



PRODUCTION TECHNOLOGIES OF FORMED PREMIXES

Abstract

The article presents theoretical analysis and practical experience of the production of premixes (P) by different technologies of preparation of the filler. Their advantages and disadvantages are stated. The classification of premix fillers is presented and the distribution of biologically active substances in the premix composition, which is made on different fillers, is schematically presented.

The technology of production of a complex filler of premixes (CFP) in the form is theoretically and practically substantiated. Various methods of forming depending on the composition of the complex filler are considered, as well as the technological scheme of their production is presented.

The results of industrial approbation of technologies of forming (granulation, briquetting, rolling, extrusion) of fillers and ready premixes in the production conditions of TG "VBA" "Izvestnyaki" are presented. The physical indicators of the formed complex fillers / premixes were investigated, and on the basis of the analysis of the obtained data it was found that granulation and briquetting can be subjected to CFP consisting of 75... 50% wheat bran and 25... 50% limestone flour. The pellet is a CFP consisting of 85% wheat bran and 15% limestone flour. Optimal technological modes of forming KNP and P in different ways have been established, as a result of which it is possible to obtain particles of P, which, upon further mixing with the feed components, ensure a high homogeneity of the finished feed.

The results of the study of microbiological parameters are presented, it is established that the formation of CFP or P reduces the bacterial flora and improves the conditions during their storage.

The proposed technological methods of preparation of CFP can eliminate the stratification and stabilize its composition during transportation and storage.

Keywords: premix (P), excipient, complex filler of premixes (CFP), granules, pellets, extrudate, cereals, granulation technology, technological modes, homogeneity, physical properties, microbiological parameters.

Introduction

The quality of the premixes depends largely on the quality of the raw material that is included in their composition, the physical properties of the filler and the efficiency of the manufacturing process.

In the production of premixes, the filler plays an important role in ensuring their quality, since the uniformity of the distribution of micro components depends on its properties. The main purpose of premix fillers is to separate one particle from another chemically incompatible biologically active additive (BAA) preparation, which helps to preserve the activity of the latter, and to ensure their uniform distribution, both in the premix itself and in the protein-vitamin additive feed (PVA), protein-vitamin-mineral additives (PVMA), feed mixture [1-4].

In the 70 ... 80-ies of the last century in the production of premixes used classical mono filler (organic or mineral) [3, 5, 6].

The development of premix production technologies is due not only to technological innovations [7, 8], but also to changes in the properties of BAA preparations [9-11] and the improvement of preparation of premix fillers [1, 2, 12-14]. Substantial changes in the physical properties of BAA preparations (increase in density, bulk mass, etc.) used for the production of premixes have prompted scientists and manufacturers of premixes to search for and introduce into the technology of production of premixes of complex fillers, the physical properties of which best meet the requirements of mixing BAA

and ensure the stability of the finished product composition.

In the early 2000s, premix manufacturers began to use complex fillers, which consist of two or three fillers, which perform the functions of a carrier that maximally retains the BAA and ensures homogeneity of the mixture, and a diluent that improves the physical properties of the mixture and maintains the activity of BAA [15- 17].

The most effective and cost-effective is the use of complex premix filler (CFP), which consists of wheat and limestone flour (75:25; 50:50; 15:85), whose technology was developed in 2002-2006 by Yegorov B.V., Makarynska A.V., Brazhenko V.E. [18-20]. The use of dry neutral filler diluent, namely limestone flour in the composition of the complex filler, in a certain ratio, affects the redistribution of moisture in the finished complex filler, which allows to obtain a filler with a predetermined value of the mass fraction of moisture in the range from 8 to 10% without the use of energy. The increase in the mass fraction of wheat bran in the composition of complex fillers more than 75% leads to a mixture that does not meet the requirements for fillers in terms of the content by mass of moisture in the production of premixes [21, 22].

BioPro and Adisseo Eurasia LLC have developed a pseudocapsulation technology that anticipates the production of premixes containing BAA that are fixed on carrier particles (wheat bran) and covered externally by a



mineral shell of classic pre-mixes, such as premixes, turtle flour). The pseudocapsule thus obtained has less contact with water and oxygen, is therefore more resistant to oxidation and does not disintegrate, which has a positive effect on the preservation of BAA drugs [23].

