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THE RESEARCHES OF RECEIVING A PELLETED FEED FOR POULTRYBASED ON BINARY COMPOSITIONS

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ABSTRACT

Poultry farming in the Russian Federation is a dynamically and successfully evolving branch of agricultural production at the present stage of national economic development. The question of effective and efficient feeding in aviculture has always been a very acute problem. In the structure of the final cost of products formation feeding stuffs reach 75% according to various estimations. The most expensive in the production of feed mixtures are such protein components of the food ration as fish meal and bone tankage, soy and sunflower meal, protein additives and concentrates. However, as the study shows, the possibilities of such high-protein cultures, as soybean are not fully in use for feed production. Along with soybean and its processed products, it is also possible to use food waste products from the meat and fish industry, in respect that the waste processing of poultry is more than 30% of the bird's carcass weight. These components of the feedstuff are also quite valuable, because they are rich in high-grade protein and able to meet the daily demand of poultry in amino acids. Until now, it has not been paid enough attention to applied researches, related to obtaining binary soy-meat and bone meal, soy-fishbone meal, soy-herb and soy-luminaria feed mixtures. In such combinations, the moisture contained in the raw material is average and, therefore, it is possible, at least twice, to reduce the energy costs for its removal during drying. At the same time, as a result of the analytical review, it was revealed a contradiction between the desire and endeavor of producers to improve the efficiency of poultry production by finding rational methods of preparation, application of modern technologies and improved technical means in the preparation of feed pellets based on binary compositions on the one hand and a known level of scientific knowledge about the laws of obtaining meat-bone, fish-bone or vegetable-grass pastes, the processes of averaging of moisture in the binary compositions and mechanisms of formation of the final product, namely, seals, molding pellets with a low crumbling and their subsequent drying on the other hand. In this connection, studies aimed at improving lines for production of feed products in the form of protein-mineral and protein-vitamin compositions using soy component are relevant and have important economic significance. The presence of this problem is also due to the lack, at modern stage of development, of special equipment and technologies, as well as scientifically-based data for the design and construction. The paper proposes the design of a promising device – a press granulator designed for the preparation of granulated feed for poultry on the basis of soy-meat and bone compositions and the results of experimental studies.

KEYWORDS

Binary soy-meat and bone composition, feeding, poultry, press granulator.

1. INTRODUCTION

The structure of known technological lines for the production of granulated feed mixtures includes, as a rule, storage bins, dispensers, feed component grinders, mixers, devices for pressing and drying of finished products, as well as additional and auxiliary equipment. At the same time, the main machines of such lines are mixers and devices for pressing feed mixtures, producing granules. Mixers are widely used in various sectors of the economy. Their design depends on the physical and mechanical properties of the products to be mixed and methods of feeding components, etc. [1,2].

Depending on the type of mixed products mixers can be designed for the preparation of dry bulk feed, loose wet and liquid feed. As judged by the nature of the process, there are batch and continuous mixers; by the organization of the working process, all mixers are divided into two large groups: with a rotating chamber and with a fixed chamber [2].

It is known that pressing into granules is carried out depending on the

purpose and granulometric composition of feed mixtures. Pellets - are feed components or their mixture pressed to a certain density in cylindrical pieces with a diameter of 10 mm, pre-ground into flour or fine particles which are intended for the subsequent processing or put on storage for a period of more than two months. The required quality of the granules is determined by their density, strength and crumbling, which depends on the moisture content of the material, granulometric or fractional composition, temperature and pressing pressure [3-5].

Development of feed preparation technologies is reflected in the works of Russian and foreign scientists [1,6-10]. In the works where the studies of physical and mechanical properties of fish, meat and bone raw materials as well as structural and mechanical properties of poultry slaughtering waste were carried out [3, 11-14].

Beside the use of traditional methods in the field of slaughtering waste processing, specialized organizations have recently conducted quite a large number of development justifying the rationality of

implementation the extruders and methods for enzymatic processing in applied technology. According to the analysis of the conducted studies, all of them are unacceptable for obtaining granules from a mixture of soy components and meat and bone or fish paste, as well as from sea cabbage or herbal raw materials.

