Efficiency of using malt sprouts in calf diets

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Abstract. The study is aimed at analyzing the effectiveness of the use of malt sprouts (SR) in feeding calves. In the work, indicators of the level of replacement of barley in the composition of experimental samples with malt sprouts are determined. The resulting difference in the increase in live weight of animals and control groups showed the feasibility of using malt sprouts, and the cost of making a standard compound feed was higher than the cost of making experimental compound feed.

1. Introduction
Over the past few years, such industries as poultry and pig breeding have been actively developing in many regions of the Russian Federation. Both poultry and pigs' diets are based on high-energy grains. There is speculation that the inclusion of grains in cattle diets will decline in the future. For this reason, it becomes necessary to search for alternatives. The current conditions in the field of animal husbandry also determine the importance of research aimed at the development of combined feed for calves, which will include not too scarce components (in terms of their significance for humans) [1-6].

In this context, such a component as malt sprouts, which is a product of barley processing in the production of malt, becomes especially interesting. Comparative analysis of the named components (SR and barley) suggests that their chemical composition and basic nutrients are practically identical in many properties, and in some cases the sprouts are superior to barley [7-9].

For example, the content of crude and digestible protein in SR is 2 and 2.2 times higher than in barley, respectively, and the content of phosphorus is 2.1 times higher [7]. Sprouts also significantly surpass barley in the content of other useful elements, for example, sulfur, copper and zinc [8]. Important in this context is the fact that SR protein is 2-2.5 times cheaper compared to cereal protein. At the same time, it is fair to mention that sprouts include less crude fat and starch compared to barley [4-5].

It is obvious that the use of SR in calf feeding is an optimal and profitable solution. This is due to the nutritional properties of the sprouts: their high content of protein and various microelements. Another plus is the ability to avoid a rise in the cost of compound feed when using SR.

2. Materials and methods
In order to implement a series of experiments, the calves born on the farm were divided according to the principle of analogous groups. In total, 5 groups of 12 calves each were involved in scientific and economic experiments. When forming the groups, the features were taken into account, such as:

• Breed;
Feeding and keeping of animals was organized taking into account the principles of breeding technology. Its phases:

- I (milk). Lasts no more than 65 days. Condition - use of dairy products for feeding (reconstituted whole milk substitutes);
- II (post-milk). Lasts up to 95 days. The condition is to use only plant-based feed for feeding.

According to the scheme, summarized in a tabular form (table 1), the first group was the control group. Calves in it received feed according to the scheme of the economy. The diets of the experimental groups were different and differed in different ratios of displacement of barley SR in individual formulations "K 60-29-89" (combined feed).

Table 1. Research scheme.

| Group of calves           | The essence of the experience (155 days) |
|---------------------------|------------------------------------------|
| First control (I)         | Main diet: whole milk substitute, alfalfa hay, legume haylage, corn silage, molasses, "K 60-29-89", salt, premix |
| Experimental second (II)  | The main diet with the replacement of SR barley by 25% in the compound feed "K 60-29-89" |
| Experimental third (III)  | The main diet with the replacement of SR barley by 50% in the compound feed "K 60-29-89" |
| The fourth experimental (IV) | The main diet with the replacement of SR barley by 75% in the compound feed "K 60-29-89" |
| Fifth Experienced (V)     | The main diet with the replacement of SR barley by 100% in the compound feed "K 60-29-89" |

Second experience

| First control (I)         | Basic diet: whole milk substitute, alfalfa hay, haylage, corn silage, molasses, "K 60-29-89", salt, premix |
| Experimental second (II)  | The main diet with 40% replacement of SR barley in the compound feed "K 60-29-89" |
| Experimental third (III)  | The main diet with 50% replacement of SR barley in the compound feed "K 60-29-89" |
| The fourth experimental (IV) | The main diet with 60% replacement of SR barley in the compound feed "K 60-29-89" |
| Fifth Experienced (V)     | The main diet with 70% replacement of SR barley in the compound feed "K 60-29-89" |

During Phase I, the reconstituted whole milk replacer was given to each calf individually (buckets). Hay and compound feed were dispensed in troughs per group. Feeding - twice a day: morning - whole milk replacer and combined feed, evening - replacer and alfalfa hay. To provide water, automatic drinkers with free access were provided.

During Phase II, haylage and corn silage were used instead of whole milk and hay substitutes. The diets were prepared in accordance with the principles of accepted feeding standards. They changed as the study was carried out every week, taking into account the calf productivity plan - 650 - 700 grams of average daily live weight gain.

Feed consumption was determined by taking into account consumption volumes and residues (GOST 25967-83). For control feedings every 10 days, the consumption was calculated:
• Average daily;
• For the period of experience.

The value of nutrient consumption per 1 kg of live weight gain was also calculated. The control over the change in the last calves of the experimental groups was carried out by means of individual weighing monthly during the study period (in the morning before feeding).

