American-Eurasian J. Agric. & Environ. Sci., 14 (5): 401-406, 2014
ISSN 1818-6769

DOI: 10.5829/idosi.aejaes.2014.14.05.12357

Use of New Supplement Feeds Based on Organic Iodine in Rations of Lactating Cows

[1,2]*Ivan F. Gorlov,* [1]*Natalia I. Mosolova,* [1]*Elena Yu. Zlobina,*
[2]*Alina A. Korotkova and* [2]*Natalya A. Prom*

[1]400131, Rokossovskogo street, 6, Volgograd, Russia,
Volga Region Research Institute of Manufacture and Processing of Meat-and-milk Production
[2]400005, Lenin avenue, 28, Volgograd, Russia, Volgograd State Technical University

Abstract: The aim of the study is to investigate the influence of the organic iodine-based supplement feeds on the milk producing ability and to examine the extent of the organic iodine transition into the raw milk and its products. The research has found that by adding the studied agent to the ration the milk producing ability of the experimental cows raised by 7,8-10,9% compared to control animals. The values of milk quality indexes: protein, fat, casein, lactose have also increased. The cows in the experimental group (compared with the cows in the control group) have shown the tendency to increase the amino acid content in milk, including key amino acids by 0.107 and 0.084%, respectively and nonessential amino acids by 0.042 and 0.056%. The concentration of iodine has also increased in dairy raw materials and refined products by 36.1 and 35.7%.

Key words: Iodine deficiency · Feeding · Ruminating · Lactation · Productivity · Raw milk.

INTRODUCTION

Iodine deficiency and diseases associated with it belong to the global problems that require urgent solution [1, 2]. More than 2.0 billion inhabitants on the planet suffer from lack of iodine [3]. The human body can absorb this mineral nutrient from the environment (air, water, plant and animal food) and the animals get it mostly only from green feed [4, 5]. Analysis of domestic and foreign scientific researches allows to consider the factors necessary for the normal functioning of the thyroid gland as stimulators of production efficiency and as improvement in the milk quality [6, 7]. Due to the natural-caused iodine deficiency, it is necessary to add some appropriate mineral supplements to the cow ration. Inorganic forms of iodine, used as a fortifier in agriculture and food industry, are known to be inferior significantly to organic forms in stability and physiological efficiency [8, 9]. In modern literature there is some evidence of high efficiency of minor elements in organic form and, particularly, iodine, selenium, zinc and cobalt in dairy feed [10-14]. Thus, the enrichment of agricultural raw materials, in particular milk, with organic iodine by directional formation of its composition during the life of a living organism, is of strategic importance for the task of improving the livestock farming productivity and for production of functional foods.

In recent years, some new supplements based on organic iodine «Yoddar» and «Yoddar-Zn» (LLC «Fili H-Farm», Moscow) have been developed and produced. Their effectiveness in milk production has not been unexplored yet. The composition of the supplement «Yoddar» contains iodine in organic form, «Yoddar-Zn» also contains organic zinc salts.

The aim of this study is to investigate the influence of the organic iodine-based supplement feeds on the milk producing ability and to examine the extent of the organic iodine transition into the raw milk and its products.

MATERIALS AND METHODS

To carry out the scientific and economic experiments on the principal of analogous pairs, some groups of first-calf heifers of red-white breed were formed with regard to age, health status, calving time and insemination, live weight and productivity.

Corresponding Author: Ivan F. Gorlov, 400131, Rokossovskogo street, 6, Volgograd, Russia.
Volga Region Research Institute of Manufacture and Processing of Meat-and-Milk Production,
Tel: +78442391101, +78442393566.

The similarity of cows was set, based on the methods of the All-Union Academy of Agricultural Sciences, according to the documents with livestock records and registration data of daily milk yields and live weight [15].

For the duration of the experiment, a ration balanced with regard to basic nutrients and related to the detailed standards of cattle rationing [16] was worked out for all experimental groups of cows. The software «KormOptima» was used for the purpose.

