organic fertilizers

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INTRODUCTION

Poultry farming is one of the fastest growing livestock industries. Feeding and keeping poultry requires a relatively lower cost per unit of production compared to other livestock industries. The population of many countries of the world, including Uzbekistan, regularly uses chicken eggs and poultry in their diet, which are indispensable natural products.

In Uzbekistan, poultry farming is one of the leading livestock industries. To date, in Uzbekistan, the total number of poultry has reached 100 million. The number of large poultry farms is more than 50 pieces. Currently, work is underway to develop fundamentally new projects for the construction of new and reconstruction of existing poultry farms at the level of international standards. With an increase in the number of poultry farms, the volume of bird droppings also increases. Bird droppings are a valuable and most effective source for organic and mineral fertilizers. By its qualities, it is equivalent to mineral fertilizers, all crops respond well to its application, but the highest returns are for potatoes, sugar beets, silage crops and fodder root crops [1, 2].

The chemical composition of bird droppings is quite diverse and may vary depending on the feed ration, the method of keeping the bird, their age, breed, weight, moisture content and method of storing the litter. A variety of chemical composition extends only to the quantitative characteristics of an element. The qualitative chemical composition of the litter is relatively constant. The content of nitrogen and phosphorus in bird droppings is higher compared to the waste of other domestic animals. In addition to the main nutrients, bird droppings contain up to 0.2% Mg, 0.008% Cu, 0.004% Mn, 0.0026% Zn, 0.08% Co, 0.6% Mo, 0.05% B, 12.3-14.5% crude fiber, 3.5-5.0% fat, 11.5-16.5% ash, etc. [3-7]

Bird droppings, having a relatively high content of nutrients, are characterized by a rather narrow ratio of carbon and nitrogen, as a result of which it is rapidly mineralized. The main part of nitrogen in bird droppings is represented as uric acid compounds, which eventually turns into urea, and then into ammonium carbonate. The latter is hydrolyzed to form ammonia and carbon dioxide [8, 9]. In addition, fresh chicken droppings have a viscous, sticky texture and a nasty smell. During storage, chicken droppings become a source of environmental pollution according to microbiological and parasitological indicators. Processing of bird droppings remains a serious problem, the solution of which eliminates environmental pollution, makes it possible to obtain effective organo-mineral fertilizer that increase fertility of soils and crop yields.

In [10], the technology for the preparation of organic mineral fertilizer based on bird droppings is presented, according to which bedless droppings with initial moisture are mixed with mineral components. As a result of mixing the litter with the mineral components, without additional energy costs, it is possible to reduce the litter humidity by almost half and significantly increase the nutrient content. At the same time, the share of litter in the obtained fertilizers is at least 50%. The use of phosphate ores, ammonium sulfate, and a solution of sulfuric acid is proposed as mineral components. The technology for the preparation of organic fertilizers consists of four interrelated technological processes – the preparation of mineral components, stabilization of nutrients in the litter, the preparation of organic-mineral mixture and granules. Also, in this work, a diagram of the quantitative and qualitative balance of nutrients is provided, from which it follows that after granulating and drying the granules to a moisture content of 14%, the nutrient content in organic fertilizer is 26.7%. The use of this fertilizer allowed to increase the grain yield by 0.34-0.47% t/ha, that is, by 18-25% relative to the control. The nutrient content of organomineral fertilizers can range from 26 to 35% and depends on the nutrient content in the mixed components, their percentage.

In [11], it was shown that in the process of droppings from poultry to the root system of plants, nitrogen is lost up to 85%, phosphorus and potassium 40-50% of the initial content. More than 60% of nitrogen-containing excretion is accounted for by processes occurring outside the livestock building during processing (30%), introduction (20%) and storage (10%) of litter. Based on the foregoing, it was assumed that in order to justify the environmental component of the assessment of manure disposal technology and litter, nitrogen losses to the environment should be used as an indicator. Losses of nitrogen from poultry manure illustrate well the data of [12], which show comparative indicators of nitrogen loss in various methods for processing poultry manure, Table 1.

