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Multicomponent Mixtures In The Preparation Of High-Protein, Energy-Saturated Silos.

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ABSTRACT

The study presents a technology for preparing and producing adaptive-variable silos aimed at increasing their protein and energy nutrition using annual high-protein and cereal crops grown in mixed crops. Optimal seed ratios were determined during sowing, the chemical composition was studied, and the energy content of the green mass of feed mixtures and silos was calculated, taking into account new approaches to evaluating and rationing protein for ruminants (solubility, cleavability). Among single – component silos, a higher concentration of 11.77 MJ OE and 18.13% of raw protein was obtained from the feed wiki. Mixed crops of annual grains and legumes such as peas, vetch, feed beans, soy, and sorghum in different proportions and ratios provided silos with an energy value of 10.04-10.75 MJ of exchange energy and a content of 10.48-11.94% of raw protein in 1 kg of dry feed substance. Of the two-component mixtures, the optimal option was (beans + corn) in a ratio of 1:1 with an energy of 10.62 MJ and a protein concentration: raw 119.47 g; digestible 78.11; soluble 68.37; cleavable 82.83 g. In silos with pea-bean and Vico-bean mixtures, there was an increase in the concentration of exchange energy from 3.71 to 5.26%, protein-raw from 33.34 to 39.11%, digestible from 48.94 to 53.37%, soluble from 9.15 to 12.66% and cleavable from 3.72 to 5.27%, than in corn silage. The evaluation of feed nutrition showed that silos prepared from multicomponent mixtures were characterized by a higher content of exchange energy and protein: corn + sorghum + beans in the ratio (3:2:3); corn + beans (1:1), as well as mixtures containing 25-50% of leguminous components (peas, vetch and feed beans). These variants of silos guarantee a high energy value – 10.04-11.77 MJ of exchange energy and a concentration of raw protein 10.48-11.95% in 1 kg of dry matter.

Keywords: cereals and legumes; green mass; silage; chemical composition; nutrition; energy; protein-raw, digestible, soluble, breakable; organic acids.

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INTRODUCTION

The use of mixed crops, in comparison with single-species, increases the collection of not only feed, but also protein per hectare by 10-20%.

Silage is a dietary, milk-based, vitamin-rich feed [1,2,3]. In the Russian Federation, the main silage crop is corn, the main disadvantage of which is the low content of protein (protein) in it, which leads to over-spending of feed per unit of production, worsens the health of animals and reduces their productivity. Therefore, increasing the protein and energy content in the silo becomes of great scientific and industrial importance.

The purpose of this study was to determine the optimal ratio of seeds of annual cereals and legumes in mixed crops to produce high-protein, energy-saturated silos.

MATERIALS AND METHODS

26 variants of forage crops in single-species and mixed crops were sown for silage preparation and laboratory-production experiments in the conditions of the Ufa pilot farm of the Bashkir research Institute of agriculture (scheme 1). Phase of silage preparation milk-wax ripeness of cereals [4,5,6,7,8].

Scheme 1: Forage crops, seed ratio during sowing

| Options | The ratio of seeds in the crops, % |
|-------------------------------|--|
| Single-component crops | |
| 1 | Feed peas 100 |
| 2 | Feed beans 100 |
| 3 | Wick feed 100 |
| 4 | Oats 100 |
| 5 | Barley 100 |
| 6 | Corn 100 |
| Two-component crops | |
| 7 | Peas 50 + oats 50 |
| 8 | Wick feed 50 + oats 50 |
| 9 | Feed beans + corn (1:1) |
| 10 | Barley 50 + oats 50 |
| 11 | Feed beans 75 + feed peas 25 |
| 12 | Feed beans 75 + wick feed 25 |
| 13 | Corn + sorghum (compacted crops) |
| 14 | Corn + feed beans (compacted crops) |
| Three-component crops | |
| 15 | Feed beans 50 + feed peas 25 + oats 25 |
| 16 | Feed beans 50 + wick feed 25 + oats 25 |
| 17 | Feed beans 25 + feed peas 50 + oats 25 |
| 18 | Feed beans 25 + wick feed 50 + oats 25 |
| 19 | Barley 25 + feed peas 25 + oats 50 |
| 20 | Barley 25 + feed peas 50 + oats 25 |
| 21 | Barley 25 + wick feed 25 + oats 50 |
| 22 | Barley 25 + wick feed 50 + oats 25 |
| 23 | Barley 50 + feed peas 25 + oats 25 |
| 24 | Barley 50 + wick feed 25 + oats 25 |
| 25 | Corn + sorghum + feed beans (3:2:3) |
| 26 | Corn + sorghum + soy (3:2:3) |