The scientific and economic experiment on lactating cows was held in OJSC «Oblomov» in Volgograd region and lasted 300 days. For the experiment, 60 cows were selected and three groups of 20 animals each were formed. The cows of the I and II experimental groups, unlike analogue cows in the control group, were fed with supplements «Yoddar» and «Yoddar-Zn» in addition to basic ration, based on 4 g and 100 g per ton of mixed cattle feed, respectively.

In carrying out the scientific and economic experiment the following points have been studied:

- Food consumption in each group of cows tested by weighing the given feed and its orts every ten days during two adjacent days;
- Nutrient digestibility of the ration, balance of nitrogen, calcium and phosphorus in the body were evaluated in three animals from each group by the balance experiments [15];
- Hematological parameters in the experimental cows: the total protein content by the refractometry method, protein fractions by the nephelometric methods monthly;
- Milk producing ability of each cow individually, on the basis of control milkings with the definition of fat and protein in milk every ten days; other quality characteristics of milk, on a monthly basis, in accordance with the requirements of GOST: the titratable acidity - by the titrimetric method according to GOST 3624-92; the active acidity - by ionomer according to GOST 26781-85; the nitron density – by the areometric method according to GOST 3625-84; the mass fraction of fat – by the acid method according to GOST 5867-90; the mass fraction of dry basis and of nonfat milk solids (SNF) – by the arbitration method according to GOST 3626-73; the mass fraction of total protein - sensu Kjeldahl according to GOST 23327-98; the mass fraction of casein - by the formol titration method according to GOST 25179-90; the mass fraction of lactose – by the photoelectric colorimeter (PEC) to GOST R 51259-99; the calcium content – by the complexometric method; the phosphorus content – by the spectrometric method according to GOST R 51473-99;
- Quantitative and qualitative indicators of cream, sweet-cream butter, nonfat cottage cheese, ice cream, secondary products of milk processing (whey, buttermilk).

Sampling of milk and other products was conducted in accordance with GOST 26809-86 «Milk and dairy products. Acceptance procedures, sampling methods and preparation of samples for analysis».

Technological milk properties were studied at the beginning, in the middle and at the end of the experiments. The samples of cream, butter, ice cream, cottage cheese, as well as of secondary products of milk processing (whey, buttermilk) were subjected to the organoleptic and physico-chemical analysis by generally accepted methods.

In studying the safety of the dairy products the following rules were walked by: SanR&S 2.3.2.1078-01 «Hygienic requirements for safety and nutritional value of foods», Federal Law of June 12, 2008 ¹ 88-FL «Technical regulations for milk and dairy products»; Guidelines GL 1.2.2961-11 «Scientific rationale of maximum permissible levels of contaminants of chemical nature and of food additives in food products».

Determination of the chemical elements (including heavy metals) concentration in milk and products was performed on the atomic absorption spectrometer Quantum-2AT according to GOST 30178-96, on the quadrupole mass spectrometer Elan 9000 and on the atomic emission spectrometer Optima 200 DK.

Economic efficiency of the studied supplement feeds was determined by the method proposed by the All-Union Academy of Agricultural Sciences [17].

The research materials were processed by the method of variation statistics [18], by the software package «Microsoft Office» on the PC and by the definition of the criterion of the difference validity sensu Student-Fisher. Three reliability thresholds were identified (*p<0,05, **P<0,01 and ***P<0,001).

RESULTS

The studies showed that the digestibility of solids of cows in the I and II experimental groups was higher than that of their analogues in the control group, by 1.9 and

2.5%, respectively; the digestibility of organic matter – by 1.6 and 2.3%; of crude protein - by 1.2 and 1.6%; of crude fat - by 2.1 and 2.9%; of crude fiber - by 3.4 and 4.1%; of nitrogen-free extract substances - by 3.7 and 4.5%.

Analysis of the data has showen that the cows consuming a ration with the supplement feeds «Yoddar» and «Yoddar-Zn», digested nitrogen, phosphorus and calcium better than their analogues in the control group by 3.7 and 3.9%; 7.0 and 11.6%; 1.3 and 2.0%, respectively. Higher rates of the nutrient digestibility and of the balance of nitrogen, phosphorus and calcium were observed in the milk of the cows that were fed with the supplement feed «Yoddar-Zn».

