BENEFITS OF USING ADDITIVES FOR IMPROVING THE QUALITY OF PELLETIZED ANIMAL FEED

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ABSTRACT

The animal husbandry sector is one of the largest in the world. In order to maintain the same effectives of animals throughout the year, the necessary feed needs to be ensured. Due to the fact that the animal feed is seasonal, is important to find ways to preserve the fodder to be used all year. One of the best ways to preserve fodder is to pelletize it. The paper presents a series of researches on the benefits of using additives in animal feed pellets, improving a series of quality attributes, such as overall aspect, durability, single pellet and bulk density.

INTRODUCTION

Intensive population growth in the last decades has automatically led to an extensive increase in food consumption. One of the sectors that has registered an extensive growth is the zootechnical sector, which had to meet the constantly growing food requests from human populations.

One of the problems of the animal husbandry sector is represented by the seasonal sector of the fodder needed to maintain animals. Fodder is available in large quantities between the months of May and October, followed by a period of scarcity between November and April. The biggest problem is caused by green fodder, which have very low bulk density (less than 100 kg/m^3), they require very large storage spaces, are hard to handle and produce large dust quantities.

These aspects have led to the arise of the necessity to find new ways to meet the animal food demands and to solve the logistic and quality problems on their entire storage duration. Thus, attention was mainly directed towards fodder compaction. This operation helps to maintain homogeneity and to store fodder in better conditions. Also, through compaction, nutritive substances and biostimulators contained by fodder are better kept. In the same time, the conservation period of fodder is prolonged and the handling, transport and storage operations are facilitated, considerably reducing the space they occupy [1-5].

Fodder compaction is beneficial because: the air between particles is eliminated and a protective outer surface is created thus significantly reducing the problems caused by vitamins degrading due to oxygen, moisture, heat, light and fats becoming rancid [2].

According to numerous research studies such as [6-8], the use of binders, additives or the introduction of another type of biomass materials can cause an increase in the kinetic durability of the pellets obtained, a reduction of power consumption during the pelleting process and a series of changes in the energy value, ash content of pellets, etc.

This paper follows a series of experiments and analysis conducted for obtaining animal feed in the form of pellets, for improving their quality.

MATERIAL AND METHOD

For studying the process of obtaining animal feed in the form of pellets, a ring die pelleting machine was used. This is an equipment destined for obtaining pellets that can be used both as biofuels as well as animal feed or bedding. The biomass material is introduced inside the feeding bunker from where it is taken in the interior of the press where it is forced to pass through the die orifices. Pellets are evacuated at the lower part of the equipment, under the die. The equipment is formed of the following main parts: feeding bunker, main engine, ring die, pelleting rollers, command panel.

For conducting the experiments, we used a series of raw materials in the form of agricultural biomass suitable to be used as animal feed, as well as a series of additives for improving the quality of pellets obtained. These materials and the recipes used are presented in table 1.

Table 1

Recipes used for conducting the experiments

Sample no.	Biomass materials	Additives used
1	Wheat straws 100%	-
2	Rapeseed stalks 100%	-
3	Wheat straws 50% + Rapeseed stalks 50%	-
4	Wheat straws 95%	Corn starch 5%
5	Wheat straws 50 % + Rapeseed talks 45%	Corn starch 5%

The experimental researches were conducted within INMA Bucharest, using a pelleting technology destined for obtaining pellets and agri-pellets, comprised of the following equipment: biomass chopper, hammer mill, material homogenizer, inclined transporter, for feeding the material in the press, pellet press.

After achieving the 5 types of animal feed pellets, they were submitted to a series of tests (analysis) of components for determining a series of important quality parameters and to assess the improvements brought by mixing the raw materials and by adding corn starch.

The equipment used for conducting the analysis are presented in table 2.

Table 2

Equipment used for determinations

Equipment / type	**Measure domain / division**
Precision weighing scales /AW 220 M, with self-calibration (Shimadzu - Japan)	0÷200 g / 0.1 mg
Furnace with temperature adjustment / UFE 500 (Memmert - Germany)	0÷260 ºC / 1 ºC
Calorimeter /CAL 2k (DDS Calorimeters - South Africa)	0.001 MJ kg^{-1}
Calcination oven, with P 320 controller (Naberterm-Germany)	0 ÷ 1400 ºC / 10 ºC
Olympus Inverted Microscope CKX53	-

All samples for analysis were prepared according to the specifications in standard SR EN ISO 14780:2017 – Solid biofuels: Sample preparation [12].

Moisture content was determined on a wet basis, according to the method described in standard ISO 18134-1:2015, Solid biofuels - Determination of moisture content - Oven dry method - Part 1: Total moisture - Reference method [9].

Bulk density was determined according to the method described in standard ISO 17828:2015 – Solid biofuels – Determination of bulk density [10].

Single pellet density was calculated by using a pycnometer.

The durability of pellets during handling, transport and storage was determined using a special pellet tester, according to the specifications given in standard SR EN ISO 17831-1:2016 - Solid Biofuels – Determination of mechanical durability of pellets and briquettes – Part 1: Pellets [11].

RESULTS AND DISCUSSIONS

The first thing analysed was the overall aspect of pellets (pellets were visually analysed to determine the state of their surface, the formation of dust, the occurrence of cracks or pellet loosening after existing the die orifice). It was noticed that the mixing of materials and the addition of corn starch was beneficial, as it can be seen in figure 1.