Studied parameters: dry matter, organic matter, ash, metabolic energy, protein-raw, digestible, soluble, cleavable, fat, fiber, BEV, sugar, calcium, phosphorus, carotene (in 1 kg of dry matter).

RESULTS AND DISCUSSION

Energy and protein nutrition of silos

The chemical analysis data showed that the concentration of raw nutrients (protein, fat, fiber, and BEV) g in 1 kg of silage dry matter was different depending on the type of crops, the ratio and the number of components.

Silos prepared from single-species legume crops had a high percentage of protein content: vetch (18.13% raw and 12.56% digestible); feed beans (15.79 and 11.85); peas (12.23 and 9.05), as well as their mixtures (beans 75 + peas 25) and (Boby 75 + vetch 25), respectively, 11.77-8.69% and 12.89-9.51%.

In terms of fat content of silage, prepared from single-species crops of legumes surpassed analogues from cereals, especially from corn, and prepared from mixed crops occupied an intermediate position.

Silos prepared from the green mass of cereals had the highest concentration of fiber compared to legumes. The optimal level between them was occupied by silos obtained from mixed crops.

In silos (single-species) prepared from cereals, the amount of BEV (nitrogen-free extractive substances) prevailed in comparison with analogues from legumes.

As for other nutrients and biologically active substances (sugars, macro- and microelements, vitamins), there are no big differences or deviations from the norms between them in silos.

The assessment of energy nutrition of feed showed that higher content of exchange energy was characterized by silos prepared from feed vetch, multicomponent mixtures (corn + sorghum + beans in a ratio of 3:2:3), (corn + beans in a ratio of 1: 1), as well as mixtures containing 25-50% of legume components-peas, vetch and feed beans. The concentration of exchange energy in them was from 11.77 to 10.04 MJ.

Table 1 shows that the preparation of silage from Vico-oat mixture increases the concentration of energy and the content of raw protein in the dry matter of feed by 12.68 and 13.54% compared to oat silage, and when adding 50% of the green mass of peas only 7.89 and 6.47%. The same trend is observed with soluble and cleavable protein, that is, with the inclusion of the legume component, the degree of its decomposition in the rumen increases directly proportionally.

Silos prepared from 3-component mixtures (beans 50 + vetch 25 + oats 25) and (beans 25 + vetch 50 + oats 25) are characterized by a higher content of metabolic energy and high solubility and cleavability of raw protein than compared to 2-component mixtures, but they have a slightly lower concentration of raw and digestible protein. In 1 kg of dry matter, these silos contain more exchange energy by 24.56 – 25.80% and protein by 5.99 – 14.97%, respectively, compared to feed from oats.

Preparation of silage from the green mass of barley with the addition of 25-50% vetch and 25-50% peas increases the energy value of the dry matter of the feed by 9.17-22.24% compared to feed from one barley.

The content of raw and digestible protein in the dry matter of the feed significantly increased when silaging the green mass of barley with the inclusion of 25-50% vetch and 25% oats. At the same time, the protein level in the dry matter of silage increased by 10.30-16.77% in comparison with the feed from barley. With the inclusion of the bean component from 25 to 50%, the concentration of soluble and cleavable protein in these silos increased from 24.44 to 59.28% and from 9.17 to 22.26%.

The presence of legumes in the silage mass (corn + sorghum + feed beans) and (corn + sorghum + soy) in the ratio of 3:2:3 allowed to increase the energy level and protein content in the dry matter of the feed by 21.74-19.25% and by 13.67-11.19% compared to corn silage.