The cows fed with a ration, which contains supplement feeds, had changes in some morphological and biochemical parameters of blood. So, after six months of feeding the supplements, higher content of the erythrocytes was marked in the blood of the cows of the I and II experimental groups as compared to their analogues in the control group – by 3.65 and 4.72%; higher content of hemoglobin – by 6.15 and 5.92% (P<0.05).

The total protein content in the serum of the cows in the I and II experimental groups was higher than that of their analogues which did not consume the supplement feeds by 0.80 (P <0.05) and 1.06% (P <0.05), respectively, the content of albumin – by 5.10 (P <0.01) and 6.36% (P<0.01). That indicates their susceptibility to higher milk producing ability.

Feeding the lactating cows with the studied supplement feeds «Yoddar» and «Yoddar-Zn» contributed to the lactation performance increasing per lactation of the cows in the I and II experimental groups in comparison with their analogues in the control group by 7.84% (P<0.01) and 10.91% (P <0.001) (Table 1).

The lactation curve in the experimental groups is uneven, but the superiority is consistently viewed in the yield of the animals consuming the supplement feeds «Yoddar» and «Yoddar-Zn».

The highest relative superiority in the yield of the cows in the I and II experimental groups was noted during the second month of lactation – 9,8 (Ð<0,001) and 12,3% (p<0,001), the seventh month – 11,9 (P<0,001) and 14,46% (P<0,001), the eighth month – 11,2 (P<0,001) и 14,2% (P<0,01) and the tenth month – 7,6 (P<0,001) and 15,3% (P<0,001), respectively (Figure 1).

The qualitative analysis of the milk showed that apart from fat and protein, the casein content increased in the milk of the cows that consumed these supplement feeds by 0.03 and 0.04 %; the lactose content increased by 0.09 (P <0.05) and 0 18% (P <0.001) (Table 2).

Table 1: Lactation performance of the cows in the experiment, kg/animal

	Parameter			
Group	Days of lactation	Value of fat per lactation	Value of fat in milk	Value of protein in milk
Control	286	5260,4±109,2	203,0±4,7	168,3±5,4
I experimental	292	5672,8±96,7**	222,4±3,1**	187,8±6,7*
II experimental	297	5834,2±101,6***	230,4±3,8***	195,4±6,5**

Table 2: Quality and technological milk properties of the cows in the experimental groups

	Group		
Parameter	Control	I experimental	II experimental
Dry basis, %	12,50±0,04	12,69±0,05**	12,84±0,05***
Nonfat milk solids, %	8,64±0,04	8,77±0,03*	8,89±0,04**
Fat, %	3,86±0,03	3,92±0,04	3,95±0,03*
Protein, %	3,20±0,02	3,31±0,03**	3,35±0,03***
Incl. casein, %	2,74±0,04	2,77±0,02	2,78±0,03
Lactose, %	4,71±0,02	4,80±0,03*	4,89±0,02***
Ash, %	0,73±0,01	0,73±0,01	0,74±0,01
Iodine, mg/kg	98,6±0,76	134,2±1,14***	133,8±0,03***
Zinc, mg/kg	2,17±0,02	2,09±0,03*	2,86±0,02***
Density, g/cm^3	1,027±0,01	1,028±0,01	1,028±0,01
Titratable acidity, ^{i}t	17,31±0,04	17,38±0,07	17,39±0,05
Rennin coagulation property, min.	41,98±3,7	36,11±2,4	35,03±2,9
Group of temperature resistant	I	I	I
Somatic cells score (SCS), thous./cm3	124,6±4,71	112,8±3,68	112,3±5,16

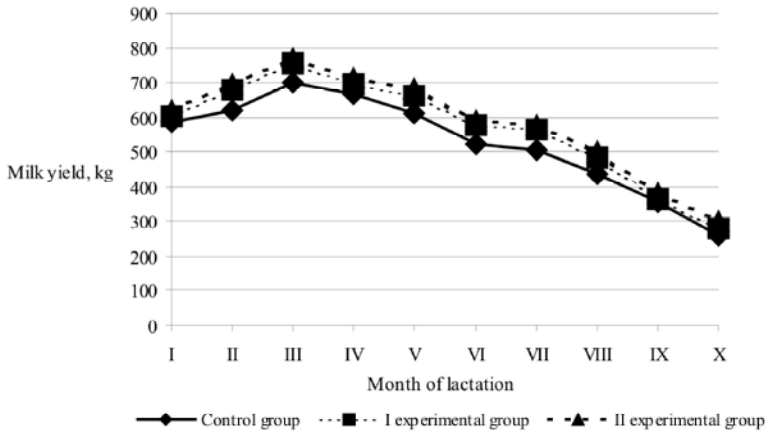

Fig. 1: Dynamics of lactation performance of cows during lactation.

