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RESEARCHES ON DRY EXTRUSION PROCESSING OF SOYBEAN SEEDS FOR THEIR SUPERIOR CAPITALIZATION IN ANIMAL FEED

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Abstract: *The extrusion technology is one of the perspective and efficiency processes, combining hydrothermal and mechanical processing of raw material (soybeans seeds), allowing obtaining new-generation products and components with predetermined properties, with a new structure called instant products, which are successfully used in animals fodder ration. The paper presents the installation for soybean seeds superior capitalization IVSS (consisting of screw conveyor, supply system, extruder, cooling system, mobile belt conveyor and a unit for command and control) and the experimental research in the establishment of its optimal operating parameters. In conclusion, this installation for soybean seeds superior capitalization using seeds dry extrusion as processing method ensures: reduction of raw material processing losses on food chain, realization of complex fodder receipts, obtaining food products ready for consumption or creating components for them, having high thickening and water and fat retention capacity with increase assimilability and reduction of products microbiological contamination. Taking into consideration all these aspects, this project tries to transform typical farmer in professional livestock farmer*.

Keywords*: Dry extrusion, soybean seeds, animal feed*

1. Introduction

The quality of mixed fodder significantly influences the quality of animal products obtained. From this point of view, fodder producers and farmers worldwide are facing serious problems with food security, ensuring comfort for animals and the environment protection.
In our country too, it is noted that more and more livestock breeders are interested in providing a full-value food to farm animals, which includes rich fodder receipts that lead to increased milk and meat production.
By its amino acid content, soybean completes together with cereals the ration of these animals, which leads to the production of mixed fodder, balanced in terms of essential amino acids and makes possible to achieve performance and economic potential of the respective animals. [2, 3]
Progresses in livestock field have shown that fodder rations containing soybean may be supplemented with vitamins eliminating the need for adding animal protein in the ration. Soy grit is also an important protein component in animals fodder ration, especially for pigs. [1, 2]
Taking into account that raw materials to satisfy nutritional needs are necessary, one must consider the processing method used to obtain these ingredients, which can influence the animal's performances. Most commonly used is the heat treatment of soybeans. Taking into consideration that the anti-nutritional factors, in most cases, are proteins, the processing method can adversely affect soybean proteins. Therefore, it is important to obtain a product rich in nutrients (energy and usable proteins) and free of anti-nutritional factors.
Worldwide, there is a growing concern to produce fodder processing machines and installations flexible, with the highest yields possible, low specific energy consumption to allow livestock breeders produce their own fodder for their animals feed at low costs, fresh and in sufficient quantities [4, 5, 6].

Taking into account the importance of knowing extrusion processing of soybean seeds, this paper presents the extrusion technology to obtain feed ingredients, used by the installation for soybean seeds superior capitalization – IVSS, produced by INMA Bucharest.

2. Materials and methods

The installation for soybean seeds superior capitalization – IVSS (figure 1) with a productive capacity of 150÷200kg/h was designed as a support of farmers who want to approach a strategy on: choosing fodder recipes depending on the animals in the farm, using own fodder and not only, the technical base necessary to the farm, and in the same time they will meet the requirements according to which agriculture no longer serves only to produce wheat, corn, milk and other agricultural products, but it also provides environment conservation and product consumers food safety.