Taking into account the data obtained, the calculations of the relative, average per day and absolute indicators of weight gain in calves in the experimental groups were carried out.

The economic efficiency was determined on the basis of the results obtained, as well as calculations of the cost of the amount of feed spent. For this, head costs, proceeds from estimated sales, profit and profitability were calculated. The numerical data were processed using variation statistics.

3. Results

The work aimed at reducing the costly raw materials in the diets pursues a single goal - to increase economic efficiency.

Note that in both phases within the framework of the experiment, the productivity of calves in the control and experimental groups differed significantly. Consequence - differences in live weight gain. The cost of the latter, together with the difference in costs for barley and SR, are factors that determine the differences between calves of different groups.

In the process of analyzing and evaluating the effectiveness of the use of SR when feeding calves, the volume of barley displacement in experimental combined feed was calculated. Also, the financial indicators were calculated when malt sprouts were included in such feeds. The data obtained are summarized in table 2.

| Index | Group 1 | Group 2 | Group 3 | Group 4 | Group 5 |
|-------|---------|---------|---------|---------|---------|
|       | Diet volume per head during phase I, kg. |       |       |       |       |
| Barley| 63.8    | 48.1    | 31.9    | 16.1    | 0       |
| SR    | 0       | 16      | 31.9    | 48.3    | 64      |
|       | Cost of funds during phase I, rubles. |       |       |       |       |
| Barley| 299.7   | 226.1   | 150.1   | 75.7    | 0       |
| SR    | 0       | 60.9    | 121.4   | 183.5   | 243.2   |
| Total | 299.7   | 287     | 271.5   | 259.2   | 243.2   |
|       | Saving money, rubles. |       |       |       |       |
| On the head | 0 | 12.7    | 28.2    | 40.5    | 56.4    |
| Per ton of feed | 0 | 225     | 450     | 675     | 900     |

The presented data allow us to say that the use of SR makes it possible to:

• To save the consumption of barley;
• Reduce the costs of compound feed production.

Calculations of costs for barley and SR during phase I confirmed that when barley is replaced by a quarter in "K 60-29-89", the savings reach 4.4%. An increase in the amount of SR in the composition of feed instead of barley makes it possible to reduce costs in the case of one hundred percent substitution to 56.4 rubles. (in percentage terms - 5.2%).

It is important to note that the savings calculations during Phase I are based on actual consumption of standard and experimental combination feeds.
Thus, with the application of "K 60-29-89" subject to partial and complete replacement of SR barley during phase II, the savings will remain.

It should be borne in mind that in practice, phase I can be longer or shorter. For this reason, in order to objectively assess the feasibility of replacing barley, the calculation of savings was carried out taking into account the indicators that are valid for the manufacture of standard and experimental compound feed. Based on the results of these calculations, it can be concluded that the use of SR makes it possible to save on the production of a ton of "K 60-29-89" from 225 to 900 rubles. (in prices at the time of research).

The data obtained should not be considered absolutely objective, since they do not take into account the productivity of animals. The costs were based on the consumption of compound feed based on consumption (actual, kg) and the structure of the components during the experiment.

And during the first phase, and during the second, as well as during the period of the experiment, the productivity of calves of different groups differed. These differences were significant. The consequence is the difference in the absolute gain in live weight. The cost of the latter, as well as the cost of barley or SR, are factors that determine all the differences.

The results of calculations of economic efficiency are summarized in tabular form (table 3).

| Group | I | II | III | IV | V |
|-------|---|----|-----|----|---|
| Phase I | | | | | |
| Absolute gain in live weight over the period, kg | 42.3 | 42.7 | 43.5 | 43.1 | 42.3 |
| Total costs, rubles, including for: | 2458.8 | 2451.5 | 2435.3 | 2423.6 | 2408.3 |
| Barley | 282.3 | 215.3 | 143.3 | 71.9 | 0 |
| SR | 0 | 59.7 | 115.5 | 175.2 | 231.8 |
| Profit, rubles | 36.9 | 67.8 | 131.2 | 119.3 | 87.4 |
| Profitability,% | 1.5 | 2.76 | 5.38 | 5.92 | 3.62 |
| Phase II | | | | | |
| Absolute gain in live weight over the period, kg | 62.7 | 64.7 | 66.1 | 61.5 | 61 |
| Total costs, rubles, including for: | 3272.5 | 3240.5 | 3216.4 | 3181.8 | 3156.9 |
| Barley | 585.6 | 436.2 | 292.8 | 144.3 | 0 |
| SR | 0 | 117.4 | 236.7 | 350.6 | 470 |
| Profit, rubles | 426.8 | 576.8 | 683.5 | 494.9 | 442.1 |
| Profitability,% | 13.04 | 15.11 | 21.25 | 15.55 | 14 |
| For all experience | | | | | |
| Absolute gain in live weight over the period, kg | 105 | 107.4 | 109.6 | 104.6 | 101.8 |
| Total costs, rubles, including for: | 5763.8 | 5587.8 | 5420.9 | 5247.3 | 5077.1 |
| Barley | 871.4 | 651.9 | 435.7 | 216.7 | 0 |
| SR | 0 | 46.2 | 92.8 | 138.2 | 184.7 |
| Profit, rubles | 431.2 | 748.8 | 1045.5 | 924.1 | 905.5 |
| Profitability,% | 7.48 | 13.4 | 19.28 | 17.61 | 17.83 |