Table 1: Concentration of energy and protein in silos

| Options | Composition, % | Contained in 1 kg of dry matter | | | | |
|------------------------|--|---------------------------------|------------|------------|---------|---------|
| | | Exchange energy, MJ | protein, g | | | |
| | | | raw | digestible | soluble | fissile |
| Single-component crops | | | | | | |
| 1 | Feed peas 100 | 9,82 | 122,29 | 90,50 | 57,79 | 76,60 |
| 2 | Feed beans 100 | 10,45 | 55,83 | 33,49 | 61,22 | 78,62 |
| 3 | Wick feed 100 | 11,77 | 181,35 | 125,64 | 83,57 | 91,81 |
| 4 | Oats 100 | 8,06 | 91,15 | 63,83 | 34,52 | 62,87 |
| 5 | Barley 100 | 8,72 | 93,95 | 60,47 | 43,25 | 68,01 |
| 6 | Corn 100 | 8,83 | 78,47 | 44,37 | 44,70 | 68,87 |
| Two-component crops | | | | | | |
| 7 | Peas 50 + oats 50 | 8,75 | 97,45 | 70,15 | 43,64 | 68,25 |
| 8 | Wick feed 50 + oats 50 | 9,23 | 105,42 | 73,80 | 49,99 | 71,99 |
| 9 | Feed beans + corn (1:1) | 10,62 | 119,47 | 78,11 | 68,37 | 82,83 |
| 10 | Barley 50 + oats 50 | 9,86 | 99,79 | 67,85 | 58,32 | 76,91 |
| 11 | Feed beans 75 + feed peas 25 | 9,17 | 117,71 | 86,89 | 49,20 | 71,53 |
| 12 | Feed beans 75 + wick feed 25 | 9,32 | 128,88 | 95,15 | 51,18 | 72,70 |
| 13 | Corn + sorghum (compacted crops) | 9,44 | 93,49 | 53,73 | 52,77 | 73,63 |
| 14 | Corn + feed beans (compacted crops) | 9,90 | 98,99 | 72,15 | 58,85 | 77,22 |
| Three-component crops | | | | | | |
| 15 | Feed beans 50 + feed peas 25 + oats 25 | 10,71 | 97,59 | 66,85 | 69,55 | 83,54 |
| 16 | Feed beans 50 + wick feed 25 + oats 25 | 10,14 | 96,61 | 66,58 | 62,02 | 79,09 |
| 17 | Feed beans 25 + feed peas 50 + oats 25 | 10,40 | 99,27 | 67,65 | 65,46 | 81,12 |
| 18 | Feed beans 25 + wick feed 50 + oats 25 | 10,04 | 104,80 | 76,75 | 60,70 | 78,31 |
| 19 | Barley 25 + feed peas 25 + oats 50 | 9,52 | 98,73 | 71,29 | 53,82 | 74,25 |
| 20 | Barley 25 + feed peas 50 + oats 25 | 9,61 | 95,77 | 83,66 | 55,01 | 74,96 |
| 21 | Barley 25 + wick feed 25 + oats 50 | 9,58 | 98,83 | 67,08 | 54,62 | 74,72 |
| 22 | Barley 25 + wick feed 50 + oats 25 | 10,35 | 112,32 | 82,29 | 64,79 | 80,73 |
| 23 | Barley 50 + feed peas 25 + oats 25 | 10,66 | 97,79 | 64,52 | 68,89 | 83,15 |
| 24 | Barley 50 + wick feed 25 + oats 25 | 10,48 | 105,73 | 77,73 | 66,51 | 81,74 |
| 25 | Corn + sorghum + feed beans (3:2:3) | 10,75 | 89,20 | 52,27 | 70,08 | 83,85 |
| 26 | Corn + sorghum + soy (3:2:3) | 10,53 | 87,25 | 53,85 | 40,73 | 66,53 |

Preparation of silos from the green mass of compacted crops of corn with sorghum and corn with feed beans increased the energy value of the dry matter of the feed by 6.91 and 12.12% and the concentration of raw protein by 19.14 and 26.15% than in corn silage.