1. Long aging and application;
2. Passive composting in collars and introduction;
3. Active composting in piles and application;
4. Biofermentation in chamber-type installations and application;
5. Biofermentation in drum-type installations and application;
6. Thermal drying of the litter with subsequent granulation and application.

Table 1

Key indicators of poultry manure processing

Таблица 1. **Основные показатели переработки птичьего помета**

Indices	Unit	Technology					
		1	2	3	4	5	6
Litter formation	t/year	45625	45625	45625	45625	45625	45625
Capital expenditures	Thousand roubles	77400	64100	56200	131150	147000	67650
The amount of source nitrogen	Tons	821.3	821.3	821.3	821.3	821.3	821.3
Nitrogen loss	Tons	517.4	484.5	451.7	205.3	164.3	615.9

The best index of the criterion of economic efficiency, taking into account the safety of nutrients, is Technology 5 – Biofermentation in drum-type plants and the application of solid organic fertilizers. However, this technology has a significantly high value of the criterion of unit costs in comparison with other technologies. In addition, large losses of nutrients occur in all of these technologies.

The paper [13] critically analyzes the existing bird droppings processing technologies, shows the non-rational use of bird droppings in on-board composting, using such fillers as peat, shavings, sawdust, wood bark, household waste, when burning to produce heat and electricity, as well as other developed processing technologies bird droppings. According to the conclusion of this work, modern technologies for the utilization of bird droppings do not meet the ecosystem approach of rational agricultural production.

Based on the foregoing, we carried out a number of studies on the production of organic fertilizers based on substandard phosphorites, cattle and poultry manure by composting and also accelerated methods [14, 15]. It is shown that even from such waste phosphorite, such as mineralized mass and sludge phosphorite, it is possible to obtain highly effective nitrogen-phosphorus-humic fertilizers. The resulting organic fertilizer using mineralized mass and bird droppings has the composition (wt.%): P_2O_{5total} – 6.53; $P_2O_{5acceptable}$ – 4.04; CaO_{total} – 17.12; N – 4.21; organic matter – 28.38; humic acids – 1.56, fulvic acids 6.12, water-soluble organic substances 1.42, and using sludge phosphorite(wt.%): P_2O_{5total} – 5.55; $P_2O_{5acceptable}$ – 3.79; CaO_{total} – 16.43; N – 4.33; organic matter – 28.74; humic acids – 1.65, fulvic acids – 6.24, water-soluble organic substances – 1.52 [16].

In [17], modern technologies and methods for utilization of bird droppings are described in more detail. According to which the main methods of processing bird droppings are: biothermal (composting); Vermi composting thermal drying; anaerobic digestion, another combination of these methods is used. However, with these methods, not only the humification of organic substances is inherent, but also their mineralization. Mineralization causes large losses of nutrients, pollution of the atmosphere, water bodies, soils and subsoil waters with toxic substances.

It should be noted that at the present time, there is a decrease in the resources of high-quality phosphate raw materials and the content of humic substances in the soils of cultivated crops. In 2019, enterprises of JSC Uzkimyosanoat of the Republic of Uzbekistan produced 153.8 thousand tons of phosphorus fertilizers (in terms of 100% P_2O_5). And the need for agriculture is 691.7 thousand tons of P_2O_5. These figures indicate that the availability of phosphorus fertilizers in agriculture is insufficient. Currently, in the Kyzylkum phosphorite plant, when highly carbonized phosphorites of the Central Kyzyl Kum are enriched, waste is generated in the form of off-balance ore with a content of 13-15% P_2O_5 and sludge phosphorites with a content of 10-12% P_2O_5. The total volume of accumulated waste phosphorites already reaches 15 million tons.

In the face of an acute shortage of high-quality phosphate raw materials, the most affordable way to use substandard phosphorites is to process it together with bird droppings. Co-processing reduces the loss of organic matter and nitrogen from bird droppings and increases the availability of phosphorus to plants, which leads to an increase in the effectiveness of both components since bird droppings contain a significant amount of carboxylic acids that can bind calcium ions. That is, under the influence of organic acids formed during the decomposition of bird droppings, phosphorus pentoxide, which is part of the phosphate raw material, passes from an unapproachable form into a form that is digestible for plants and thereby will show its fertilizing properties. In addition, the phosphorite mineral binds $(NH_4)_2CO_3$ and free NH_3 manure into non-volatile forms of nitrogen.

