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METOD OF CONCERVATION AND USING THE WET GRAIN OF SORGHUM IN FEEDING OF HIGHLY PRODUCTIVE COWS

It was developed and tested the method of biological conservation and using of highly productive cows in feeding of wet grain of sorghum, which provides the long-term «aerobic stability» of canned feed by using the hay preservative ingredient flour of Galega oritalis L. which provides:

- conditions for the directed synthesis of lactic and acetic acids, which creates a satisfactory aerobic stability for canned grain sorghum in the summer conditions of storage;

- improving the preservation of nutrients;

- improving its quality performance and reduces the cost of preserving the procurement and storage of wet grain sorghum by 4%.

It was made the comparative assessment of the nutritional value of canned and dry grain sorghum in the summer conditions of its use in feeding of highly productive dairy cows and was established its influence on the physical and chemical properties of milk and fatty acid composition.

Keywords: *biological preservative, wet grain of sorghum, forage aerobic stability, productive performance, cows, milk.*

Formulation of the problem. The global change of climate in the direction of warming caused the reduce the productivity of major crops that under stressful situations is 50-60%, and in some years is much more. Prolonged droughts are the one of the most serious problems of agriculture. According to the Ukrainian Hydrometeorological Center during the twentieth century the average temperature of air in Ukraine increased on 0,8°C. The conclusions of international experts show that in Ukraine the warming will be at least another hundred years. In the next 40-50 years the climate of southeast Ukraine becomes more continental and less humid. [1] An effective way to solve this problem is the selecting plants with high drought tolerance yield and versatility of use. According to state agrarian stations of Crimea, Kherson, Mykolaiv and Odessa regions, sorghum crop yields exceed 19-58% corn on bohar and at 14-15% for irrigation. There are objective factors that indicate the possibility of expanding the cultivation of grain sorghum:

- simplicity to complex agrometeorological growing conditions and stable performance in harsh soil and climatic conditions;

- to grow sorghum is economically beneficial because by spending 900 to 1400 UAH per 1 ha cost of grown products at the prices of 2005 (not too high) was from 1800 to 2000 UAH per 1 hectare.

- low seeding rate (4-7 kg per 1 ha) and long term storage of seed together with late planting dates make sorghum potentially strategic crop for replanting during the mass death of winter and early spring crops [2]. However during the harvesting of sorghum grain its moisture content is 25-20%, which needs the final drying for what according to I.A. Bystrova can be spent over 3% of the crop [3]. In Ukraine was developed a number of biological bio-mineral preservatives for preserving wet forage, but their stabilizing role in the use of food is not yet fully satisfies its resistance for repeated fermentation. Therefore our development expected that wet forage after depressurization for use in animal feed had stable resistance during aerobic storage to mold and re-fermentation for

2-3 weeks. However canned biological preservative forage has got preventive - curative properties because it is made from plant material of Galega oritalis L., which makes environmentally friendly use and high Energy-saving manufacture. With raw material which costs 700 - 1000 UAH per ton additional cost of 1 ton for preserving of wet forage will be 19 - 27 UAH. By taking into account that the developed preservative has nutritional value the cost will be reduced on 1.5-2 times.

Analysis of recent researches and publications in which is a solution of the problem. The storage silosed feed is the most difficult problem which acquired global significance. The causes of reducing the quality of silosed and canned feed during the storage and selecting are well known. It is the development in the stern of aerobic microorganisms as a result of the penetration of air in it. In foreign literature this phenomenon is called «aerobic impression of food». These changes on the first stage caused bacteria and yeast and then mold that causes the oxidation of amino acids in the background of fermentation. The growth of mold can lead to the formation of toxins in significant concentrations, and introduction in the diet of grain affected by toxigenic fungi leads to slower growth and high mortality of animals [4].