The presence of protected forms of vitamin preparations Adisseo, BASF, DSM Nutritional Products, Kaesler Animal Nutrition, Orffa Additives BV, Lonza, MIAVIT, Sunvit, while adhering to the technology of production of premixes with the use of complex fillers guarantees the uniform distribution of all BAA in the composition of premixtures domestic and foreign scientists [24-28]. However, in the further transportation, movement of the premix and its mixing with other components of compound feed there is a pressing question to ensure the stability of the composition and the uniform distribution of the BAA. Technology for the production of premixes in the form of "granules" without the use of heat treatment, proposed by "Nutristar International" S.A. (France) allows to ensure uniform distribution of BAA in the composition of the premix, but such a premix is used to enrich and balance the diets of industrial laying hens and breeding adult poultry only in bulk feed and excludes its use for young animals [29].

To eliminate these shortcomings, we have proposed a technology of mechanical encapsulation, which provides: separate preparation of fillers in the traditional way, by sieving on the puncture sieves PS No. 12 (\varnothing 1.2 mm) with subsequent grinding of a large fraction and mixing the pass fractions of PS No. 12 in these ratios; the introduction of 0,1-2,0 % of the enhancer Thixosil[®] 38A (Aventis); the introduction of 1,5-2,0 % vegetable oil at the stage of formation of the pre-mixture of filler and BAA; selection of the powder fraction at the stage of preparation of fillers through sieve kapron No. 27 and its subsequent deposition at the final stage of production of complex filler [30].

Also, in the production of complex fillers, methods for reducing the cost of ready-mix premixes have been proposed due to the use of trace element-rich diluents (bentonite clays, algae groats) and subsequent conversion of mineral and complex premixes [31-33].

The purpose and objectives of the study

The purpose of the work is to improve the technology of preparation of complex filler, which will ensure efficient distribution of BAA and their stability in the composition of premixes.

To achieve this goal it was necessary to solve the following problems:

- to carry out the analysis of technologies of preparation of fillers;
- improve the technology of preparation of CFP by its formation in various ways;
- to investigate the physical and microbiological quality indicators of CFP and premixes based on them;
- determine the homogeneity of the distribution of microcomponents in the premix;
- to carry out industrial testing of CFP production using different methods of formation and use in the production of premixes and compound feeds.

Materials and equipment

Objects of study - crumbly and molded CFP, consisting of bran of wheat and limestone flour in a ratio of 75:25; 50:50; 15:85; extruded CFP, consisting of wheat bran and kelp kelp in a ratio of 85:15 [34]; complex premixes based on them [18-20], 0,2 % Rovimix P-5-2 MCLN blend DSM for broilers.

Formation of CFP / complex premixes was carried out on the basis of ONAFT Department of Combined Feeds and Biofuels Technology and industrial conditions of Izvestnyaky "VBA" (Kamyanets-Podilsk) using technological equipment (Fig. 1), the technical characteristics of which are given in Table 1 .



Fig. 1 - Technological equipment for producing molded CNC

a - plate granulator "T" 150 M, b - press granulator OPG-150, c - extruder EZ-150

Table 1 - Technical characteristics of process equipment

Type of equipment	Overall dimensions (length, width, height, diameter, mm)	Engine power, kW	Productivity, t / h	Final product
Plate granulator «T» 150 M	1860x1950x2300 \varnothing plates 1500 mm	5,5	0,8-1,8	You roll
Granulator OPG 150	800x400x900 \varnothing die 4,7 mm	4,0	0,1-0,15	Granules
	\varnothing die 19,0 mm			Briquettes
Extruder E3-150	1700x750x2000	19,0	0,15	Extrudate



In the work used standard methods for determining the physical properties of raw materials and finished products [4, 35].

Microbiological quality indicators were determined by: total number of mesophilic anaerobic bacteria and optional anaerobic microorganisms per 1 g of product (MAFAM); the number of molds in 1g; the presence and titer of bacteria of the group of Escherichia coli (BGEC); the presence of pathogens of the genus Salmonella and Staphylococcus; the presence of obligate anaerobic microorganisms.

The analysis was washed with microorganisms from particles of bran and premixes. To obtain reliable results on the degree of contamination of the samples by microorganisms were prepared ten times dilution of the wash 100 and 1000 times. The total number of microorganisms in 1 g was determined by sowing 1 cm³ with a dilution of 1000 times, pathogenic and obligate-anaerobic microorganisms were found from a dilution of 10 times, the titer of BGKP - from a dilution of 10, 100 and 1000 times according to [36-37].