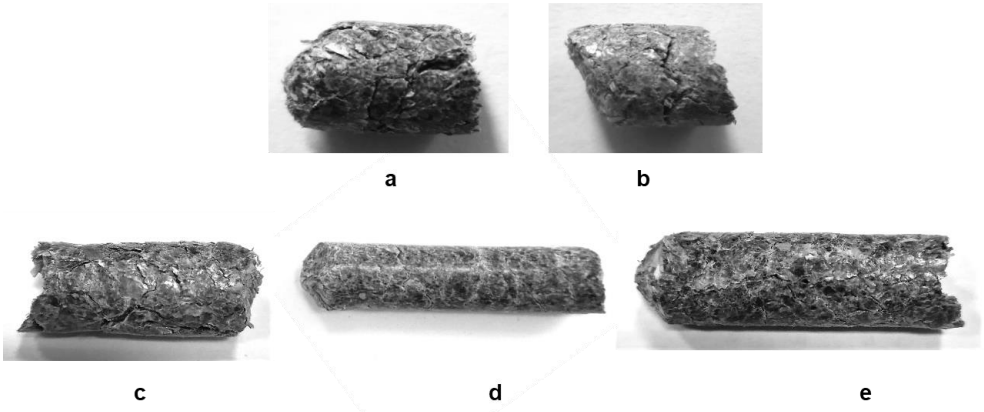

Figure 1 – Pellet samples (a: wheat straws 100%; b: rapeseed straws 100%; c: wheat straws 50% + rapeseed straws 50%; d: wheat straws 95% + corn starch 5%; e: wheat straws 50% + rapeseed 45% + corn starch 5%

From figure 1, it can be noticed that the addition of corn starch had a beneficial effect on the pellets obtained, resulting in better length, less surface cracks and better linked

Based on the methods previously mentioned, after the analysis conducted, the following results were obtained (Table 3):

Table 3

Results obtained from experiments

Sample no.	Moisture content [%]	Bulk density [kg/m^3]	Single pellet density [kg/m^3]	Mechanical durability [%]
1	8.14	546.93	961.85	88.41
2	9.95	498.84	892.07	87.26
3	9.18	521.17	948.29	88.12
4	7.65	624.72	1158.98	93.87
5	7.94	608.46	1104.16	92.28

CONCLUSIONS

Based on the experimental results, the following conclusions can be drawn:

• the visual analysis has shown that by using additives, products are obtained in a more regular form, having less surface cracks, are better bound, indicating better storage and handling attributes.

• the moisture content of pellets registered lower values for pellets obtained using additives indicating that additives are beneficial for decreasing moisture and keeping it in the optimal storage and use.

• bulk and single pellet density registered significant increases for samples obtained using additives in the recipes;

• The use of corn starch determined an increase in durability for both samples.

The experimental researches showed that the use of additives had an overall beneficial effect on animal feed pellet recipes giving a solution for ensuring quality animal feed made from green fodder throughout the entire year, thus overcoming the shortage of quality fodder in winter and spring periods.

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BIBLIOGRAPHY

1. **Abedi A., Dalai A. K.,** 2017 - *Study on the quality of oat hull fuel pellets using bio-additives*, Biomass and Bioenergy 106, pp. 166-175;

2. **Chelemen I.,** 1983, *Zootechnical machines and installations – Part II*, Ed. Polytechnic Institute Bucharest, Faculty of Agricultural Machinery;

3. **Florean R., Bică C. M., Şerban E.** Unit operations, 2008 – *Mixing and agglomeration*, Transylvania University Pub. House, Braşov;

4. **S. Obidzinski, J. Piekut, Dec D.,** 2016 - *The influence of potato pulp content on the properties of pellets from buckwheat hulls*, Renewable Energy 87, pp. 289-297;

5. **D. Lu, L. Tabil, D. Wang, G. Wang**, 2013 - *Manufacturing Wheat Straw Pellet with Wood Waste and Binders*, CSBE/SCGAB 2013 Annual Conference, Univ. of Saskatchewan, Saskatoon;

6. **C. Kirstena, V. Lenza, H.W. Șchröder, J.U. Repke**, 2016 - *Hay pellets - The influence of particle size reduction on their physical – mechanical quality and energy demand during production*, Fuel Processing Technology 148, pp. 163-174;

7. **D. Vukmirović, R. Čolović, S. Rakita, T. Brlek, O. Đuragić, D. Solàoriol**, 2017 - *Importance of feed structure (particle size) and feed form (mash vs. pellets) in pig nutrition – A review*, Animal Feed Science and Technology, Volume 233, pp. 133-144;

8. **M.R. Wu, D.L. Schott, G. Lodewijks**, 2011 - *Physical properties of solid biomass*, Biomass and bioenergy 35, pp. 2093 – 2105.

9. *SR EN ISO 18134-1:2016* - Solid biofuels - Determination of moisture content - Oven dry method - Part 1: Total moisture – Reference method;

10. *SR EN ISO 17828:2016* - Solid biofuels - Determination of bulk density;

11. *SR EN ISO 17831-1:2016*–Solid biofuels–Determination of mechanical durability of pellets and briquettes–Part 1: Pellets.

12. *SR EN ISO 14780:2017* – Solid Biofuels. Sample preparation.