In practice, it is necessary to consider that survives a significant number of embryos of mold and yeast because of what after opening forage can occur secondary warming. After opening the refuge through the open plane the feed receives sufficient air conducive to heat and mold the secondary feed. The improving the stability of silosed feed based on two principles: reducing the number of yeast during laying and limit of the growth of yeast in the open place due to the active surface of acetic acid. Effectiveness of acetic acid on yeast amplifies by the action of lactic acid because of the low pH acetic acid is in the more active form. On this is based and principle of acetic acid in silosed feed. Created acetic acid reduces the amount of yeast germs in the foundation and inhibition of growth yeast in conditions of access the air after depressurization the repository. Increased concentration of acetic acid in silosammount assists to enlarge the stability which saves energetic value and increases the value of food consumption [5].

For this were used the developed for a specific purpose rather competitive homo fermentative lactic acid bacterias (eg, R. pentosaceus), which rapidly convert plant sugars into lactic acid and rapidly reduce pH. To increase the concentration of acetic acid in the silage needs the hetero fermentative lactic acid bacteria (eg, L. buchneri). The use of a combination of lactic acid bacterias of homo and hetero types in in preservative allows to achieve both the required results by the best way [6]. A common disadvantage of such preservatives is that for their production and storage are necessary the special equipment and conditions. They have a limited period of effective use and conditions of their using. Because currently bacterial preparations to fully satisfy the conditions are not yet silage and have a seasonal character of production and limited shelf life, the search for new and more affordable approaches to conservation of biological feed is important.

From the literature we know about high fungicidal properties of during Galega oritalis L. the manufacture of feed [7]. It was established experimentally that 20% aqueous extract of Galega oritalis L. has inhibitory effect on the growth of bacteria. The use vegetative mass of eastern Galega oritalis L. in technological processes of harvesting the wet forage and its productivity effect on the organism of animals in zootechnical literature is not studied enough.

The purpose of the work. To develop a way to increase the «aerobic stability» of canned feed by using preservative ingredient that would ensure improvement of safety of nutrients and improve its quality indicators and reduce the expenses were spent for preserving during the curing and storage of wet sorghum grain. To give a comparative assessment of the nutritional value of canned and dry grain sorghum in the summer conditions of its use in feeding of highly productive dairy cows and establish its impact on the physical and chemical properties of milk and its fatty acid composition.

Material and methods of research. For this purpose the Flour of Galega oritalis L. was

investigated as a preservative agent in the amount of 1.0-5.0% by weight of total feed. The study of quality indicators of silosed feed was made in small volumetric containers in which it was laid mixture of sorghum grain and hay flour of Galega oritalis L. different ratio of the density of 820-850 kg/m^3 according to the scheme presented in table 1.

The intensity of the general decomposition of nutrients in feed during the ensiling and preserving was determined by the number of dedicated gas fermentation by the method of analytical weighing of laboratory tanks with water locks. By weight difference was established the preserving effect of hay meal Galega oritalis L. Visual inspection of the demonstration of secondary fermentation was mold on the surface of food.

Table 1

Scheme of preserving action hay meal of Galega oritalis L.

Variant of the experiment	Specifications version
control	Wet grain of sorghum
I – trial	Wet grain of sorghum + 1,0% by weight of hay meal Galega oritalis L.
II – trial	Wet grain of sorghum + 2,0% by weight of hay meal Galega oritalis L.
III– trial	Wet grain of sorghum + 3,0% by weight of hay meal Galega oritalis L.
IV – trial	Wet grain of sorghum + 5,0% by weight of hay meal Galega oritalis L.

For holding the production and research to establish the efficient use of canned food in the feeding of highly productive dairy cows were laid for storage in big bag of 500 kg of wet grain sorghum with the input of optimum amount of 2.7% hay flour Galega oritalis L.

The material for the research were highly productive cows with the milk yields over 7000 liters of milk per previous lactation and average duration of 73 days of lactation fluid and canned and dry grain sorghum.

Experiments on high productive cows were held by the method of group-periods of 33 days each. Canned and dry forage were feed in crushed form. According to the diet of cows during the comparing period got the egalitarian herb green mass till 50 kg, bran from grains of cereals by 3.5 kg, canned beet pulp 10 kg and salt 80 grams that characterized as a basic ration (BR). During the first accounting period to the main diet was added an additional 3.0 kg of canned bran grain of sorghum, and in the second period it was replaced by a similar quantity of dry substance of dry grain sorghum in an amount of 2.75 kg. Experimental studies were conducted in summer of 2015 with an average temperature of + 29 degree.