The data given in the table indicate that due to the differences in the increase in live weight, the cost of the latter also becomes different. In addition, the cost of making "K 60-29-89" is significantly reduced when it comes to replacing SR barley.

In phase I of rearing, the proceeds from the sale of the increase in live weight in calves of the control group – 2.495.7 rubles. It:
- 1% lower than calves from group II;
- 2.8% lower than that of calves from group III;
- 1.9% lower than calves from IV;
- Similar to V.

The total costs of growing, as well as the costs of compound feed, are higher for calves of group I. This is due to the fact that there is a difference in the cost of barley and SR.

For this reason, the profit from the use of sprouts instead of barley in the composition of "K 60-29-89" during the first phase differs as well as the cost of the total costs of cultivation.

It should be noted that in terms of the profit received, the calves of the experimental groups (II-V) surpassed the calves from group I by 1.8, 3.5, 3.2 and 2.4 times, respectively.

Calf rearing profitability:
- Group I - 1.5%;
- II-V groups - 2.76, 5.38, 5.92, 3.62%, respectively.

These results suggest that the difference is significant.

It is worth noting that during phase II of cultivation, the dependence of economic efficiency on the proportion of barley substitution with CP in the formulation of the combined feed continued to persist. So, during this rearing period, the proceeds from the sale of live weight gain in calves from the control group is 3699.3 rubles, which is 3.1, 5.2% lower than that of calves from groups II and III. At the same time, in calves from groups IV and V, this indicator is lower than in the control by 2.0 and 2.8%.

The rearing profitability is higher in the calves of the experimental groups in comparison with the calves in the control group. For groups II-IV, the indicator is higher by 2.07, 8.21, 2.51, 0.96%, respectively.

The indicators of profit and profitability when calculating the economic efficiency of rearing calves for the period of the experiment have intermediate values in terms of different phases of rearing. At the same time, differences in performance indicators are characterized by sufficient stability.

Summarizing the data obtained, we can say that with an increase in the share of SR instead of barley in the composition of "K 60-29-89" to 75% and higher, the growing efficiency begins to decline.

For this reason, an additional experiment was organized, within the framework of which barley was replaced with SR by 40, 50, 60 and 70% in K 60-29-89. The scheme made it possible to accurately identify the optimal proportion of SR for replacing barley, which made it possible to recommend the developed compound feed recipe for use for production purposes.

The results of calculations of economic efficiency are summarized in tabular form (table 4).

From the data obtained, it can be concluded that due to differences in the growth rates of live weight, the cost of the latter among calves of certain groups also differs. The costs of making "K 60-29-89" for the control group are higher compared to the same costs for the manufacture of combined feed for calves of the experimental groups.

In phase I of rearing, the proceeds from the sale of the increase in live weight in calves of group I - 2383.6 rubles. This indicator is 0.2, 1, 2, 0.7% lower compared to the indicators for groups II-V. The total costs of growing, along with the costs of producing compound feed, are higher in the case of group I. This is due to the differences in the cost of barley and SR. According to the scheme, 40, 50, 60 and 70% of barley were replaced by sprouts.

For the reasons described, the profit from the inclusion of SR in the composition "K 60-29-89" during phase I of cultivation differs along with the dynamics of total costs. In terms of the final profit for this phase, the calves from the experimental groups surpass the calves from group I (the profit is 1.7, 1.4, 1, 3 and 0.5 times more, respectively, for groups II-V). The profitability according to the results of the phase in calves of the control group was 1.31%, and in calves of experimental groups II-V - 2.8, 3.87, 5.06 and 2.67%, respectively. The difference in the duration of phase I is significant.
Table 4. Cost-effectiveness of using SR in the diet of calves.