It can be seen from the foregoing that the development of new technologies for the production of organic fertilizers based on waste from livestock farms and low-grade phosphorites with increased agroecological value and effectiveness is relevant.

EXPERIMENTAL PART

For studies of the processes of obtaining organic fertilizers as organic raw materials used bird droppings composition (wt.%): Moisture – 64.78; ash – 11.29; organic substances – 23.93; humic acids – 1.04; fulvic acids – 7.27; water-soluble organic substances – 1.28; P_2O_5 – 1.25; N – 0.95; K_2O – 0.74; CaO – 1.55.

Table 2 shows the results of mass spectrometric analysis (ICP – MS) of poultry ash. From the table it follows that bird droppings contain in their composition a number of trace elements necessary for the growth and development of plants.

Table 3 shows the results of liquid chromatographic analysis (an Agilent Technologies 1200 chromatograph with a DAD detector, a 75×4.6 mm Discovery HS C18 column, 3μm, a flow rate of 1.2 ml/min, a detector of 269 nm) of bird droppings with determination of the contents of various amino acids. Qualitative analysis and quantification of amino acids were compared with standard amino acids. Tables 2 and 3 show that in the initial bird droppings there is almost the entire spectrum of amino acids found in living organisms. It should be noted that amino acids are the building material for the formation of cells and perform many other important functions in plant organisms.

Mineralized mass and sludge phosphorite were used as phosphate raw materials. They are the waste products of the phosphate ore enrichment process in the Central Kyzyl Kum. The first is formed by dry sorting of phosphate ore, and the second – when washing raw materials from chlorine. Before use, they were ground to a particle size of 0.25 mm. The composition and properties of substandard phosphorites are given in Table 4.

Table 2

The results of mass spectrometric analysis of bird droppings ash

***Таблица 2*. Результаты масс-спектрометрического анализа золы птичьим помете**

Name and content of elements, in g/t									
The composition of the bird droppings ash									
Li 127	Be 2,61	B 267	Na 9950	Mg 26011	Al 63889	P 325	K 3547	Ca 164077	Cr 22,8
Mn 5474	Fe 46174	Co 7.17	Ni 8.65	Cu 63.0	Zn 4438	Mo 1.46	Ag 1.05	Ba 127	Ti 126

Table 3

The content of various amino acids in the original bird droppings

***Таблица 3.* Содержание различных аминокислот в исходном птичьим помете**

Amino acids	The content of amino acids (wt.%)
	Bird droppings
Aspartic acid	0.2244
Glutamic acid	0.3263
Serine	0.0896
Glycine	0.1080
Asparagine	0.0124
Threonine	0.0811
Argenin	0.0124
Alanine	0.1405
Proline	0.0098
Tyrosine	0.0434
Valine	0.0424
Histidine	0.0160
Leucine	0.1009
Phenylalanine	0.0401
Tryptophan	0.3951
Lysine HCl	0.1028

Table 4 shows that they are characterized by a low phosphorus content (11.5-14.33% P_2O_5), a high carbonate content (14.70-20.91% CO_2) and a high calcium modulus (CaO: P_2O_5 = 3.0-3,55).

To develop a method for producing organic fertilizers based on poultry waste and substandard phosphorites, information is needed on the physico-chemical and physico-mechanical properties of fossy. These include disperse composition, humidity, bulk density, angle of repose, fluidity, pH, hygroscopicity, moisture capacity. These properties are determined by the techniques described in [18].

The results in the Table. 4 show that at initial humidity (1.73-2.15%), the free bulk density of the mineralized mass is 1.06 g/cm^3, sludge phosphorite – 0.81 g/cm^3, and with a seal of 1.36 and 1.04 g/cm^3, respectively. The smaller the slope angle, the greater the mobility of the particles is friability. For a mineralized mass, the angle of repose is 24, and for sludge phosphorite – 39°, that is, the mineralized mass has high mobility and is easily dispersed. The hygroscopic point turned out to be 47.5% for the mineralized mass, and 46.7% relative air humidity for sludge phosphorite. The maximum moisture capacity of the samples of phosphate raw materials of the Central Kyzyl Kum is 5.6-7.4%, and at higher humidity they lose their friability.