The homogeneity of premixes was evaluated by a complex technique by determining the content of a key component (vitamin B2) by the colorimetric method [38], analyzing the hydrogen extracts of the experimental samples of the premix on the photocolimeter of the KFK and pH meter [18].

Results of the studies and their discussion

On the basis of analysis and generalization of existing technologies of premix production we have developed a classification of premix fillers, which is presented in Fig. 2.

The vast majority of compound feeds today are made in the form of pellets or compound feed. In connection with what we have, based on the previous development of the technology of production of compound feeds of granulometric composition [39, 40] and the use of thermostable forms of preparations of BAA [36, 41], the following hypotheses were put forward:

- obtaining molded fillers and premixes on its basis will allow to produce stable premixes of fixed composition;

- production of granulometrically prepared premixes will improve the mixing conditions with other components of compound feed, in particular in the production of compound feed in the form of cereals.

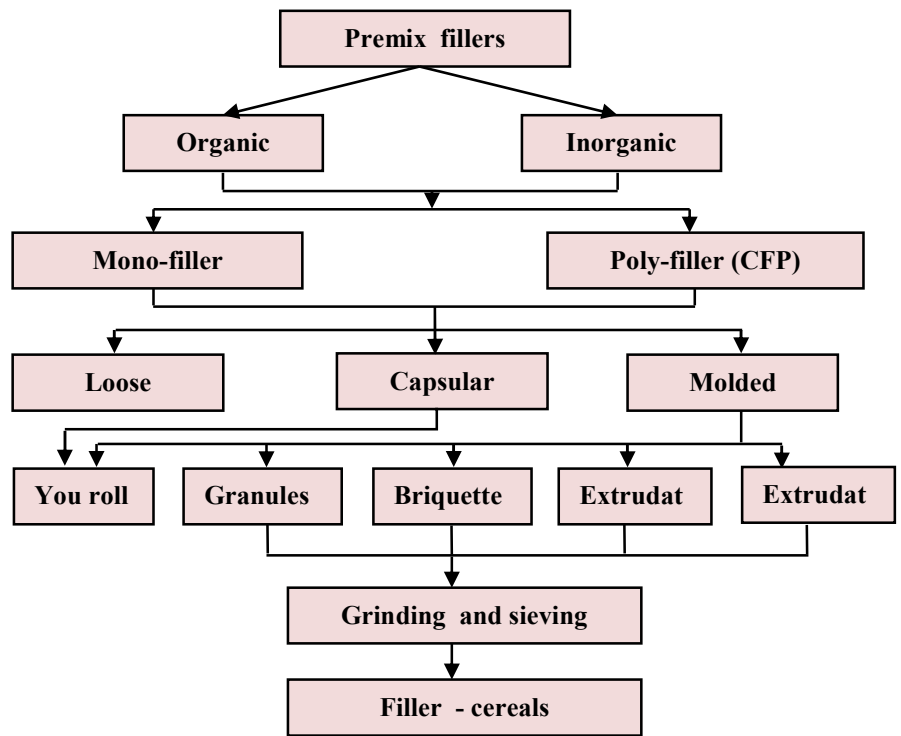


Fig. 2 - Classification of premix fillers

On the basis of a number of experiments in the production conditions of the enterprise of "VBA" "Izvestnyaki" (Kamyanets-Podilsk), it was proposed to use the technology of rolling with obtaining spherical granules in the preparation of CPF for mineral premixes (ratio of wheat bran and limestone flour - 15:85) different fractions from 0.3 to 3 mm (Fig. 3), since the formation of molded particles by the method of classical granulation or extrusion was physically impossible.