From the data in table 2, it follows that the content of lactic acid in all silos exceeded acetic acid, which indicates that the biochemical fermentation processes took place in the desired lactic acid direction during the maturation of feed. It is necessary to note the presence of a small amount of butyric acid in silos with legume components, which is explained by their belonging to difficult-to-silage plants.

Table 2: Organic acid Content in silos

| Options | The composition of the silos | Ratio of organic acids, % | | | pH feed |
|------------------------|------------------------------|---------------------------|--------|------|---------|
| | | dairy | acetic | oil | |
| Single-component crops | | | | | |
| 1 | Feed peas 100 | 83,38 | 16,62 | - | 5,0 |
| 2 | Feed beans 100 | 77,23 | 21,75 | - | 5,0 |
| 3 | Wick feed 100 | 71,51 | 28,49 | 0,53 | 4,8 |
| 4 | Oats 100 | 83,00 | 17,00 | - | 5,1 |
| 5 | Barley 100 | 73,88 | 26,12 | - | 5,0 |

| | | | | | |
|-----------------------|--|-------|-------|------|-----|
| 6 | Corn 100 | 77,77 | 22,14 | - | 4,5 |
| Two-component crops | | | | | |
| 7 | Peas 50 + oats 50 | 82,97 | 15,94 | 1,09 | 5,0 |
| 8 | Wick feed 50 + oats 50 | 72,15 | 27,53 | 0,32 | 5,1 |
| 9 | Feed beans + corn (1:1) | 76,41 | 22,18 | - | 5,0 |
| 10 | Barley 50 + oats 50 | 86,79 | 13,21 | - | 5,0 |
| 11 | Feed beans 75 + feed peas 25 | 6,81 | 93,19 | 2,46 | 4,8 |
| 12 | Feed beans 75 + wick feed 25 | 43,65 | 56,35 | - | 4,8 |
| 13 | Corn + sorghum (compacted crops) | 76,52 | 20,43 | - | 4,1 |
| 14 | Corn + feed beans (compacted crops) | 74,22 | 23,32 | 3,05 | 4,9 |
| Three-component crops | | | | | |
| 15 | Feed beans 50 + feed peas 25 + oats 25 | 81,10 | 18,11 | 0,79 | 4,1 |
| 16 | Feed beans 50 + wick feed 25 + oats 25 | 72,37 | 26,31 | 0,32 | 5,0 |
| 17 | Feed beans 25 + feed peas 50 + oats 25 | 83,07 | 16,93 | - | 4,4 |
| 18 | Feed beans 25 + wick feed 50 + oats 25 | 15,44 | 84,56 | - | 5,1 |
| 19 | Barley 25 + feed peas 25 + oats 50 | 78,98 | 20,38 | 0,64 | 5,0 |
| 20 | Barley 25 + feed peas 50 + oats 25 | 81,04 | 18,96 | - | 4,9 |
| 21 | Barley 25 + wick feed 25 + oats 50 | 65,58 | 34,42 | - | 4,8 |
| 22 | Barley 25 + wick feed 50 + oats 25 | 71,97 | 28,03 | - | 4,2 |
| 23 | Barley 50 + feed peas 25 + oats 25 | 76,95 | 23,05 | - | 5,0 |
| 24 | Barley 50 + wick feed 25 + oats 25 | 75,73 | 24,27 | - | 3,9 |
| 25 | Corn + sorghum + feed beans (3:2:3) | 82,17 | 17,83 | 1,41 | 4,2 |
| 26 | Corn + sorghum + soy (3:2:3) | 76,19 | 23,28 | - | 4,9 |

The level of concentration of hydrogen ions in silos from cereals and legumes of annual crops, as well as from maize mixed with legumes forage crops is 4.1-5.0, which corresponds to the pH of feed of good quality.

CONCLUSION

Mixed crops of cereals with annual legumes such as peas, vetch, feed beans, soy, and sorghum in different proportions and ratios provide good quality silos with a concentration of exchange energy of 10.04-11.77 MJ and raw protein of 10.48-11.95% per 1 kg of dry matter.

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