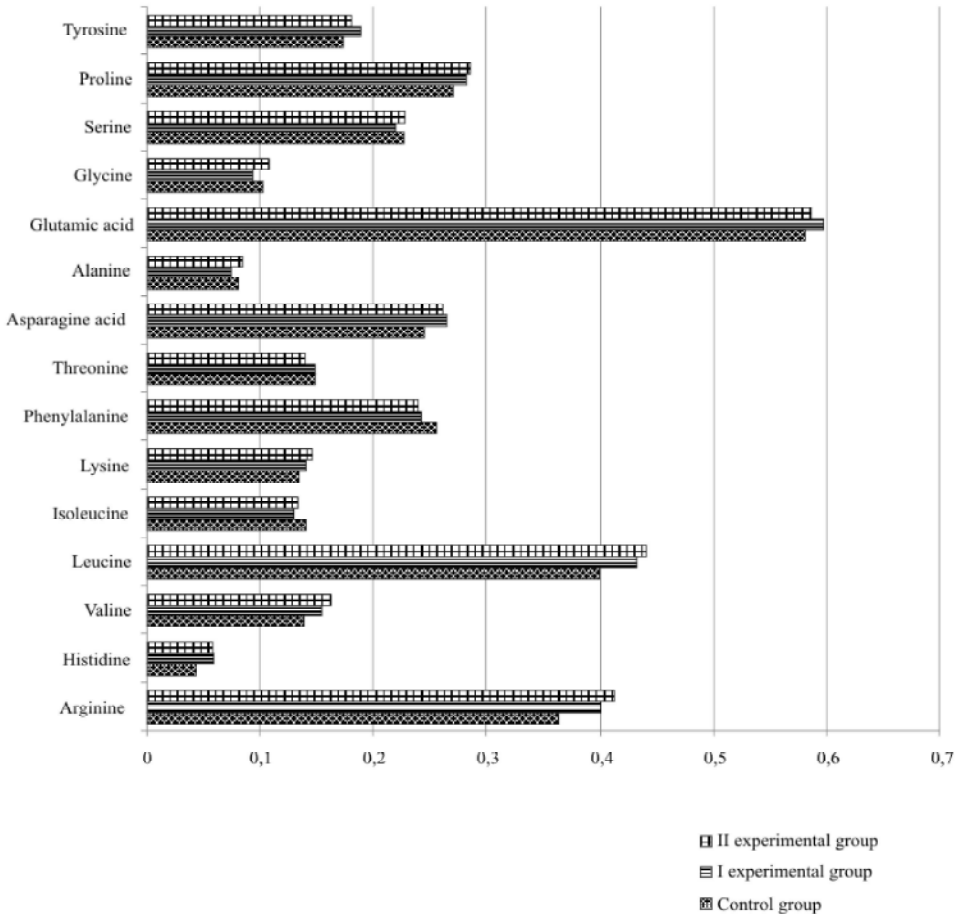

Fig. 2: Amino acid milk composition of the experimental cows.

The studies established the uptrend of the amino acid content in the milk of the cows consuming the supplement feeds «Yoddar» and «Yoddar-Zn». The value of the essential amino acids in the milk of the cows in the I and II test groups was higher than of the cows in the control group by 0.084 and 0.107%, respectively; the value of the nonessential amino acids - by 0.042 and 0.056% (Figure 2).

