Technology and Technical Support for Rough Feed Treatment for Ecological and Low-Waste Cattle

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Abstract. The article provides a brief analysis of technological solutions for preparing rough feeds for feeding with an emphasis on the existing shortcomings in the implementation of the technological process, taking into account its technical support. There have been proposed and considered two technical and technological schemes for the preparation of rough feeds, the effectiveness of which is aimed at their rational use as a factor of low-waste technology and reducing the influence of a secondary factor when performing the considered technological process. The pollution of the airspace of the livestock building and the skin of animals with dust particles, including small particles of feed and microflora of dry food, can be considered as the very factor affecting the environmental safety of the internal space of the livestock building and indirectly the quality of products (milk). This is confirmed by the presented research results for separate technological operations.

1. Introduction

At livestock facilities the technological process of feeding cattle, the quality of its implementation directly affects the production for main products (milk, meat). At the same time, rough feeds (hay; straw) in livestock rations make up 4 to 20% of the total amount of feeds [1, 2, 3]. It should be noted that such types of rough feeds as hay, straw and straw residues are used as litter in certain livestock management practices (loose housing; deep litter housing system).

Studies and practice have established that digesting rough feeds without pre-treatment increases in cattle’s energy consumption to digest rough feeds, but at the same time there increases in feed loss, while the internal space of the livestock buildings and the livestock skin are contaminated with a certain composition of bacteria and microorganisms. Consumption of rough feeds together with other feed components contributes to the intensity of their digestion, reduction of feed losses and an increase in their nutritional value. At the same time, both with manual and mechanized feed distribution, without pre-treatment there takes place an active dusting and saturation of the airspace of the livestock building with bacteria and microorganisms, and the feed itself can be a source of harmful microflora [4, 5]. Therefore, in order to perform the technological process of feeding cattle, technical and technological low-waste and environmentally friendly solutions should be developed and used partially or comprehensively.

To increase the nutritional value, taste, and feed digestibility, they should be treated. In most cases, feed treatment is carried out in special buildings: feed processing rooms, feed preparation station – in accordance with a multi-operation technology using such basic technological operations as mechanical chopping and heat treatment of feed.

Mechanical chopping is the simplest way of treating rough feeds, which consists in their chopping to 5 ... 10 cm. In the case of using rough feeds as feed mixture, they are chopped up to 2 ... 5 cm. If a feed is used to prepare granules or bales, it should be subjected to finer chopping up to 0.5 ... 3 cm [6, 7].

Heat treatment of such rough feeds as straw can be carried out in two ways: by boiling water steeping, followed by holding for up to 10 hours in closed containers with the addition of salt at the
rate of 150 ... 200 g per 10 liters of water; by steaming for an hour in steaming mixers. After steaming, the straw is cooled and fed warm to the cattle. On the basis of steamed straw, feed mixtures can be prepared [8].

However, heat treatment does not hydrolyze the fiber into simpler compounds. To ensure the hydrolysis of fiber, it is necessary to carry out chemical treatment of the straw, as a result of which the microflora of the animal’s proventriculus is becoming more prepared.

The chemical method for straw treatment is to treat it with caustic soda solutions, ammonia water, lime or soda and salt solution. However, the chemical method of treating rough feeds has significant disadvantages. These include: high power consumption, purchase of expensive equipment for the production of caustic soda, as well as the aggressive effect of the chemicals on the environment.

We propose a more efficient and environmentally friendly technical and technological solution to treat rough feeds using activated media. The technology for treating rough feeds provides for the following technological operations: chopping, supply of the chopped mass into the mixer and introduction of the required amount of catholyte there, feed blending and extracting. At the end of the extracting process, rough feeds are fed in pure form or mixed with other feeds [6].

Treatment of rough feeds is possible, while it should be useful for straw to be treated with activated solutions in loose form or in rolls and bales.

The technical and technological scheme for the treatment of rough feeds using this technology is shown in Figure 1.

![Figure 1. Technical and technological scheme for the treatment of rough feeds:](image)

1 – pipelines for anolyte supply; 2, 4, 6, 9, 19, 21, 25, 26, 30 – valves; 3, 29 – centrifugal pumps; 5 – inlet pipeline; 7 – electric activator; 8, 10, 11 and 12 – recirculated pipes; 13 – cover; 14 – section for anolyte; 15 – compartment wall; 16 – section for catholyte; 17 – activated liquid container; 18 – pipeline for catholyte supply for treating hay or straw in rolls (bales); 20 – a roll of hay (straw); 22, 24 – sprayers; 23 – steaming mixer; 27 – pipeline for catholyte supply to the steaming mixer; 28 – tee

The technological process of treating rough feeds is as follows. Water flowing through the supply pipeline 5 enters the electric activator 7, where, being under the action of a direct electric current, it is divided into anolyte and catholyte, which enter the corresponding sections 14 and 16 through recirculated pipes 8 and 11. After filling up an activated liquid container to the required level, valve 6 closes and the further process of water separation proceeds due to its circulation through pipes 10 and 12. When the anolyte and catholyte reach the required pH level, valves 9 are closed and the activation process stops.

The straw chopped to the size of particles 3 ... 5 cm is supplied into a steaming mixer 23. Catholyte is fed into the chopped mass through sprayers 24 with a pump 29 through pipeline 27. The
prepared mass is mixed for 30 minutes, then it is kept for 3 ... 4 hours and then distributed to the animals in pure form or mixed with other feeds.

In the case of treating hay or straw in rolls (bales), the technological process proceeds as follows. Sprayers 22 are introduced into a roll of straw (hay) from both sides, and the required amount of catholyte is supplied by pump 29 through pipeline 17. After that the moistened feeds are chopped to a target size and fed to the animals.