For physical and biochemical studies once a decade was selected average daily sample of milk from each cow from which was apportioned milk fat and its fatty acid composition from the average sample was determined by gas-liquid chromatography on the chromatograph "Chrome-5".

Physical and chemical properties of milk were determined on the milk analyzer "Ekomilk." The experimental data were statistically elaborated by using the program Statistica and Excel.

Results and discussion. Canned corn sorghum of experimental and control options were stored in sealed conditions during 110 days. After its depressurization observed the onset of re-fermentation and changes in feed quality indicators. By observations was found that wet corn in the control option retained its structure and had nice wine smell. Reducing of pledged weight forage in this version was 3.73% and the difference between the least losses in the fourth experimental option before the control was lower on 36.9% and in other variants from 24.1 to 29.7%, which is one of indicators of preserving action of biological preservative. On the fifth day of aerobic storage in

grain of control variant were detected the first signs of mold and was found the temperature increase that indicate the beginning of a secondary fermentation in the forage and as its consequence higher level of ethanol by 35.6% in compared with the third experimental option. Biochemical indicators of quality canned grain sorghum were presented in table 2.

After depressurization canned grain sorghum in experiment 1, 2, 3 and 4, which was stored under conditions of control variant observed the changes in fermentation and quality of food. By researches were established that corn has retained its structure, had pleasant not sour odor and pH was 4,6-4,5 units. On the fifth day of aerobic storage was not installed the displays of a secondary fermentation. On the 10th day of storage the mold was appeared after adding a preservative at a dose of 1.0% and after adding 2.0; 3.0 and 5.0% its features were seen on the 17th day of storage under aerobic conditions.

Table 2

Biochemical indicators of quality canned corn of sorghum

Indicator	Variants of the trial				
	Control	I trial	II trial	III trial	IV trial
Moisture,%	29,21	29,84	28,66	29,46	29,95
pH	4,77	4,64	4,80	4,50	4,53
Ammonia nitrogen,%	37,1	35,70	28,7	29,9	30,9
Total acidity,%	1,11	1,26	1,23	1,37	1,56
Lactic acid,%	0,69	0,84	0,87	0,91	1,01
Acetic acid,%	0,22	0,27	0,29	0,31	0,46
Butyric acid,%	0,017	0,021	–	–	–
Isovaleric acid,%	0,105	0,108	0,052	0,66	0,056
Nylon acid,%	0,018	0,020	0,012	0,020	0,015
Ethanol,%	0,188	0,166	0,133	0,121	0,126

The content of organic acids in canned forage shows that experimental versions 1, 2 and 3 content of acetic acid had higher concentrations on 22.7; 31.8; 40.9% and in the fourth it was twice higher in comparison with the control. The content of isovaleric acid as a product of bacterial synthesis, characterized by smaller data of preservative from 2 to 5% the concentration caproic acid had no specific differences between versions. The number of lactic acid was higher in the experimental versions on 21.2; 26.0; 31.8 and 146.3%, so hay flour of the Galega oritalis L. as biological preservative provides directed synthesis of lactic and acetic acid which causes higher aerobic stability of canned grain sorghum. Resistance of canned grain sorghum to refermentation in experimental variants byadding 2, 3 and 5% of biological preservative almost satisfite the production process of its use in feeding farm animals. The middle optimal value of biological preservative is 2.5-3.0%.

It was established that during experimental research on high productive cows as in laboratory studies unpacked preserved forage during the use in feeding of cows kept structure and organoleptic characteristics of mold was not observed the content of organic acids was 1.4%, of which for lactic acid was about 65%, for acetic 32% with the absence of butyric acid at a pH of 4.5 units.

The conducted chemical analysis of canned grain sorghum shows that in absolutely dry matter was contained more crude protein, crude cellulose and crude ash under 5.6; 51.9; 33.9% and crude fat and nitrogen free extract on 10.4 and 8.1% less. At these changes in the chemical composition of canned corn sorghum was affected the adding of 2.7% hay meal Galega oritalis.

Fat and protein content in milk must satisfite the basic standards approved by the Cabinet of Ministers in due course.

