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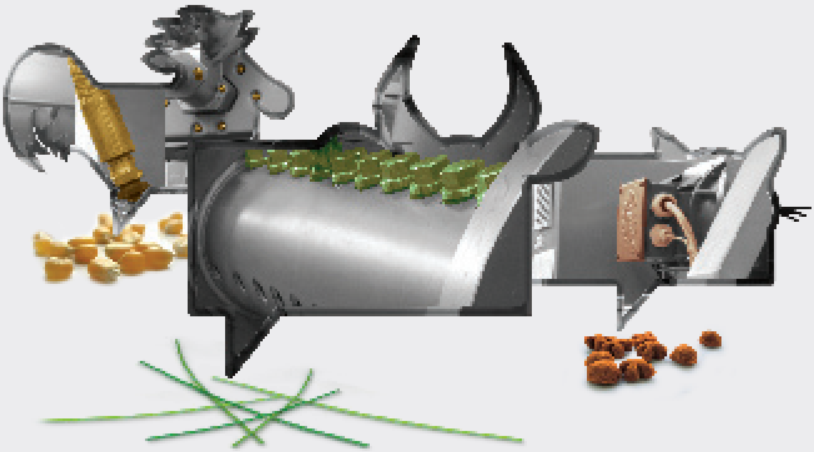

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# CONTENT

# IMPACT OF BENTONITE ON THE QUALITY OF PELLETED FODDER

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## ABSTRACT

Main goal of this research was the investigation of the quality of pelleted complete feed mixtures without addition of the binding substance - bentonite (I) and with the supplement of the same material (II). Bentonite was included in feed mixture during the mixing of components, in the quantity of 2%. Testing of pellet quality was carried out in laboratory through establishing the obliteration index, the hardness of pellets, and thorough the examination of microbiological and mycotoxicological correctness. Lower obliteration index was detect in the feed mixture II wherein bentonite was included (10.7%), while in the feed mixture I, wherein bentonite was not included, it was 14.1%. Higher hardness of pellets was detected in mixture II and it was Khal J/kg, while in mixture I it was lower - exactly 3,7 Khal J/kg. There was a higher total count of bacteria in the mixture I (39.000 per 1 g of sample), while in the mixture II it was multiple lower (5.000 per 1 g of sample). A higher amount of yeasts and molds was detected in the mixture I (30 g per 1 g of sample) and 8 species were identified, while in the mixture II amount of yeasts and molds was slightly lower (10 g per 1 g of sample) and just three fungal species were determined. The quality of pelleted fodder mixture was higher when it contained bentonite as binding substance. When decision about the suitability of binding material must be done, it is important to have in mind some of its additional effects as well as price, origin and some other circumstances.
***Key words:*** animal feed, quality, pelleting, bentonite

## INTRODUCTION

Production of safe food for humans and animals is the most important task for the producers, and this is the reason for increased importance of technological procedures which result in higher quality. One of those procedures is pelleting of feed mixtures. It is additional technological processing of homogenized, finely grounded feed, in order to produce granules, by passing the mixture thorough openings of press. There is a wide range of positive effects of feed mixtures pelleting. Primary, some of those are more important such as decreasing of decomposition, reducing of the number of total microorganisms, increasing of density, decreasing of losses in transport, achieving of possibilities to use some more finely grounded feed, gaining of better traits of feed for various manipulations [4, 1, 12, 5]. Exposure of mixture to influence of steam, pressure and temperature, leads to chemical transformations of nutritive ingredients and consequently to increased digestibility of starch, hemicelluloses and pentosans [14, 15, 6, 8]. The result of increased temperature (70 - 80 $^{0}C$) is degradation of most of anti-nutritive ingredients in feed. As a result of pelleting of feed mixtures, consumption and utilization of food by domestic animals are increased and the consequence is achieving better results in animal production. There is a wide range of binding materials that can be used in order to improve quality of pellets (increasing of hardness, persistence and resistance to obliteration and crumble). The most commonly used binding materials are Ca – lignosulfonate, Na and Ca – bentonite, as well as other organic and inorganic materials [14, 15].

Bentonite is a hydrous aluminum silicate of volcanic origin, consisting mostly of montmorillonite (50-90%). There are different types of bentonites and their names depend on the exchangeable ions, such as sodium bentonite ($Na^+$), potassium bentonite ($K^+$), calcium bentonite ($Ca^+$) and magnesium bentonite ($Mg^+$). The chemical composition of bentonite can be different due to the place of mining, but mostly bentonite contains $SiO_2$, (46-58%), $Al_2O_3$, (12-22%), $K_2O$, (0.20-0.40%), $Na_2O$, (0.04-0.08%), MgO, (1.70-3.50%), CaO, (3.30-5.90%), $Fe_2O_3$, (3.50-4.70%). Burning loss is 12-17%. Bentonite have a high potential to bind liquids (water and oil). The thickness of layers in crystal lattice of bentonite is approximately 1 nm. In the presence of water occurs the separating of those layers, so the water enters in void between them. Separation of layers can reach the distance up to 0.9-2.1 nm. This is the main explanation for the swelling of mineral. In contact with water weight can be increased 1.5 times and volume 1.2 times as well. Cation exchange capacity (CEC) is 80-120 meq / 100 g. Bentonite have very large covering surface (1 g covers 700-800 $m^2$).