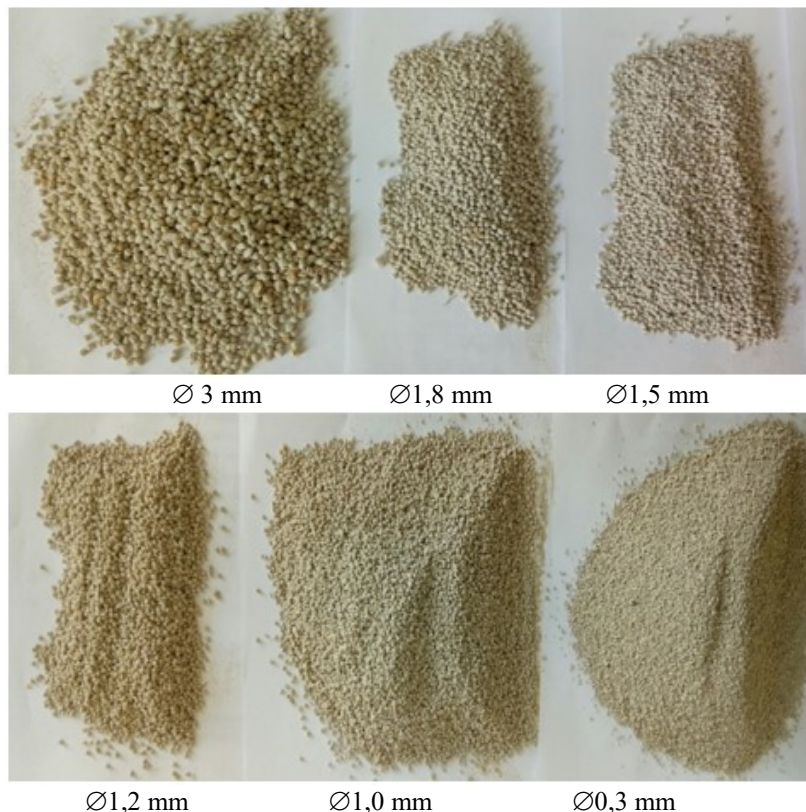


Fig. 3 - CFP pellets obtained by rolling

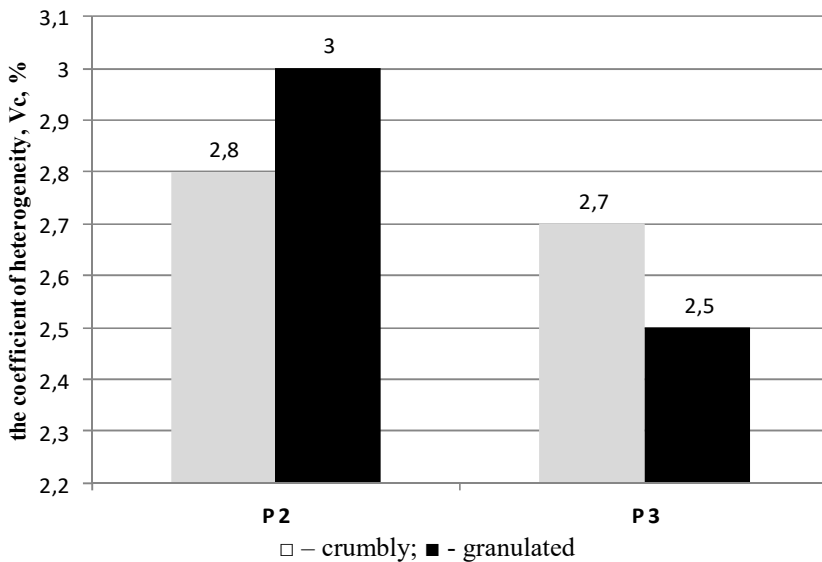


Fig. 4 - Homogeneity of mineral premixes (P) in the content of vitamin B2:
P1 (based on CFP 75:25), P2 (CFP 50:50), P2 (CFP 15:85), the first value corresponds to wheat bran, the second - to limestone flour

The technology provided for the production of CFP by dosing and mixing of components, granulation by the method of pelleting at the following technological modes: d plates = 1,5 m, tilt angle of the plate 55-60 deg., Without heating the plate, the speed of the plate n =

150 revolutions⁻¹, use of binders (2,5 % hydrogen solution of carboxymethylcellulose (CMC)), fractionation of spherical granules by size.

This technology has been tested to produce 1 % of premixes based on CFP. The assessment of the homogeneity of premixes was determined by the content of vitamin B2 in the hydrogen extracts of the test samples. The research results are presented in Figs. 4. The obtained data indicate that the method of curing is advisable to use in the production of mineral premixes on the basis of CFP 3, because it was at the ratio of wheat bran and limestone flour 15:85 was obtained the most homogeneous mixture (the coefficient of variation was the lowest - 2.5%). This technology has been patented in 2019.