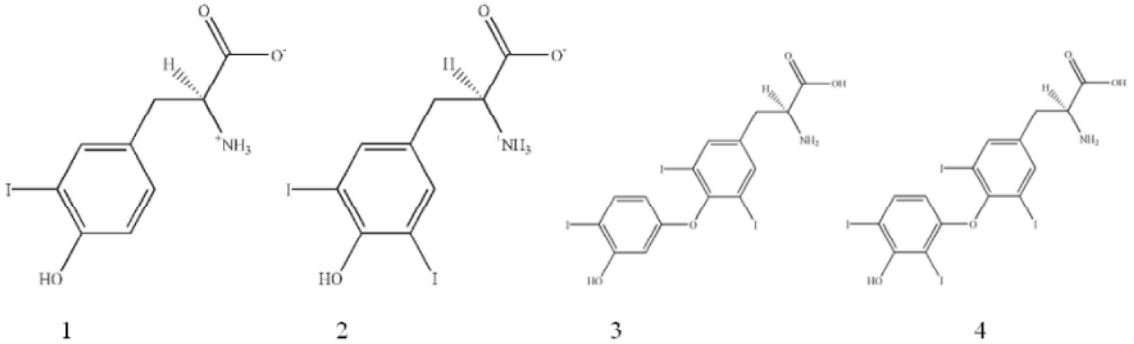

Fig. 3: Structural Formulas:
1. L-3-monoiodotyrosine, 2. L-3,5-diiodotyrosine, 3 . L-3,5,3'-triiodothyronine, 4. L-3,5,3',5'-tetraiodothyronine (thyroxine)

The studies have shown that the iodine concentration in the milk of the experimental cows increased by 36.1 and 35.7% and the content of heavy metals was significantly lower than the maximum allowable concentration (MAC).

The milk obtained from the cows, that consumed the supplement feeds «Yoddar» and «Yoddar-Zn» and the products produced from the milk had higher nutrition and consumer value, as well as the environmental safety. And the greatest efficiency of milk production was achieved by using the supplement feed «Yoddar-Zn».

DISCUSSION

The increase in the lactation performance and the milk quality is achieved by optimizing the mineral and protein metabolism. Due to the supplementing of the iodine deficiency in the ration, the content of this mineral nutrient in raw milk and in its products increases. As shown in studies [8, 14], the use of the iodine-containing extra nutrition in rations of cows, to prevent iodine deficiency, contributes to the intensification of the free fractions secretion of the thyroid hormones by the thyroid gland: free T3 (triiodothyronine), free T4 (tetraiodothyronine, thyroxine) and the approximation of their values to the physiological parameters. The transition of free T3 and free T4 into milk during lactation has resulted from their increase in blood. It provides obtaining the iodine-enriched raw milk and functional dairy products. To use the supplement feeds based on the organic iodine forms is more advisable as compared with the inorganic ones due to their greater effectiveness and physiological safety for the organism. As indicated above, the principal active ingredient in the supplements are agglomerated powder milk proteins, tyrosine iodinated. The thyroid hormones are known to be formed by joining the iodine atoms to the tyrosine (Figure 3) [19].

Milk proteins are characterized with a high content of this amino acid and the degree of their assimilation by the body reaches 96-98% [20]. Thus, the use of the investigated supplement feeds in ration of lactating cows allows to accelerate the thyroid hormone synthesis due to the fall of tyrosine residues from the enzymatic iodination cycle stage, to compensate the thyroid hormone deficiency in the animal body and as a consequence, to increase the iodine content in milk, that may be used in the manufacture of functional dairy products. The effect of the zinc, included as a compound of the supplement feed «Yoddar-Zn», can be explained by the presence of this element in the triiodothyronine receptor. Zinc, containing the superoxide dismutase enzyme, provides the antioxidant protection of the thyroid gland and the decreased activity of this enzyme increases the risk of hyperplasia.

CONCLUSION

The use of the supplement feeds «Yoddar» and «Yoddar-Zn» as part of ration of lactating cows allows:

- To enrich raw milk with bioavailable forms of iodine and to receive functional product;
- Due to the resetting the hormonal profile of the lactating cows, to increase their level of milk producing ability and milk quality indicators;
- To optimize the technological milk properties for its further processing.

Information about Research Grants: The work has been performed under the grant of the President of the Russian Federation [1] SS-2602.2014.4.

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