Due to amphoteric properties (receives and releases hydrogen ions) bentonite can be used for maintaining of pH of rumen content in cattle nutrition and readjustment of unfavorable effects of low rumen pH value on content of milk fat [2, 9]. Bentonite binds aflatoxins ($B_1$, $B_2$, $G_1$ and $G_2$) in food and reduce presence of aflatoksin $M_1$ residues in milk (up to 60-90%). However, potential of bentonite to adsorb zearalenone and ochratoxin is limited [10]. Inclusion of bentonite in rations of cows effected on reduction of $^{137}Cs$ and $^{134}Cs$ contamination of milk by 50-80%. In rumen content, when concentration of $NH_3$ is high, bentonite can adsorb it, and later releases it when concentration of $NH_3$ drops down. In this mode of action it is possible to achieve better utilization of ammonia for synthesis of microbial proteins. Due to bentonites potential for water binding, and consequently because of increased volume of ingested food, it runs slower thorough digestive organs which leads to extended impact of digestive enzymes and increasing of nutrient matters digestibility. Bentonite can reduce solubility of copper (Cu) in rumen as well as Cu concentration in liver, and this may be usefully for solving the problem of chronic copper poisoning of animals. Disadvantage of bentonite usage is that in addition to binding of some minerals it may have an affinity to bind some vitamins [7].

The goal of research presented in this manuscript was to determine effects of bentonite, as a binding material, on quality of feed mixture pellets (hardness and obliteration index) as well as their microbiological and mycotoxicological correctness.

## MATERIAL AND METHODS

Complete feed mixtures for hen nutrition were produced in Fodder factory „Component“, in town of Ćuprija. The composition of mixtures is presented in *Table 1*.

*Table 1. Composition of mixture for hen nutrition (%)*

| **Component** | **I** | **II** |
|---|---|---|
| Corn grain | 45.9 | 45.9 |
| Soybean meal | 12.5 | 12.5 |
| Limestone | 9.8 | 9.8 |
| Extruded full fat soybean meal | 6 | 6 |
| Sunflower meal | 9.30 | 9.30 |
| Soybean meal, expeller | 5 | 5 |
| Yeast | 1.5 | 1.5 |
| Wheat middlings | 6 | 4 |
| Soybean oil | 1.5 | 1.5 |
| Na bicarbonate | 0.1 | 0.1 |
| Monocalcium phosphate | 1 | 1 |
| Salt | 0.2 | 0.2 |
| Premix | 1 | 1 |
| Methionine | 0.1 | 0.1 |
| Lysine | 0.1 | 0.1 |
| Bentonite | 0 | 2 |
| **Total** | **100.0** | **100.0** |

Applied bentonite is produced by the special technological procedure (isolation of impurities, washing, drying, grinding and milling) in the Institute for Technology of Nuclear and other Mineral Raw Materials in Belgrade. The ingredients of this bentonite were $SiO_2$ (48,37%), $Al_2O_3$ (22,39%), $K_2O$ (0,40%), $Na_2O$ (0,07%), MgO (1,81%), CaO (5,86%), $Fe_2O_3$ (4,73%), and $TiO_2$ (0,34%). Particle size was below 50 µm.
After the production of feed mixtures, samples were taken for microbiological, mycotoxicological and other analysis. Samples were deposited in nylon bags, 20 cm above the floor. They were stored in ventilated, low-lighted and dry room, during the 20 days (October). the average temperature in storage room was $18^oC$. Determination of pellets obliteration index was carried out by methods for pellet quality [3, 19].
**Microbiological investigations** were performed according to *Regulations on maximal quantity of harmful materials and ingredients in fodder* [18]. Total count of bacteria, molds and yeasts as well as identification of pathogenic microorganisms (*E. coli*, coagul. positive *Staphylococcus* spp., *Proteus* spp., *Salmonella* spp., sulphito-reducing *Clostridium* spp.) was done having in mind Official Gazette of SFRJ [16]. Identifications of fungi were performed according to Samson and van Reenen-Hoekstra [12].
**Mycotoxicological investigations.** The presence of aflatoxin B1 (AFL B1) and zearalenone (ZON) was determined according to standard method [17], while

diacetoxyscirpenol (DAS) and T-2 toxin were analyzed by applying the method of Pepeljnjak and Babić [11].