Table 4

Physico-chemical properties of substandard phosphorites

***Таблица 4.* Физико-химические свойства некондиционных фосфоритов**

The chemical composition of substandard phosphorites										
Types of substandard phosphorites	The content of components, weight. %									$P_2O_{5\ assimilab.}$ / $P_2O_{5total.}$ %
	P_2O_5	CaO	Al_2O_3	Fe_2O_3	MgO	F	CO_2	SO_3	H.O.	
Mineralized Mass	14.33	43.02	1.18	1.38	1.19	1.85	14.70	2.22	13.23	9.01
Sludge phosphorite	11.57	41.08	1.84	1.42	0.61	1.52	20.91	0.46	14.9	11.50

Physical characteristics of substandard phosphorites		
Properties of substandard phosphorites	Indices	
	Mineralized mass	Sludge phosphorite
The initial humidity,%	2.15	1.73
Free bulk density, g / cm3	1.06	0.81
Density with seal, g / cm3	1.36	1.04
Slope angle, degrees	24°46′	39°29′
Dispersibility, sec.	Evenly, without any difficulty	
Hygroscopic point,%	47.5	46.7
Moisture content,%	5.6	7.4
pH of a 10% suspension	7.14	9.40

The dispersed composition of substandard phosphorites		
Size class, mm	The output fraction, weight. %	
	Mineralized mass	Sludge phosphorite
-2 + 1	-	-
-1 + 0.63	0.2	-
-0.63 + 0.4	0.6	-

Table 4

The dispersed composition of substandard phosphorites		
Size class, mm	The output fraction, weight. %	
	Mineralized mass	Sludge phosphorite
-0.4 + 0.315	1.4	-
-0.315 + 0.2	23.9	0.4
-0.2 + 0.16	9.9	43.8
-0.16 + 0.1	36.5	41.6
-0.1 + 0.05	19.0	9.4
-0.05	8.5	4.8
Initial mass	100	100

During the research, chemical and physico-chemical methods of analysis were used. Chemical analysis of bird droppings, mineralized mass, sludge phosphorite and products of their processing was carried out by the following methods.

Humidity was determined according to GOST 26712-85, ash content according to GOST 26714-85 and organic matter according to GOST 27980-80. The amount of the water-soluble fraction of organic substances extracted from the products with water was determined by filtration and evaporation in a water bath, drying the solid residue to a constant weight, and then burning it to determine the ash content and subtract it. Humic acids were isolated by treating the products with 0.1 N alkali solution followed by acidification of the solution with mineral acid [19, 20]. The solid phase after separation of alkali-soluble organic substances from it contains residual organic matter. It was thoroughly washed with disco, dried to constant weight and the content of organic substances was determined. The difference between the amounts of alkali-soluble organic substances and humic acids gives us the content of fulvic acids. The sum of humic acids and fulvic acids gives us the content of humic substances.

All P_2O_5 forms were determined by the gravimetric method by precipitation of the phosphate ion with a magnesia mixture in the form of magnesium ammonium phosphate, followed by calcination of the precipitate at 1000-1050 °C according to GOST 20851.2-75. Digestible P_2O_5 forms were determined by solubility in both 2% citric acid and 0.2 M Trilon B.

The CaO content was determined complexometrically: by titration with 0.05 N Trilon B solution in the presence of the fluorexone indicator, the assimilable form of CaO was in solutions of 2% citric acid.

The carbon dioxide content in the samples was determined by the volumetric method, decomposition of carbonates with diluted HCl. The degree of decarbonization of fossyry was calculated from the change in CO_2 content.

The pH value of 10% aqueous suspensions of the starting materials and finished fertilizers was measured in the I-130M ionomer with the ESL 63-07, EVL-1M3.1 and TKA-7 electrode system.

The essence of the proposed method is to treat bird droppings with nitric acid, followed by mixing the resulting acidic products with substandard phosphorites.

