

UDC 631.363

## IMPROVING THE QUALITY AND SAFETY OF FEED THROUGH THE USE OF EXTRUSION TECHNOLOGIES

**Obodovych O. M.***Doctor of science, professor*  
ORCID: 0000-0001-7213-3118**Tselen B. Ya.***PhD, Senior researcher*  
ORCID: 0000-0001-5213-0219**Nedbailo A. Ye.***PhD*  
ORCID: 0000-0002-8590-5823**Gozhenko L.P.***PhD*  
ORCID: 0000-0002-8999-1917**Radchenko N.L.***PhD, Senior researcher*  
ORCID: 0000-0002-5315-1609*Institute of Engineering Thermophysics of NAS of Ukraine,  
Kyiv, Marii Kapnist 2a, 03057*

**Abstract.** *The paper investigates the need to increase the productivity and energy efficiency of feed production technologies. Based on the analyzed sources, the priority of extrusion technologies development is determined. The authors propose to increase the efficiency of extruders by expanding the range of products. That is, not only bulk feeds, but also of pasty mixture and liquid feed using two or more components. The advantage of the proposed solution is minimal modernization, capital investment and the involvement of additional service personnel. This is achieved by processing the grain component in the extruder and then mixing it with other components using extrusion heat. This heat is accumulated in the extrudate particles during extrusion and is used to decontaminate and mix the entire mixture. The effectiveness of the proposed solution is analyzed by controlling qualitative indicators. They include determination of the composition of the main limiting amino acids; trypsin reduction level; microbiological indicators; moisture content and forms of its bonding. The study conducted on the example of soybean processing using the following methodological approaches. The results proved the effectiveness of the proposed mixing method for all studied parameters. In the future, the proposed approach can be recommended for use in technologies for the production of pasty and liquid mixtures for various purposes and compositions.*

**Key words:** *extruder, soybean, extrudate, mixing, feed mixture.*

### **Introduction.**

Creating energy-efficient grain processing technologies for the needs of the feed industry is always a topical issue. Extrusion technologies meet these requirements. They are simple, compact and allow processing a wide range of raw materials and producing extrudates for various purposes [1, 2]. However, feed products are often multi-component mixtures. They include components of different properties and nature. All this greatly complicates the organization of the next stage - the mixing process. It affects the quality of the final feed product. That is, it determines nutritional value, microbiological index and storage. Having studied the state of this problem, the authors consider the possibility of increasing the efficiency of the operating extruder. This is achieved by expanding the scope of its application. That is, it is proposed to

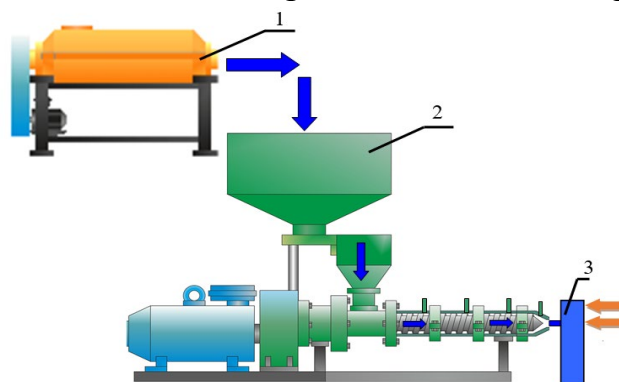
produce not only dry feed, but also liquid feed. To do this, after processing the grain component in the extruder, it is planned to mix it with liquid components using the heat of extrusion. This heat is concentrated in the extrudate particles during processing and released at the outlet to sterilize the components.

To justify the feasibility of using the proposed approach, **the task** was to study the mechanism of influence of extrusion heat on the quality indicators of the resulting mixture. They include an analysis of the composition of limiting amino acids in feeds used in the diets of young animals. These include lysine, methionine, cystine and threonine. The tasks also include determining the level of trypsin reduction in the extrudate; disinfection efficiency in terms of microbiological indicators and moisture content and its forms of bonding.