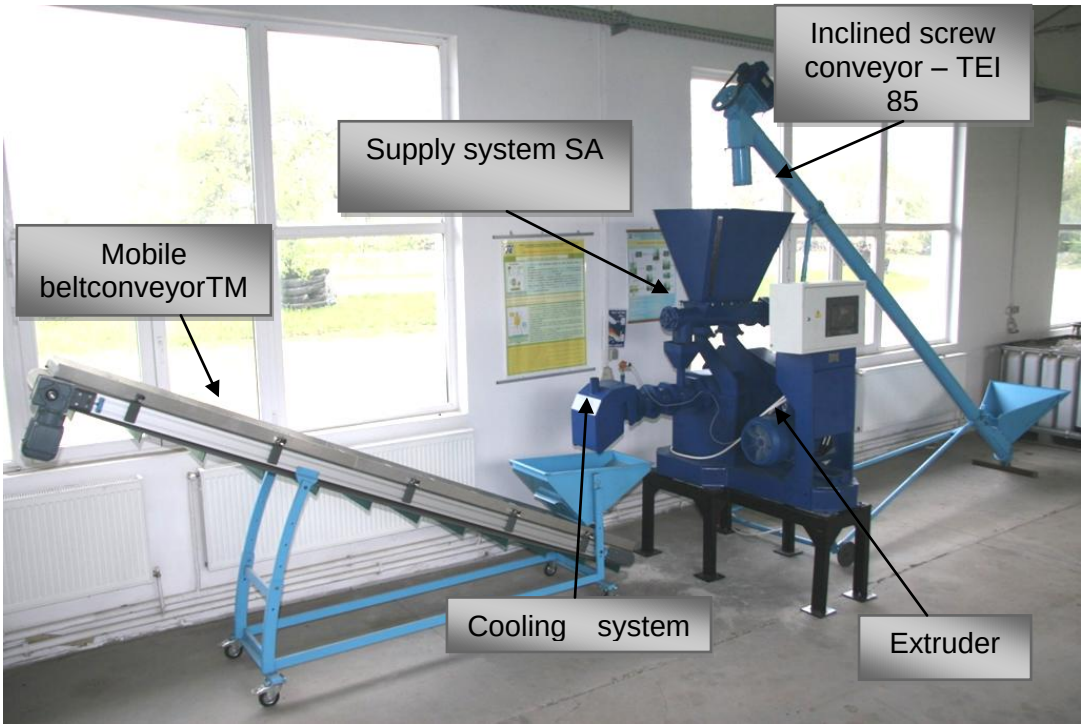

Fig. 1. Installation for soybean seeds superior capitalization – IVSS;

a) b)

Fig. 2. Material images (soybean seeds) at the installation inlet and outlet (final product “full fat soybean”)
a- Soybean seeds before processing; b- Final product “Full fat soybean”

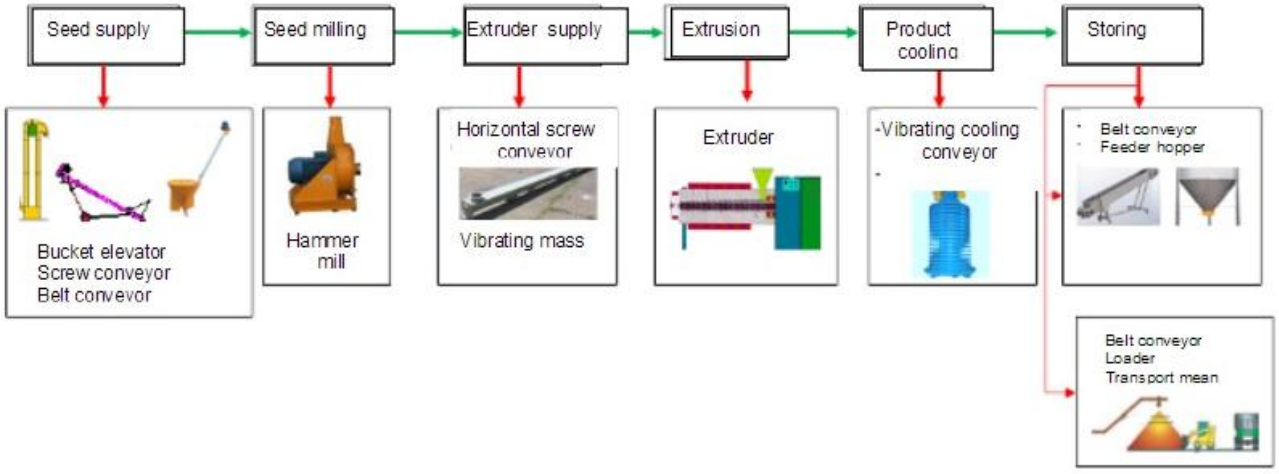

Fig. 3. Technological flow scheme of soybean seeds extrusion processing

During the extrusion process, the product can reach temperatures of approx. 140-150°C. As a result of the combination of temperature and pressure is ensured the distortion of anti-nutritional factors, oxidative enzymes and the release of oil from the cells by breaking the cell walls.
The main function of the extruder, besides transport, is to create a certain pressure necessary for the processed material to pass through the die orifice. The basic components that contribute to achieving this function are: the screw, the extrusion barrel and the die (Fig. 4).