RESULTS AND DISCUSSIONS

Nitric acid with a concentration of 59% was used to acidify bird droppings. At the first stage of the work, fresh manure was acidified in order to stop the evolution of ammonia into the gas phase. The acidification was carried out to pH = 4, 5, 6, and 7. The mineralized mass and sludge phosphorite were treated with acidified manure at 70 °C for 60 min. Drying was carried out at 80 °C, and granulation by pressing. Activation of mineralized mass and sludge phosphorite with acidified manure was carried out in the range of weight ratios of bird droppings to mineralized mass and sludge phosphorite from 100 : 10 to 100 : 30. The experimental results are given in Table 5 and 6. From the tables it is seen that for both types of phosphate raw materials with a decrease in the pH of bird droppings in the obtained products, the relative content of the assimilable form of phosphorus increases. This reduces the content of organic substances and humic acids. When processing mineralized mass, the most phosphorus-concentrated products are obtained than when processing slurry phosphorite. However, the compositions of the two types of organomineral fertilizers are of great interest for agricultural production. When processing a mineralized mass with acidified droppings to a pH value of 5 and a ratio of bird droppings: mineralized mass = 1: 0.10, a fertilizer of the composition:

P_2O_{5total}. – 5.04%; P_2O_5 : P_2O_{5total} = 62.38%, CaO_{total}. = =11.79%, N – 3.86%, organic substances – 44.20% and humic acids – 14.20%. When processing sludge phosphorite taken in the same ratio and pH, the fertilizer contains P_2O_{5total} – 4.42%; P_2O_5 : P_2O_{5total} = 69.64%, CaO_{total} = 10.51%, N – 3.89%, organic substances – 44.43% and humic acids – 14.30%.

Table 5

The chemical composition of nitrogen-phosphorus-humus fertilizer based on acidified bird droppings and mineralized mass

Таблица 5. **Химический состав азотно-фосфорно-гумусового удобрения на основе подкисленного птичьего помета и минерализованной массы**

pH of acidified litter	$P_2O_{5total.}$, %	$\frac{P_2O_{5assimilab.}}{P_2O_{5total.}}$, %	$CaO_{total.}$, %	Organic matter, %	Humus,%	N, %	pH
The mass ratio of bird droppings: mineralized mass = 100 : 10							
7	5.25	35.68	11.58	47.42	15.23	2.40	6.78
6	5.13	43.74	11.32	46.35	14.89	2.91	6.17
5	5.01	60.38	11.05	45.24	14.53	3.42	5.01
4	4.92	72.48	10.84	44.41	14.27	3.84	4.39
The mass ratio of bird droppings: mineralized mass = 100 : 15							
7	5.90	31.62	14.00	41.94	13.47	2.13	7.06
6	5.78	42.31	13.72	41.09	13.20	2.58	6.68
5	5.65	52.87	13.42	40.20	12.91	3.04	5.94
4	5.56	63.38	13.20	39.52	12.70	3.41	5.67
The mass ratio of bird droppings: mineralized mass = 100 : 20							
7	6,62	30,35	16,44	38,82	12,47	1,97	7,29
6	6,49	40,21	16,13	38,07	12,23	2,39	6,96
5	6,36	50,32	15,80	37,29	11,98	2,82	6,53
4	6,25	57,31	15,54	36,69	11,79	3,17	6,21
The mass ratio of bird droppings: mineralized mass = 100 : 25							
7	7.13	27.43	18.27	35.59	11.43	1.80	7.68
6	7.00	39.38	17.94	34.95	11.23	2.19	7.07
5	6.87	46.83	17.60	34.28	11.01	2.59	6.78
4	6.76	53.35	17.33	33.76	10.84	2.92	6.56
The mass ratio of bird droppings: mineralized mass = 100 : 30							
7	7.62	25.51	19.95	33.08	10.63	1.68	7.89
6	7.49	37.46	19.61	32.52	10.45	2.04	7.21
5	7.35	43.66	19.26	31.93	10.26	2.41	6.97
4	7.24	49.32	18.97	31.46	10.11	2.72	6.72

Table 6

Chemical composition of nitrogen-phosphorus-humus fertilizer based on acidified bird droppings and sludge phosphorite