**Methods and object of research.** The study is conducted on the example of soybean processing. Today, it is the protein base of most feed mixtures.

The experimental part of the study carried out on the following experimental equipment Fig.1. It included: grain moisturizer 1 to achieve the recommended [1] soybean moisture content before processing, extruder 2, in which the soybeans were crushed and heat-treated, and a specially designed device for mixing 3 with other components.

Before the experiment, soybeans were pre-moistened from 7 % to 13 % in a humidifier 1. Mixing of the extrudate with the liquid component with water carried out at a temperature of hot extrudate particles at the outlet of the extruder of 140°C without contact with the medium. The water temperature before mixing was 20°C.



**Figure 1 - Schematic diagram of the experimental stand**

*1 – grain moistening device; 2 – extruder; 3 – device for mixing extrudate with liquid components*

The samples were analyzed using standardized methods. In particular, determination of the amount of amino acids, trypsin and microbiological parameters. Determination of the amount of moisture and forms of bonding in the samples carried out by low-temperature scanning calorimetry.

**Discussion of the results.** The data on the composition of the main limiting amino acids in feeds used in the diets of young animals were obtained. These include lysine, methionine, cystine and threonine. The results showed a quantitative increase in threonine by 10.0 %, lysine by 8.2 %, and methionine by 7.3 % in the paste compared to soybeans before treatment. In addition, a quantitative increase in aspartic acid by 9 % and a 4 % increase in the amount of cystine in the paste were found.

The obtained data on trypsin content showed that the level of reduction of its activity in the extrudate reached 94.8 %, and in the paste mixture 94.6 %.

Evaluation of the effectiveness of the mixture disinfection after mixing proves the effectiveness of the proposed method. This is evidenced by the insignificant dynamics of microflora growth. It increased from 2 CFU to 14 CFU within 30 days of sample storage. The results showed the absence of enteropathogenic strains of *E. coli*, toxin-producing anaerobes and salmonellae in all the samples tested, which indicates that all components of the mixture have been sterilized.

As a result of experimental studies, data on the distribution of moisture and forms of its bonding in samples of liquid feed were obtained. It was found that when the moisture content in the mixture was from 45 to 60 %, the amount of moisture that froze was on average 70 %. Such water is considered free and can directly affect the course of biochemical and chemical reactions. It can also affect the development of microflora during storage. The amount of bound moisture was 30 %, i.e., water that did not freeze. It is associated water that is bound to the components of the product, in particular, proteins, fats and carbohydrates, through chemical and physical bonds. The data obtained showed the distribution of moisture in the feed product, which became the minimum necessary for the vital activity of microorganisms and ensured stability during storage for at least 30 days.

#### **Summary and conclusions.**

Have been considered the mechanism of influence of extrusion heat used for mixing and sterilization on the quality characteristics of the resulting paste mixture. Were received the results proved the effectiveness of the proposed mixing method, which can be further recommended in the technologies of production of pasty and liquid mixtures for various purposes and composition.

#### **References:**

1. Ivanytskyi H., Tselen B., Nedbailo A., Radchenko N. Vplyv ekstruziinoi obrobky na stan zhyriv kormovykh sumishei // Scientific works, 2023. - No 1(87). - P. 28-35. <https://doi.org/10.15673/swonaft.v87i1.2687> [In Ukrainian]
2. Sichkar V. Vykorystannia ekstrudovanoi ta povnozhyrovoyi soi v hodivli silskohospodarskykh tvaryn i ptytsi // Propozytsiia. 2008. URL: <https://propozitsiya.com/ua/vikoristannya-ekstrudovanoyi-ta-povnozhyrovoyi-soyi-v-godivli-silskogospodarskih-tvarin-i-ptici>

Article sent: 27.11.2024 p.

© Obodovych O. M., Tselen B.Ya., Nedbailo A. Ye.,  
Gozhenko L.P., Radchenko N.L.