The productivity of cows during the research is presented in table 3.

Table 3

The productivity of cows in egalitarian and accounting periods, *M±m, n=4*

Feeding period and characteristics	Total lactation days	Milk yield			% to control basic fat
		kg	% fat	Basis fat 3,4%	
Egalitarian basic diet (BD)	294	21,65±1,7	4,09±0,17	26,04±1,89	100,0
Accounted, BD+ Canned corn of sorghum	327	24,06±1,01	4,30±0,08	30,43±0,55*	116,86
Accounted, BD+dry sorghum grain	359	23,83±0,87	4,34±0,08	30,42±1,09*	116,82

*Note: * P<0.1*

The data in table 3 shows that in comparative period the average milk yield was 21.6 kg with 4.09% fat equivalent to the basic fat is 26 kg. For additional to the main feeding ration of three kilograms of canned corn sorghum the productivity of cows increased on 16.9% (P<0.1) and was 30.4 kg per basic fat 3.4%, while physical milk yield increased on 11.1% and the fat content of milk on 5.1%.

After the replacing in the diet of cows of canned corn on dry grain sorghum their production has not changed and remained at the same level that gives us the reason to rate the considered results as the equivalent of productive action at feeding of highly productive cows.

So the developed technological method of preserving the wet grain sorghum by biological preservative as hay flour Galega oritalis satisfite the production requirements of its use in the summer and for productive action in feeding of dairy cows provides the analogic to dry grain sorghumas to natural milk yield so to physical and chemical characteristics and fatty acid composition.

The greatest influences on technological properties of milk do seasonal changes of chemical composition which have roughly the same legitimacies for all natural raw material regions. Seasonal changes are mainly conditioned to lactation period rations and conditions of keeping the cows.

Fresh natural cow's milk is the raw material that was derived from healthy animals and is characterized by certain physical and chemical (mass proportion of fat and protein, acidity, density, conductivity, etc.), organoleptic and technological (heat resistance, ability to coagulate under the influence of rennet, etc.) properties. That's why their determination allows evaluating the naturalness, quality and suitability of milk for processing to certain dairy products. In the dairy industry is important to use milk that is characterized by high mass fraction of fat, protein, solids, the milk with full chemical composition. Any changes in the content and condition of the components of milk are accompanied by changes of its physical and chemical properties. The density of milk is one of the main indicators of a safety and quality of raw milk in the production of all dairy products and depends on its chemical composition, breed cattle feed rations. Because the chemical composition of milk is not constant, that's why the density ranges from 1027 to 1032 kg/m^3 [8].

Physical and chemical properties of milk of experimental cows are shown in table 4.

Table 4

Physical and chemical indexes of milk, *M±m, n=4*

Indicator	Units of measurement	Periods of trial		
		egalitarian	accounted-I	accounted-II
Density	kg/м^3	1,032±0,0007	1,030±0,007	1,030±0,0008
Active acidity	Рн	6,63±0,05	6,64±0,05	6,63±0,05
Freezing temperature	˚С	0,552±0,002	0,555±0,004	0,556±0,003
Fat content	%	4,09±0,17	4,30±0,08	4,34±0,08
Protein content	%	3,17±0,091	3,15±0,045	3,19±0,043
The content of skimmed milk remain	%	8,97±0,24	8,92±0,16	8,99±0,22

From presented in table 4 data is shown that the milk was characterized by the main indicators by relative stability of physical and chemical composition. Minor fluctuations are observed by density in the range of 1032 to 1030 kg/m^3, that is explained by some differences of its chemical composition in comparative and accounting periods.

One of the features of digestion in ruminants is the transformation of fatty acids in the diet was influenced by rumenal microflora. Particulary much of the unsaturated fatty acid of feed is under the biohidrohenisation to acids without double bonds acids with an odd number of carbon atoms iso and hydroxy acids [9].

Milk fat contains a considerable amount of polyunsaturated fatty acids that are not synthesized in the human body. In comparison with other fats the milk is better absorbed to what was assisted the low melting point (27-34^{o}C) and existing it in the form of small fat globules.