In the preparation of CFP for vitamin and complex premixes, it is proposed to use granulation or briquetting technology, with subsequent production of CFP



Fig. 5 - Premix obtained by the following methods:
briquetting (a), granulation (b), cereals (c), rolling (d)

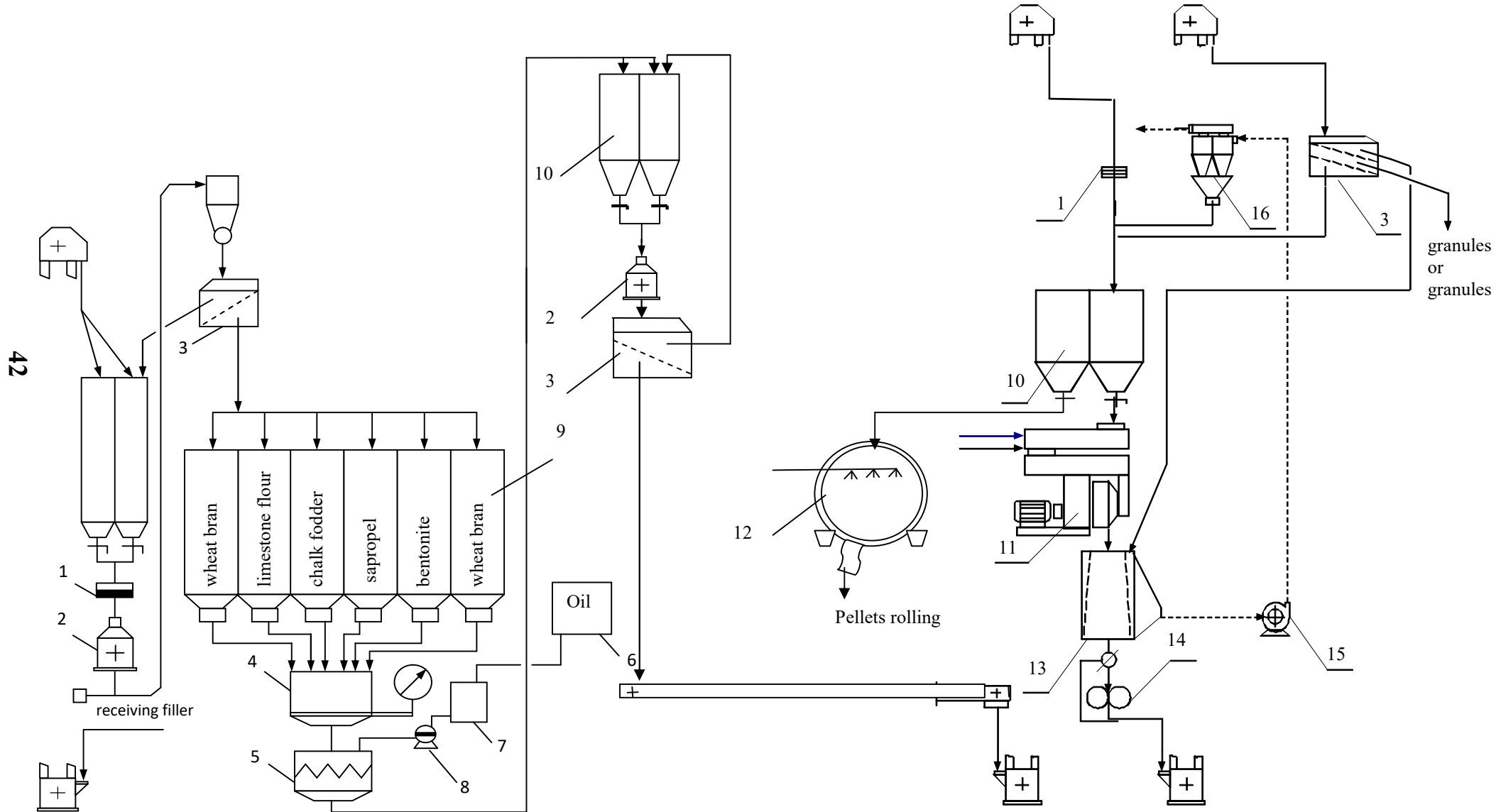


Fig. 6 - CFP production technology:

1 - magnetic separator, 2 - crusher, 3 - screening roller, 4 - weight dispenser, 5 - mixer, 6 - oil container, 7 - filter, 8 - pump dispenser, 9 - over metering bins, 10 - hopper, 11 - press granulator, 12 - plate granulator, 13 - cooling column, 14 - roller shredder, 15 - fan, 16 - filter cyclone



particles corresponding to the feed grain size.