Таблица 6. **Химический состав азотно-фосфорно-гумусового удобрения на основе подкисленного птичьего помета и шламового фосфорита**

pH of acidified bird droppings HNO_3	$P_2O_{5total.}$, %	$\frac{P_2O_{5assimilab.}}{P_2O_{5total.}}$, %	$CaO_{total.}$, %	Organic matter, %	Humus,%	N, %	pH
The mass ratio of bird droppings and sludge phosphorite = 100 : 10							
7	4.65	47.33	11.07	46.89	15.06	2.63	6.97
6	4.54	56.19	10.80	45.75	14.70	3.16	6.38
5	4.38	69.64	10.43	44.20	14.20	3.86	5.27
4	4.33	81.37	10.30	43.63	14.02	4.16	4.62
The mass ratio of bird droppings and sludge phosphorite = 100 : 15							
7	5.21	41.57	13.60	42.26	13.58	2.37	7.31
6	5.09	52.78	13.29	41.31	13.27	2.86	6.87
5	4.94	63.62	12.88	40.03	12.86	3.50	6.12
4	4.88	71.62	12.72	39.54	12.70	3.77	5.88

Table 6

The mass ratio of bird droppings and sludge phosphorite = 100 : 20							
7	5.67	37.68	15.67	38.46	12.36	2.16	7.51
6	5.55	50.72	15.34	37.66	12.10	2.61	7.15
5	5.39	56.87	14.90	36.58	11.75	3.20	6.71
4	5.33	59.71	14.73	36.16	11.61	3.45	6.4
The mass ratio of bird droppings and sludge phosphorite = 100 : 25							
7	6.05	36.12	17.40	35.29	11.34	1.98	7.85
The mass ratio of bird droppings and sludge phosphorite = 100 : 25							
6	5.94	48.69	17.06	34.60	11.12	2.39	7.26
5	5.78	52.87	16.61	33.68	10.82	2.94	6.99
4	5.71	55.68	16.42	33.30	10.70	3.18	6.73
The mass ratio of bird droppings and sludge phosphorite = 100 : 30							
7	6.38	35.38	18.87	32.60	10.47	1.83	8.06
6	6.23	44.65	18.44	31.85	10.23	2.20	7.42
5	6.02	49.68	17.80	30.76	9.88	2.69	7.15
4	5.96	52.87	17.63	30.46	9.78	2.91	6.89

From the point of view of agrochemistry and saving of initial raw materials, fertilizers obtained by processing mineralized mass with acidified bird droppings to pH = 6 at a ratio of bird droppings: mineralized mass = 100: 10 are relatively effective. Therefore, the technology was tested on an enlarged laboratory unit at the ratio of the starting components. Fertilizers obtained as a result of experiments on an enlarged laboratory unit are almost identical in composition to products prepared in laboratory conditions.

Based on the studies and a series of experiments on an enlarged laboratory facility, the optimal process parameters were determined, a basic technological scheme was developed, and the material balance of the production of one ton of nitrogen-phosphorus-humus fertilizer was calculated.

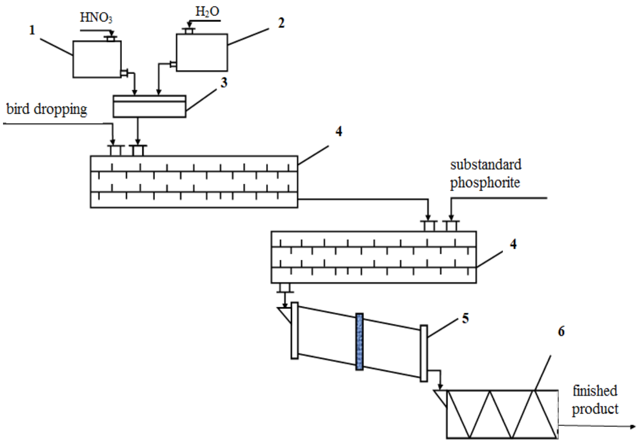

Fig. 1. The basic technological scheme of the process of obtaining organic fertilizers: 1 - HNO_3 tank; 2 - H_2O tank; 3 - automatic hub; 4 - auger mixer; 5 - drum dryer; 6 - press-granulator

Рис. 1. Принципиальная технологическая схема процесса получения органоминеральных удобрений: 1 - HNO_3; 2 - H_2O; 3 - ступица; 4 - шнековый смеситель; 5 - барабанная сушилка; 6 - пресс-гранулятор

The technology for producing nitrogen-phosphorus-humus fertilizers consists of the following main stages:

1. The acidification of bird droppings with nitric acid;
2. Processing the mineralized mass with an acidic product;
3. Drying the finished product.