Anolyte can be used for disinfection and cleaning of premises and equipment.

2. Results and discussion

Within the technology, studies were carried out on the effect of catholyte on the nutritional value of rough feeds (hay, straw). The research results are presented in Figures 2; 3; 4; 5.

![Figure 2](image2.png)

**Figure 2.** Dependence of crude fat content on the time of feed treatment with catholyte

Studies have shown that with an increase in the treatment time of hay with catholyte with pH value of 10.44 for 4 to 6 hours, a sharp decrease in the content of crude fat occurs, while the content of crude fat in the straw remains unchanged, and there is a slight increase with a treatment time increase up to 4 to 6 hours.

![Figure 3](image3.png)

**Figure 3.** Dependence of crude protein content on the time of feed treatment with catholyte
Studies have shown that the content of crude protein in hay and straw increases within 2 to 4 hours, after that there happens a slight decrease.

![Figure 4. Dependence of ash content on the time of feed treatment with catholyte](image)

Studies have established that with an increase in the time of hay treatment with catholyte to 4 hours, the ash content decreases, and with a further increase in the treatment time to 6 hours, the ash content increases.

When the straw is treated with catholyte, ash content decreases during the first 2 hours. In the future, the indicator changes slightly.

![Figure 5. Dependence of phosphorus content on the time of feed treatment with catholyte](image)

Studies have shown that the treatment of hay and straw with catholyte with a pH value of 10.44 has insignificant changes in the phosphorus content. When the catholyte exposure time is 4 hours, the phosphorus content decreases, and a further increase in the time of feed treatment up to 6 hours leads to an increase in the phosphorus content in hay and straw.

There is a well-known technology for treating rough feeds. It is implemented in accordance with a simplified scheme by moistening the feed with water or water with additives. According to this technology, before feeding rough feeds, they are moistened with clean water or salt solutions, pulp,
stillage, feed treacle. When chopped straw is moistened with clean water, the recommended water consumption equals to 1.0...1.5 liters per 1 kg of feed. For using salted water, it is recommended to prepare a solution at 80...100 liters of water for 1.5...2.0 kg of salt. The water temperature during moistening is recommended between 20...30 °C.

However, applying all methods of keeping cattle and treatment technologies for rough feeds, along with improving the quality of the feeding process for rough feeds, an important factor is the reduction of dustiness and bacterial contamination of the premises and the skin of animals. Dry feeds, both in their natural state and after chopping, are a source of microflora both in the the airspace of the livestock building and the skin of the animals, and it subsequently affects milk on dairy farms. Along with this, the water temperature ranging between 20...30 °C does not allow to reduce in the energy consumption to let animals chew and digest feeds, while the hydrogen index (pH) of such water does not allow to reduce the bacterial contamination of the skin of animals, the airspace of the livestock building and its environmental safety. Therefore, we propose a technology for treating rough feeds with water with different parameters of the hydrogen index (pH) which is considered as a temperature-controlled regime of the agent for treating feeds and the skin of animals. The technology provides for the following technological operations: water reserve; its heating with separation into fractions (alkaline and acidic); its transportation to the places of use (troughs, stationary or mobile feeders, stalls or boxes); treatment of rough feeds and skin of animals [9, 10, 11].

The implementation of this technology provides for the presence of a system of technical and technological support (Figure 6).

![Figure 6. A variant of the technological scheme for treating rough feeds and the skin of animals:](image)

1 – multi-sectional storage tank; 2 – inlet pipeline; 3, 5, 7, 10, 12, 18, 20, 21, 23, 27, 31, 34 – valve; 4 – valve-float mechanism; 6 – section for drinking water; 11 – vacuum duct; 13 – distribution pipeline; 14, 17 – pipelines for activated water supply; 19 – pipeline for water supply to the heat-generating device; 22 – distribution process pipeline; 24, 28, 32 – takeoff process pipeline; 25, 29, 33 – spraying devices; 26 – stationary feeder; 30 – mobile feeder; 35 – pipeline for water supply to the automatic drinking system

The basic element of the system for the implementation of the proposed technology is a heat-generating device – an electric heater, which provides both heating of the thermal agent and its separation according to the hydrogen index.
The research results of the working process of a heat-generating device (power equals to 0.8...1.0 kW) in combination with a two-chamber storage tank with a capacity of 40 liters confirm its compliance with the requirements of water treatment for processing feeds and the skin of animals. With the performance indicators of the heat-generating device and the length of the time cycle of 240 minutes the water temperature reaches 40...45 °C, while its chemical composition in terms of hydrogen index ranges from 5.8 pH to 9.5 pH. The intensity of this technological cycle can be regulated by the selection of the power of the device.

The water feasibility studies in the range of pH change have shown that to reduce bacterial contamination, it is appropriate to use water with a pH value of 3.5...4.5 or with a pH value of 8...11. The result is a decrease in bacterial contamination by 11...12 times.

3. Conclusions
1. The proposed technologies for treating rough feeds make it possible to improve their quality, the efficiency of their use; reduce the energy consumption of the animal for digesting of feed; improve the environmental safety of the internal space of the livestock building;
2. A technology that provides for the use of water with different parameters of the hydrogen index (pH) in technological processes as a treatment agent can be multifunctional with respect to a number of production and technological processes (sanitary disposal of internal premises of a livestock building; technological equipment; treatment of the skin of animals; washing of dairy equipment; treatment of waste feed for reuse for other purposes).
3. The optimal treatment time for rough feeds (hay, straw) with respect to increasing their nutritional value is 4 hours at a hydrogen index of pH value of 10.44.
4. For treating feeds and the skin of animals to ensure environmental and sanitary safety of the internal space of the livestock building and the products produced, it should be appropriate to use activated water with pH indicators: 3.5...4.5 and 11...12.

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