The technology provides for the production of CFP / or premix on its basis by dosing and mixing the components according to the technological scheme (Fig. 6), the subsequent formation in compliance with the respective technological modes:

	granulation	briquetting
mass fraction of moisture, W, %		
diameter of die, Ø, mm	4,7...12,7	19...25
pressure, P, MPa	1-2	1
matrix heating temperature, °C	+ 90...95	+ 80...85
temperature of the pellets at the exit of the press, °C	+ 70	+ 60
CMC binder, %	2...3	2...3

The obtained granules / briquettes of CFP / premix (Fig. 5) after cooling to a temperature not exceeding the ambient temperature of 10 °C, were crushed in a roller shredder, and then sifted on sieves punching PS No. 20-30 with a hole diameter of 2 ... 3 mm and PS No. 10

with a hole diameter of 1 mm, in order to obtain a fraction corresponding to the size of the compound feed.

Such technological techniques in the preparation of CFP and premixes themselves allow to obtain agglomerates of the product with the given sizes, to eliminate delamination and to stabilize the composition of CFP / premix during transportation and storage, which also further provides optimal conditions for its mixing with preparations of BAA / compound feed and preparation products.

Physical properties were investigated for the obtained samples of bulk and molded CFP and premixes. The results are presented in table. 2.

Analyzing these tables. 2 it can be concluded that the physical properties of CFP 1 and CFP 2 most closely approximate the physical properties of the finished compound feed, which, when mixed, will ensure a high uniformity. The best physical properties are characterized by CFP 3 in the form of pellets, since it has the smallest natural slope angles for fractions with a particle size of 1,0... 1,1 mm.

Of particular importance during the industrial testing of technology is the stability of finished products during storage, so at the final stage of industrial testing

Table 2 - Physical properties of CFP and premixes based on them

Components	Moisture content, %	The average particle size, mm	Angle of native slope, deg.	Bulk mass, kg / m ³	Density, kg / cm ³
Fillers					
Wheat bran	12,4	0,73	48	390	1,20
Limestone flour	0,9	0,43	41	1250	1,71
CFP 1 (75/25)	8,5	0,52	47	480	1,30
CFP 2 (50/50)	6,1	0,50	46	620	1,52
CFP 3 (15/85)	2,5	0,45	43	1120	1,65
Scatter premixes					
Premix 1(WB75/LF25)	8,3	0,50	46	520	-
Premix 2(WB50/LF50)	6,2	0,47	45	635	-
Premix 3(WB15/LF85)	2,3	0,42	42	1150	-
Premixes granulated (Ø 7.7 mm), crushed (sieve passage fraction Ø 1.2 mm)					
Premix 1 (pellets)	7,6	0,55	46	680	1,20
Premix 2 (pellets)	7,2	0,50	44	760	1,50
Premixes briquetted (Ø 19 mm), crushed (sieve passage fraction Ø 1,2 mm)					
		d/l, mm			
Premix 1	7,9	0,53	46	675	1,21
Premix 2	7,5	0,49	44	750	1,48
Premix 3	7,0	0,46	43	1100	1,68
Premix 3 (pellets rolling)					
Premix 3 (WB15/LF85)	6,8	0,4	45	1450	1,71
	6,8	1,0	42	1360	1,60
	6,8	1,1	40	1220	1,45
Mixed feed MF1-5 + premix granulated crushed					
MF+P1	12,0	0,55	43	550	1,35
MF+P2	12,0	0,55	43	560	1,41
MF+P3	11,9	0,56	43	575	1,48


Table 3 - The composition of the microflora of premixes before and after storage for 40 days

Sample	Bacteria, CFU / g incl.		Decaying	TBGEC caption, g	Salmonella	S.Aureus	Proteus
	the total number of	E.herbicola					
Wheat bran to storage	2500	650	not found	0.1	not found	not found	not found
after storage	3200	680		> 0.1			
Limestone flour to storage	700	not found	20	> 0.1	not found	not found	not found
after storage	705		22				
0.2% P-5-2 MCLN blend for broilers for storage	200	not found	not found	> 0.1	not found	not found	not found
after storage	200						
P 1 is granular	210	80	not found	> 0.1	not found	not found	not found
	212	82					
P 2 granular	240	60	not found	> 0.1	not found	not found	not found
	240	60					
P 3 briquetted	240	60	not found	> 0.1	not found	not found	not found
	240	60					
P is extruded	305	55	not found	> 0.1	not found	not found	not found

was studied storage efficiency of 1% and highly concentrated premixes produced in accordance with the developed technology of filler formation (Fig. 5).