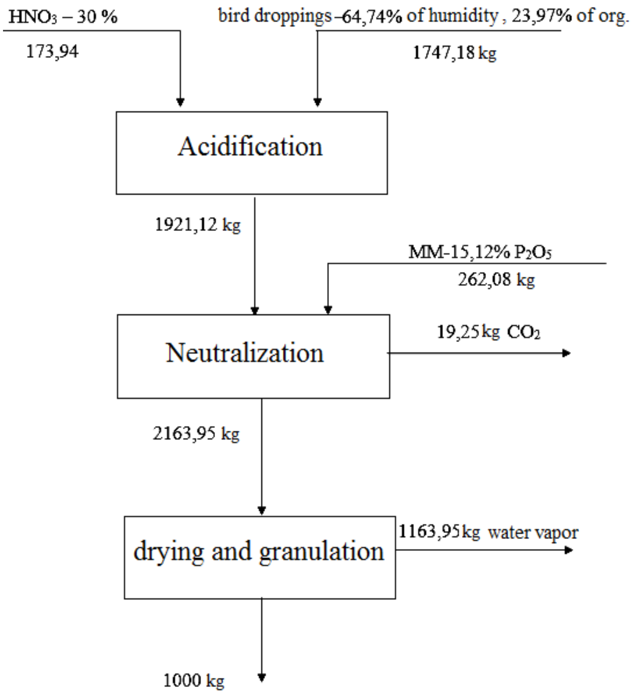

Fig. 2. Material balance of production of nitrogen-phosphorus-humus fertilizer based on acidified bird droppings and mineralized mass

Рис. 2. Материальный баланс производства азотно-фосфорно-гумусового удобрения на основе подкисленного птичьего помета и минерализованной массы

According to the Fig. 1 and 2, nitric acid with a concentration of 59% from the storage enters the pressure tank 1, then to the automatic concentrator 2, where it is diluted with water. From the concentrator, the acid is sent to reactor 3, where bird droppings are also fed. After acidification to pH = 6, the litter is sent to auger mixer 4, where phosphate feed is fed simultaneously. After thorough mixing, the resulting mass is sent to the drum dryer 5, then to the press granulator 6.

The optimal technological mode of the process for producing phosphorus-humus fertilizer is as follows:

- concentration of nitric acid for acidification of bird droppings, % 30;
- the duration of acidification, min 30;
- weight ratio of fresh litter to phosphate raw materials100:15;
- decomposition temperature of phosphorite, °C 60;
- the duration of the decomposition of fossyry, min 60;
- the drying temperature of the product, °C 80.

CONCLUSION

The composition and properties of bird droppings, substandard phosphorites – mineralized mass and sludge phosphorite were studied. The results of chromatographic and mass spectrometric analyzes showed that the initial bird droppings contained almost the entire spectrum of amino acids found in living organisms and performing important functions in plant organisms, as well as a number of trace elements necessary for plant growth and development. It is shown that substandard phosphorites and wastes of animal husbandry farms are suitable for processing into organic fertilizers according to their physical and mechanical characteristics.

It is substantiated that the joint processing of substandard phosphorites and bird droppings leads, on the one hand, to the interaction of humic acids, fulvic acids and water-soluble organic substances with phosphate raw materials and an increase in the assimilable form of P_2O_5 due to its activation, on the other hand, nitric acid and phosphorite reduce the loss of nitrogen and organic substances.

Thus, the study convincingly shows that in poultry farms, using a small amount of nitric acid, it is possible to intensively process bird droppings and substandard phosphorites into high-quality nitrogen-phosphorus-humus fertilizers.

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