In this regard, one of the main tasks of the proposed research is to justify the parameters of the mixer-granulator, designed to produce granules from a wet ($W=35,0-37\%$) mixture of components with a peculiar paste consistency, as well as a number of individual specific properties and indicators. Moreover, the sets of pressing and granulating equipment used in large-scale production are not applicable in small farms and peasant farms due to the high cost, capacity and energy intensity.

2. MATERIAL AND METHODS

Production experiments have established that it is possible to reduce the amount of energy consumption when performing work on obtaining granular feed based on soy-meat and bone compositions by using a promising, having scientific novelty device - a press granulator (PG), which received the patent of the Russian Federation on intellectual property [15,16]. The design scheme of the proposed device is shown in figure 1.

The proposed device works as follows: feed components coming through the hopper 1 into the cavity of the conical body are processed being mixed with a screw 2. In this case, the screw 2 as if "runs around" along the walls of the conical body.

After the mixer, the composition enters the press granulator 5, through the loading hopper 3, where it is further mixed to a homogeneous mixture and humidity, and then passing through the compression node (CN) 6 and the forming grid 7 at the output, we obtain formed granules with a moisture content of 35 - 40%.

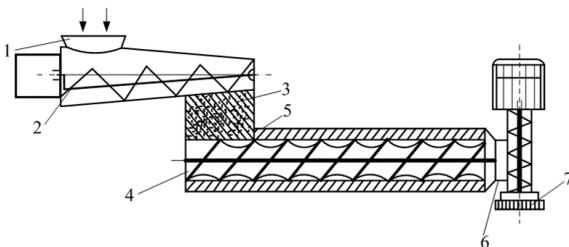


Figure 1: diagram of the press-granulator: 1-feed hopper of a screw mixer-equalization of moisture; 2-screw mixer-equalization of moisture; 3-hopper GHG; 4-screw PG; 5-the case of PG; 6-compression node PG; 7-forming grid

This device allows you to average the humidity of the incoming components and makes it possible to reduce the energy consumption for evaporation of moisture from the binary composition. According to the scheme of joint operation of the subsystem in the form of a mixer-averager and a press granulator (figure 1), the soy component, with an initial moisture content of 8-10%, in parallel with the paste-like component, which has a moisture content of 60-80%, is served in a certain ratio mixer-averager, and then to the PG loading device.

In the process of moving out of the SG chamber binary composition in the form of: "soy flour + meat-bone paste"; due to the diffusion of water molecules, the latter continue to move into the composition of soy flour, increasing its moisture content to an average optimal value in the composition [6,17-19]. Also, when the device is working equalization (averaging) of the obtained feed moisture takes place, which leads to energy savings.

3. RESULTS

Theoretical and experimental research on the use of the proposed device was carried out in the Far East State Agrarian University, Amur region, Blagoveshchensk, Russian Federation, and also in the actual production conditions of small farms and businesses [20]. For the production studies we have made of the experimental equipment and implemented it in the

production of soy-meat and bone meal granules. The equipment was arranged in a certain sequence, according to the developed technological scheme.

When carrying out laboratory experimental studies, we used the technological equipment, in which there was a possibility of variation by the studied factors within the required limits. We also used raw materials: soy and meat and bone raw materials. In the course of experimental studies, the physical and mechanical properties of raw materials were determined. As a result of research to determine the impact of design and technological parameters of the press granulator (angular velocity of the screw press unit (ω_{pu} , s^{-1})), the angular velocity of the screw granulating unit (ω_{gu} , s^{-1})), the length of the forming channel matrix grid granulomatous unit (ℓ_k , mm) of the proposed screw press granulator is the density of moist granules (ρ_{cn} , kg/m^3) we obtained the following results presented graphically in figure 2.