Premixes made on the basis of 0.2% of aperture and different CFP (samples № 1, 2, 3) were put into storage. Wheat bran (sample No. 4), limestone flour (sample No. 5) and industrially manufactured 0.2% blend P-1-2 MKHLN for laying hens of an industrial herd of breed Hi-Line W-98 (sample No. 6) were selected as controls. The samples were packed in 4-layer paper kraft bags and bags of polyethylene and stored for 40 days under unregulated conditions (at room temperature and unregulated humidity). The sanitary condition of the test specimens was evaluated before storage and during storage every 10 days. The results of the microbiota studies are given in table. 3.

Prior to storage, the microflora of the bran (sample 1) contained saprophytic microflora characteristic of wheat grain [9], which is represented by both spore-forming and non-spore-forming species (decaying bacteria - less than 1 % and grass-stick - 4% of the total number of bacteria. Mold was found only in bran, morphologically related to the genus *Mucor*.

Pathogenic staphylococcus, bacteria of the genus *Salmonella*, *Proteus* and anaerobic microorganisms were not detected in the samples tested.

Within 40 days of storage, the total bacterial count of the bran remained virtually unchanged. Spore-forming bacteria were found only in limestone flour at 20 CFU /

g. Form and yeast circles were not detected in any specimen. Pathogenic *Staphylococcus aureus* and *Salmonella* were not detected in all premix samples.

The reduction of bacterial flora in all specimens of molded premixes is due to non-spore-forming microorganisms and vegetative forms of spore-forming ones, if any before storage, and due to heat treatment during granulation and extrusion.

With respect to the BGEC titer, all prototype premixes are considered to be safe because they did not exceed 0.1 g during the entire storage process. Pathogenic microorganisms were not sown after storage.

Conclusions

As a result of our research, we have improved the technology of preparation of complex filler by forming it in different ways depending on the composition. Such technological techniques in the preparation of CFP allow to obtain agglomerates of the filler with the specified size, eliminate the stratification and stabilize its composition during transportation and storage, which also further provides optimal conditions for its mixing with the preparations of BAA and to obtain a homogeneous premix. The premixes obtained by these technologies are more stable from the point of view of the sanitary condition, and it is also expedient to use them in the production of binary compound feeds and compound feeds of balanced granulometric composition.

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ТЕХНОЛОГІЇ ВИРОБНИЦТВА ФОРМОВАНИХ ПРЕМІКСІВ

Анотація

В матеріалі статті представлено теоретичний аналіз та практичний досвід виробництва преміксів (П) за різними технологіями підготовки наповнювача. Вказані їх переваги та недоліки. Наведена класифікація наповнювачів преміксів для виробництва преміксів.

Теоретично та практично обґрунтовано технологію виробництва комплексного наповнювача преміксів (КНП) у формованому виді. Розглянуті різні способи формування в залежності від складу комплексного наповнювача, а також представлена технологічна схема їх виробництва.

Представлені результати промислової апробації технологій формування (гранулювання, брикетування, окатування, екструдкування) наповнювачів та готових преміксів у виробничих умовах підприємства ТГ «ВБА» «Ізвестьяки». Досліджені фізичні показники формованих комплексних наповнювачів/преміксів, на основі аналізу отриманих даних встановлено, що гранулюванню та брикетуванню можна піддавати КНП, які складаються з 75...50 % висівок пшеничних та 25...50 % вапнякового борошна. Окатуванню – КНП, який складається з 85 % висівок пшеничних та 15 % вапнякової муки. Встановлено оптимальні технологічні режими формування КНП та П різними способами, в результаті яких можна одержувати частинки П, які при подальшому змішуванні з компонентами комбікорму забезпечують високу однорідність готового комбікорму.



Наведені результати вивчення мікробіологічних показників, встановлено, що формування КНП або П зменшує бактеріальну флору та покращує умови при їх зберіганні.

Запропоновані технологічні прийоми підготовки КНП дозволяють усунути розширення та стабілізувати його склад під час транспортування та зберігання. Отримані за даними технологіями П є більш стабільними, їх доцільно застосовувати при виробництві бінарних комбікормів та комбікормів вирівняного гранулометричного складу.

Ключові слова: премікс (П), наповнювач, комплексний наповнювач (КНП), гранула, окатиш, екструдат, крупка, технологія гранулювання, технологічні режими, однорідність, фізичні властивості, мікробіологічні показники.

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