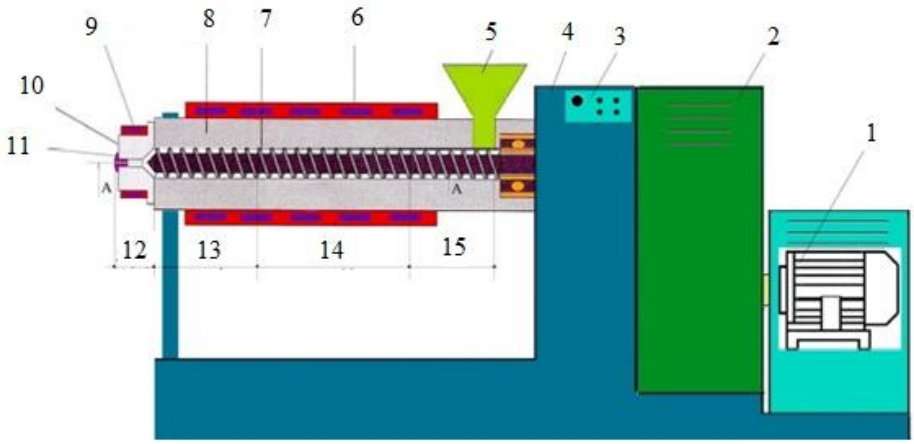

Fig. 4. Extruder scheme
1 - electric motor; 2- mechanical transmission; 3 - control panel; 4- frame; 5- supply hopper; 6- heating-cooling system for barrel; 7- screw; 8- barrel; 9- heating-cooling system for die; 10- die; 11- nozzle; 12- die section; 13- pressure section; 14- transition section; 15- feed section

The screw (7), beside the function of conveying the material from the supply hopper to the die entrance, influences, by its geometry, the mixing, shearing, the amount of mechanical energy dissipated in the heat and the pressure developed before the die.
According to the technological flow scheme in Figure 3, the product was introduced as a seed mass into the hopper of the inclined conveyor which transported it with the screw and discharged it into the feed system. From here, the seeds were dosed by a horizontal screw and discharged into the extruder feed funnel. The screw, the extruder main working element, picked up the raw material from the feed hopper, transported, processed and forced it to pass through the die hole at its end. The resulting expanded soybean was taken over by a belt conveyor and evacuated into storage hoppers.

The experimental researches were carried out at INMA Bucharest, both under laboratory and operating conditions. In the experimentation, we used soybean seeds, purchased from the cereal and industrial plants market, which underwent laboratory determinations on the physical characteristics that influence the extrusion process. For each sample we determined: product humidity, hectolitre mass, physical purity of different types of impurities removed, as shown in Table 1. In the case of soybean seeds used in the experiments, it was necessary to use the water for wetting the seeds as according to Table 1 the humidity was below 8%.

Table 1: Determinations of soybean seeds characteristics

No.	Characteristic	Parameter value		
		Sample 1	**Sample 2**	**Sample 3***
1	Humidity, %	7.35	6.89	8.94
2	Hectolitre mass, kg/hl	69.53	69.14	61.96
3	Purity, %	99.49	98.85	86.52
4	Impurities: -oleaginous, % -non-oleaginous, %	 0.22 0.29	 0.68 0.47	 13.48 (total impurities)

*unconditioned seeds

The tests of the installation amounted to 115 hours of operation and were carried out in accordance with the specific procedures [2], using the following measuring devices: electronic balance and hectolitre balance, electronic humidometer, temperature transducer, tachometer and phase and frequency analyser (for the determination of the energy indices). At the same time, the proper functioning of the equipment and the measuring devices was checked and were measured the environmental conditions (ambient temperature and relative humidity) in which they were used.

Final product parameters were calculated using the following relations [7, 8]:

- *The expansion degree* characterized by:
  - final product *density*;
  - *apparent specific volume*

$$V_s = \frac{4}{\pi D_e L_{se}} \quad (1)$$

where*:*

D_e–outer diameter of expanded product;
L_{se} - specific average length (for 1g of extruded product).

- *Expansion index* characterized by:
  - *transverse expansion index (IET)*

$$IET = (D_e/D_m)^2 \quad (2)$$

where:

D_e– outer diameter of extruded product;
D_m – diameter of die hole

Table 2: Final product parameters

No.	Parameter	Parameter value		
		Sample 1	**Sample 2**	**Sample 3**
1	Outer diameter of expanded product, D_e [mm]	9.5	9.2	8.8
2	Specific average length (for 1g of extruded product), L_{se} [mm/g]	26.49	25.49	26.17
3	Apparent specific volume, V_S [g/mm^2]	$5.5x10^{-3}$	$5.43x10^{-3}$	$5.53x10^{-3}$
4	Diameter of die hole, D_m [mm]	7.8	7.8	7.8
5	Transverse expansion index, IET	1.48	1.39	1.27

3. Conclusions

The extrusion technology is one of the perspective and high efficiency processes that combine the hydrothermal and mechanical processing of raw material - soybean seeds, enabling new generation products and components with predefined properties, with a new structure: instant products.
In the case of soybean seeds processing by extrusion compared to traditional technologies, there are several advantages:

- products ready for consumption or components, which have a high water and fat retention capacity, are obtained;
- the degree of assimilation of raw material and use is higher;
- the degree of raw material microbial contamination and neutralization of the thermolabile anti-nutritive components is reduced.

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