| Group   | Index                        | I         | II        | III        | IV        | V         |
|---------|------------------------------|-----------|-----------|------------|-----------|-----------|
|         | Phase I                      |           |           |            |           |           |
| I       | Absolute gain in live weight, kg | 40.4      | 40.5      | 40.8       | 41.2      | 40.1      |
| II      | Total costs, rubles, including for: | 2345.8    | 2324.2    | 2317.5     | 2313.5    | 2304.4    |
|         | Barley                       | 299.4     | 180.5     | 149.9      | 120.8     | 89.3      |
|         | SR                           | 0         | 97.3      | 121.2      | 146.3     | 168.7     |
|         | Profit, rubles               | 37.8      | 65.3      | 89.7       | 117.3     | 61.5      |
|         | Profitability,%              | 1.61      | 2.80      | 3.87       | 5.06      | 2.67      |
|         | Phase II                     |           |           |            |           |           |
| I       | Absolute gain in live weight over the period, kg | 64.6      | 64.9      | 65.5       | 66.3      | 63.9      |
| II      | Total costs, rubles, including for: | 3321.8    | 3279.7    | 3264.8     | 3256.8    | 3218.5    |
|         | Barley                       | 594.1     | 358.6     | 297        | 239.2     | 239.2     |
|         | SR                           | 0         | 193.4     | 240.1      | 289.9     | 320.7     |
|         | Profit, rubles               | 489.6     | 549.4     | 599.7      | 654.9     | 551.6     |
|         | Profitability,%              | 14.73     | 16.75     | 18.36      | 27.78     | 17.13     |
|         | For all experience           |           |           |            |           |           |
| I       | Absolute gain in live weight over the period, kg | 105       | 105.4     | 106.3      | 107.5     | 104       |
| II      | Total costs, rubles, including for: | 5672.6    | 5648.4    | 5625.1     | 5612.0    | 5560.4    |
|         | Barley                       | 922.1     | 583.3     | 483.6      | 389.2     | 280.6     |
|         | SR                           | 0         | 314.6     | 391        | 472.3     | 529.3     |
|         | Revenue, rubles               | 6195      | 6218.6    | 6271.7     | 6342.5    | 6136      |
|         | Profit, rubles               | 522.4     | 570.2     | 646.6      | 730.5     | 575.6     |
|         | Profitability,%              | 9.2       | 10.1      | 11.5       | 13        | 10.4      |

During Phase II, the dependence of economic efficiency on the proportion of replacement of barley with malt sprouts in K 60-29-89 remained. During the phase, the proceeds from the sale of live weight gain in calves of group I - 3811.4 rubles, which in turn:

- 0.5, 1.4 and 2.6% lower in comparison with calves of II-IV groups;
- 1.1% higher compared to group V calves.

The profitability during phase II in the calves of experimental groups II-V is also higher by 13.7, 24.6, 88.6, 16.3%, compared with the profitability for the control group, respectively.

4. Discussion
Replacing barley with malt sprouts allows not only to preserve valuable feed raw materials, but also to significantly reduce the costs of preparing high-grade compound starter feeds. Which is consistent with the studies of other authors [1-3; 10]. For example, feeding the developed feed "KR-1" with the introduction of 5% SR led to a decrease in the cost of live weight gain by 10%. The introduction of 10 and 15% SR at the same time reduces the effectiveness of the rations by 1.4 and 7.5% [1-2]. A feed additive based on malted barley sprouts with Cellobacterin, increasing the digestibility and absorption of nutrients in the diet, stimulates metabolism, promotes the manifestation of the genetic productive potential of cows, which has a positive effect on increasing milk productivity by 20.6% [3].

In our studies, based on the data of the manufacturer "K 60-29-89", its selling price for the period of the experiment was 4.9 rubles / kg. At the same time, the price of malt sprouts ranged from 3.5 to 4.0 rubles / kg. Calculations of costs for the consumption of barley and malt sprouts during the dairy...
period of calf rearing show that, even with 25% replacement of barley in the composition of "K 60-29-89", the savings are 12.7 rubles or 4.4%. A consistent increase in the mass of malt sprouts instead of barley makes it possible to reduce the cost of producing compound feed K 60-29-89 in the maximum replacement option to 56.4 rubles (5.2%).

Since the absolute gain in live weight of calves in the experimental and control groups differed, the cost of compound feed also differs. This is primarily due to the difference in the cost of barley and malt sprouts. The costs of preparing a standard compound feed are higher than when preparing an experimental compound feed. As a consequence, the total rearing costs were higher in control calves.

Conducting the second scientific and economic experiment, in which barley was replaced with malt sprouts in K 60-29-89 compound feed, respectively by 40, 50, 60 and 70%, which made it possible to more accurately determine the optimal level of barley malt sprouts replacement and recommend the developed compound feed for use on production.

5. Conclusion

Summarizing the results obtained in the course of the first scientific and economic experiment, we can conclude that with an increase in the proportion of barley replacement in the recipe for compound feed K 60-29-89 at the level of 75% or more, the efficiency of raising calves decreases.

When clarifying in the second scientific and economic experiment the efficiency of using malt sprouts in the diets of calves, it was found that the optimal option is the option in which barley in the composition of the K 60-29-89 compound feed is replaced by malt sprouts by 60%.

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