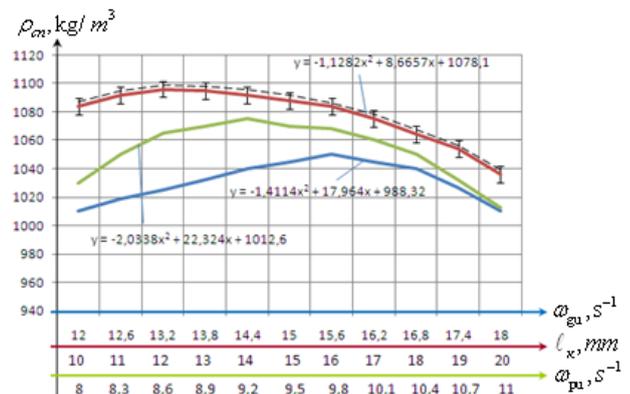


Figure 2: dependence of the density of moist granules from the design parameters for press-granulating unit (PGU)

- dependence $\rho_{cn} = f(\omega_{pu})$ when $\ell_k = 13.2$ mm
- dependence $\rho_{cn} = f(\ell_k)$ when $\omega_{gu} = 16,2$ (s^{-1})
- dependence $\rho_{cn} = f(\omega_{gu})$ when $\omega_{pu} = 7,0$ (s^{-1})
- theoretical dependence

Studies have shown (figure 2) the value of the density of moist pellets depends on the constructive-technological parameters:

- at the speed of rotation of the screw of the pressing unit (ω_{pu}) from 8 to 11 s^{-1} , the density of wet granules decreases from 1030 to 1010 kg/m^3 ;
- at the speed of the screw of the granulating unit (ω_{gu}) from 12 to 18 s^{-1} , the density of wet granules is 1010 kg/m^3 ;
- with the length of the channel of the matrix grating GU (ℓ_k), from 10 to 20 mm, the density of wet granules will decrease from 1085 to 1035 kg/m^3 .

It is known that the efficiency of any process largely depends on the energy intensity. The studies were conducted to determine the energy intensity of wet granules, the results of which are graphically shown in figure 3.

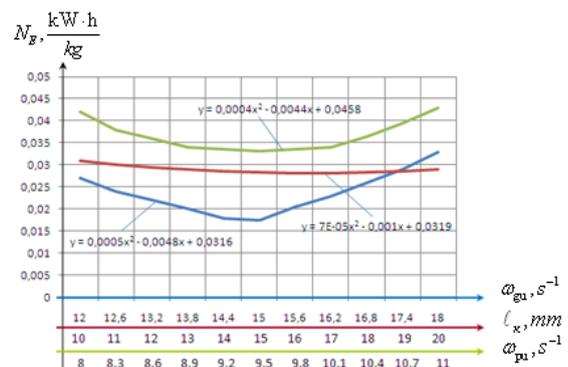


Figure 3: Experimental dependences of wet granule production energy intensity (N_g) on the design parameters of PGU

- dependence $N_E = f(\omega_{pu})$ when $\ell_k = 12,4 \text{ mm}$
- dependence $N_E = f(\ell_k)$ when $\omega_{gu} = 16,1 \text{ s}^{-1}$
- dependence $N_E = f(\omega_{gu})$ when $\omega_{pu} = 9,6 \text{ s}^{-1}$

4. DISCUSSION AND CONCLUSION

The results obtained by the experimental method allow us to conclude that the use of the proposed device - a press granulator allows to obtain granulated feed with a density of granules that meet zootechnical requirements. Taking into account certain design and technological parameters, the lowest energy intensity of the granulation process is achieved when:

- the speed of the screw pressing unit is changed from 8.9 to 10.1 s^{-1} ;
- the speed screw granulating node is changed between 12.6 to 16.8 s^{-1} ;
- the channel length of the forming grid of the matrix GU is changed from 13 to 20 mm.

Studies have shown that the proposed press granulator with reasonable design and technological parameters allows to obtain wet granules of binary compositions with the lowest energy consumption. These experiments within the confidence interval correspond to the results of theoretical studies, which indicates their reliability. In comparison with previous studies on this subject, the recommended device is the least energy - consuming, labor-and metal-intensive, which undoubtedly highlights the proposed technical solutions, forming a new conceptual line in the environment of applied science, in particular, devoted to the research of interaction in the field of knowledge "man-machine-nature". It is experimentally confirmed that the proposed device is a highly efficient design that implements original ideas and non-standard solutions. The proposed materials have been tested and successfully used in the production technologies used in LLC "Amur broiler", LLC "Amuragrocenter", LLC "Agrosev" and in a number of other leading agricultural enterprises of the Amur region, whose positive reviews confirm the effectiveness of both theoretical studies and their implementation in the agricultural industry.

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