## RESULTS AND DISCUSSION

Due to presence of similar components in feed mixtures the chemical composition in both of them was similar as well (*Table 2*). Somewhat more prominent differences were notable considering the content of Si and Al. The higher contents of those elements in mixture II were consequences of the bentonite presence in mixture (2%).

*Table 2. Chemical composition of feed mixtures (%)*

| **Parameter** | **I** | **II** |
|---|---|---|
| Moisture | 9.59 | 9.37 |
| Crude rrotein | 17.78 | 17.56 |
| Ether extracted fat | 5.32 | 5.20 |
| Crude fiber | 4.55 | 4.35 |
| Ash | 10.07 | 10.72 |
| Si | 0.11 | 1,12 |
| Al | 0.025 | 0.210 |
| Ca | 6.0 | 5.0 |
| P | 0.587 | 0.648 |
| K | 0.865 | 0.895 |
| Na | 0.133 | 0.182 |
| Mg | 0.295 | 0.293 |

Examination of appearance pointed out that more proper shape and smooth surface of pellets in mixture II while in mixture I pellets were shorter and with damaged edges. In research about the feed mixture for calves in which bentonite was included in amount of 1.5%, some similar results were obtained [15]. In our research data about pellets appearance were supported by results about hardness and obliteration index. Lower obliteration index was determined in feed mixture wherein bentonite was included (II) and it was 10.7%, while in the control feed mixture (I) it was 14.1%. Higher hardness of pellets was determined in mixture II (6 Khal J/kg) while in the mixture I it was lower (3.7 Khal J/kg), as it is presented in *Table 3.*

*Table 3. Quality of feed mixture pellets*

| **Parameter** | **I** | **II** |
|---|---|---|
| Obliteration of pellets (%) | 14.1 | 10.7 |
| Hardness of pellets (Khal J/kg) | 3.7 | 6 |

Total number of microorganisms, both bacteria and yeasts and molds, in each of the two samples (*Table 4*) was much lower compared to maximal allowed quantity according to *Regulation about the amounts of harmful matters and other ingredients of feeds for* *domestic animals* **[**18**].** However, significantly lower total number of bacteria was noted in feed mixtures II, wherein bentonite was included, (5,000.00 bacteria /g) compared to 39,000.00 bacteria /g in feed mixtures I

*Table 4. Microbiological quality*

| **Parameter** | **I** | **II** |
|---|---|---|
| Total number of bacteria/g | 39.000 | 5.000 |
| Total number of yeasts and molds/g | 30 | 10 |
| **Identified molds** | | |
| *Alternaria alternata* | + | |
| *Aspergillus candidus* | + | |
| *Aspergillus flavus* | + | |
| *Aspergilus fumigatus* | + | + |
| *Chrysosporium merdarium* | + | |
| *Fusarium verticillioides* | + | + |
| *Mucor mucedo* | + | + |
| *Rhizopus nigricans* | + | |

Considering the total number of yeasts and molds, determined differences were not statistically significant (*Table 4*) except the difference about the number of identified mold species in samples I and II (8 compared with 3). Mostly there were present saprophyte species belonging to so-called field fungi (*A. alternata* and *F. verticillioides*) or storage fungi (*Aspergillus* spp.).
Pathogenic bacteria (*E. coli*, coagul. positive *Staphylococcus* spp., *Proteus* spp., *Salmonella* spp., sulphito-reducing *Clostridium* spp.) were not identified during the present investigation.
Mycotoxicological examinations did not establishe the presence of aflatoxin $B_1$, zearalenone, ochratoxin A and type A trichotecenes (T-2 toxin and diacetoxyscirpenol – DAS). The obtained results are not surprising considering that in samples I and II most of the determined fungal species are mainly not producers of mycotoxins.
Data about the microbiological and mycotoxicological correctness of feed mixtures, suggest high quality and hygienic safety of examined mixtures, certainly due to the excellent quality of applied components and the control of critical points of the process in factory where mixtures were produced as well.

## CONSLUSION

In feed mixture II, wherein binding material (bentonite) was added, quality of pellets was higher compared to the mixture I, that did not contain binding material. Obliteration index of pellets was clearly lower in the feed mixture II, while the hardness of pellets was higher in the same sample. Microbiological and mycotoxicological quality of both examined mixtures was very good, but the total number of microorganisms (bacteria, molds and yeasts) as well as the number of determined fungal species were lower in mixture II, wherein bentonite was added. When decision about the suitability of binding material must be done, it is important to have in mind some of its additional effects as well as composition of mixtures, need to use binding substance, price, origin and some other circumstances.

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