Table5

Fatty acid composition of milk fat of the cows, %, *M±m, n=4*

Code of fatty acid	Name of fatty acid	Trial period		
		egalitarian	accounted – I	accounted – II
6:0	Caproic	0,57±0,08	0,62±0,031	0,64±0,076
8:0	Caprylic	0,63±0,15	±0,62±0,07	0,63±0,08
10:0	Capric	1,85±0,18	1,95±0,25	1,98±0,25
11:0 iso	Isoundecanoic	0,19±0,06	0,16±0,07	0,18±0,04
12:0	Lauric	3,17±0,61	3,09±0,25	3,14±0,27
14:0 iso	Isomyristic	0,04±0,019	0,05±0,042	0, 06±0,057
14:0	Myristic	10,27±0,95	11,51±0,97	11,45±0,83
15:0 iso	Isopetadecanoic	1,19±0,20	1,21±0,43	1,22±0,43
16:0 iso	Isopalmitic	0,150±0,055	0,135±0,087	0,145±0,68
16:0	Palmitic	28,94±1,14	31,73±2,40	31,60±2,56
16:1(n-7)	Palmitoleic	2,10±0,23	1,76±0,30	1,80±0,31
17:0 iso	Isopentadekanoic	0,83±0,17	0,75±0,26	0,76±0,26
17:0	Heptadecanoic	0,52±0,14	0,46±0,16	0,45±0,11
17:1(n-8)	Heptadecanoleic	0,20±0,084	0,16±0,123	0,17±0,168
18:0	Stearin	10,81±2,43	11,51±2,25	11,46±2,31
18:1(n-9)	Oleic	30,25±3,73	28,75±2,04	28,95±2,17
18:2 trans	Conjugate linoleic acid	1,46±0,21	1,08±0,26	1,13±0,21
18:2	Linoleic	3,71±1,71	2,40±0,90	2,43±0,09
18:3(n-6)	γ-Linolenic	0,15±0,089	0,11±0,059	0,12±0,056
18:3(n-3)	α-Linolenic	0,97±0,31	0,72±0,16	0,64±0,13
20:0	Arachidic	1,45±0,18	1,20±0,33	0,94±0,62
20:1(n-9)	Gondoic	0,09±0,034	0,78±0,054	0,10±0,028
20:4(n-6)	Arachidonic	0,048±0,029	0,043±0,029	±0,11±0,135
Saturated pair acid		57,67±1,01	61,94±3,34	61,92±3,35
Saturated unpaired		1,54±0,38	1,50±0,39	1,51±0,39
Saturated iso		2,39±0,41	2,31±0,85	2,32±0,84
Monounsaturated		32,64±3,52	30,74±2,18	30,81±2,17
Polyunsaturated		6,33±2,19	4,14±1,42*	4,21±1,42*
Middle-chain pair		47,50±2,05	51,24±3,28*	51,24±3,16*
Long-chain pair		42,61±3,47	41,28±1,44	41,32±1,44
L/M		0,9±0,11	0,81±0,074	0,81±0,065
n-3/n-6		0,19±0,053	0,21±0,07	0,17±0,12

*Note: * P>0.1*

In recent years more and more had importance to nutritional qualities of milk and dairy products. For lipids is primarily related to their fatty acid composition.

Given the above the question was appeared about studying of influence on fatty acid composition of milk lipids of canned and dry grain sorghum with additional feeding them to the basic diet of dairy cows.

The figures in table 5 data indicate on a slight increase in content of middle-chain fatty acids with additional basic diet fed to cows of canned and dry grain sorghum in comparison to egalitarian period on 7.9% (P>0.1). Between the first and second periods pointed changes have no significant fluctuations that indicates about more intensive formation of volatile fatty acids in the rumen of cows in the accounting periods of the experiment. Polyunsaturated fatty acids in the rumenans of ruminant largely hidrohenization and izomeryzation and the part that is absorbed in the intestine is mainly used in their body for the synthesis of phospholipids and prostoglandin in result in the triacylglycerols tissues and milk of ruminant animals contain small amount of polyunsaturated fatty acids [10]. It is noticeable that during the feeding cows on canned and dry grain sorghum decreased the content of milk in the composition of fat of polyunsaturated fatty acids to 34% (P>0.1). The decline in milk of cows of long-chain acid content is explained of compensatory response of the breast to maintain a physiologically optimal consistency of milk fat.

The key for industry development is the efficiency of milk production. Despite the fact that the prices of milk and dairy products in Ukraine is high enough and grow all the time the profitability of milk production is extremely low. If in the early 90'th profitability reached 32.2%, in 2010 was at 1.4% [8].

In the development of storage technology of wet grain sorghum for use in feed of animals the costs for its preparation, preservation and storage in big bags in 4-5 times smaller in comparison to drying in modern drying units. Using it in diets of dairy cows their performance is similar to dried grain sorghum and the cost of milk production reduced to 4%.

Conclusions and recommendations for further researches. 1. Biological hay preservative flour Galega oritalis L. for preserving wet grain sorghum provides the directed synthesis of lactic and acetic acid, which causes higher aerobic stability of canned food.

2. Taking the hay flour of Galega oritalis L. in an amount of 2.0 to 5.0% from the weight of wet forage makes it possible to provide the high aerobic resistance to forage canned to refermentation.

3. The best variant for optimal number of biological preservative of hay flour from Galega oritalis L. is 2.5-3.0%.

4.The change in the diet of highly productive cows of dry grain sorghum on canned ensure their equal performance and physical and chemical properties of milk and reduces the cost of its production to 4%.

5. The lowering in milk fat content of long-chain acids cow is the result of a compensatory reaction of breast in upholding of physiologically optimal consistency of milk fat.

6. The advantage hay flour of Galega oritalis L. as a preservative is its availability for the procurement and use in any soil and climatic zones of Ukraine.

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СПОСІБ КОНСЕРВУВАННЯ І ВИКОРИСТАННЯ В ГОДІВЛІ ВИСОКОПРОДУКТИВНИХ КОРІВ ВОЛОГОГО ЗЕРНА СОРГО

Розроблено і апробовано спосіб біологічного консервування і використання в годівлі високопродуктивних корів вологого зерна сорго, який забезпечує тривалу «аеробну стійкість» консервованого корму за рахунок використання консервуючого інгредієнту сінного борошна з галеги східної, що створює:

– умови для направленого синтезу молочної і оцтової кислот, які сприяють задовільній аеробній стійкості консервованому зерну сорго в літніх умовах його зберігання;

– підвищення збереженості поживних речовин;

– покращення його якісних показників та зменшує затрати на консервування при заготівлі і зберіганні вологого зерна сорго на 4%.

Зроблено порівняльну оцінку поживної цінності консервованого та сухого зерна сорго в літніх умовах його використання в годівлі високопродуктивних дійних корів і встановлено його вплив на фізико-хімічні показники та жирнокислотний склад молока.

Ключові слова: біологічний консервант, вологе зерно сорго, аеробна стійкість корму, продуктивна дія, корови, молоко.

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СПОСОБ КОНСЕРВИРОВАНИЯ И ИСПОЛЬЗОВАНИЯ В КОРМЛЕНИИ ВЫСОКОПРОДУКТИВНЫХ КОРОВ ВЛАЖНОГО ЗЕРНА СОРГО

Разработан и апробирован способ биологического консервирования и использования в кормлении высокопродуктивных коров влажного зерна сорго, который обеспечивает длительную «аэробную устойчивость» консервированного корма за счет использования консервирующего ингредиента сенной муки из галеги восточной, что создает:

– условия для направленного синтеза молочной и уксусной кислот, которые способствуют удовлетворительной аэробной устойчивости консервированному зерну сорго в летних условиях его хранения;

– повышение сохранности питательных веществ;

– улучшение его качественных показателей и уменьшает затраты на консервирование при заготовке и хранении влажного зерна сорго на 4%.

Проведена сравнительная оценка питательной ценности консервированного и сухого зерна сорго в летних условиях его использования в кормлении высокопродуктивных дойных коров и установлено его влияние на физико-химические показатели и жирнокислотный состав молока.

Ключевые слова: биологический консервант, влажное зерно сорго, аэробная устойчивость корма, продуктивное действие, коровы, молоко.

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