Brazilian Journal of Biology®

ISSN 1519-6984 (Print)
ISSN 1678-4375 (Online)

Original Article

Effect of zeolite-chlorella top dressing on scar metabolism and conversion of dairy cows' feed

Efeito de aperitivos de zeólita-chlorella no metabolismo cicatricial e na conversão de ração para vacas leiteiras

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Abstract

In scientific and economic experience, the effect of zeolite-chlorella top dressing (CCP) from 28-29% zeolite, 1.5-2% Chlorella vulgaris powder and 75-76% cake on the productive effect of feed and digestion metabolism of dairy cows has been studied. Tetra-edric frame-hollow zeolite crystals have selectively adsorbing and ion-filtering properties, and chlorella enriches with amino acids and vitamins. The introduction of CCP into the diet of cows of the experimental group increased the mineral-vitamin balance and positively affected the metabolism of cicatricial digestion. The pH shift from 6.14 to 6.17 activated the ecosystem of the rumen microflora, increased the synthesis of LVH 0.79 mmol/100ml, due to an increase in the volume of acetates from 54.1±3.0 to 57.2±2.2 mmol/100ml, increased the number of infusoria by 41.1 thousand/ml more than the control group. An increase in the amylolytic activity of the rumen chyme by 2.8 mg/starch, and cellulolytic activity by 2.8% increased scar digestion. This increased the consumption of the dry matter of the diet by cows of the experimental group by 0.48 ± 0.06 kg/head. /day. and daily milk yields by 1.06 ± 0.03 kg against the control. An increase in protein and fat in milk with a decrease in somatic cells, and in the blood of erythrocytes and hemoglobin increased biosynthesis, which increased the conversion rate of feed from 0.68 to 0.72, and protein from 17.0% to 18.9%.

Keywords: cows, feed, top dressing, zeolites, conversion.

Resumo

A experiência científica e econômica estudou o efeito produtivo da alimentação e o metabolismo da digestão de vacas leiteiras, de Zeolite-Chlorella (CHP), de 28-29% de zeólita, 1,5-2% de pó de Chlorella vulgaris e 75-76% de bagaço. Os cristais ocos de estrutura tetraedrítica do zeólito possuem propriedades seletivas de adsorção e ionofiltração, e a Chlorella enriquece com aminoácidos e vitaminas. A introdução na dieta de vacas de um grupo experiente de CHP aumentou o equilíbrio mineral-vitamínico e afetou significativamente o metabolismo da digestão cicatricial. A mudança de pH de 6,14 para 6,17 ativou o ecossistema da microflora cicatricial, aumentou a síntese de LLA 0,79 mmol/ 100ml, devido à uveistivanie do volume de acetatos de 54,1±3,0 para 57,2±2,2 mmol/100ml, aumentou o número de infusórios em 41,1 mil/ml mais do que o grupo controle. O aumento da atividade amilolítica do quimo da cicatriz em 2,8 mg / amido e da atividade celulosolítica em 2,8% aumentou a digestão cicatricial. Isso aumentou a ingestão de matéria seca das vacas do grupo experimental em 0,48±0,06 kg/gol./dia e a produção diária de leite em 1,06±0,03 kg contra o controle. O aumento da proteína e da gordura no leite, com a diminuição das células somáticas, e no sangue de glóbulos vermelhos e hemoglobina aumentou a biossíntese, o que aumentou a taxa de conversão alimentar de 0,68 para 0,72 e proteína de 17,0% para 18,9%.

Palavras-chave: vacas, alimentação, aperitivos, zeólitos, conversão.

1. Introduction

The productivity and health of animals, other things being equal, directly depends on the nutritional value and usefulness of their feeding diets. The realization of their genetic potential of productivity provides for normalized diets according to the indicators of the body's feeding needs. At the same time, the productive effect of feed, due to the amount of net energy produced by them, is directly related to the composition, nutritional value and digestibility of nutrients. Due to the direct conversion of part of the energy of digested nutrients during biosyn thesis directly into heat, bypassing peptide bonds, 70-75% of gross energy is retained in macroergic

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Received: May 13, 2023 – Accepted: July 9, 2023

bonds (~ATP) (Bolgov et al., 2019). The research results indicate an increase in the productive effect of feed and a decrease in heat production as the nutritional value of diets increases. From the fnziological and biochemical point of view, this is justified by the strengthening and acceleration of intracellular metabolism by increasing the influx of nutrients from the outside. The degree of this transformation is expressed by the coefficient of the productive potential of feed (KPP), calculated by the ratio ...bound energy / exchange energy..and back (Papusha, 2018; Omarkozhauly, 2011).

An objective indicator of the CHECKPOINT and the efficiency of dairy production is the feed productivity of cows (CPc), reflecting the degree of conversion of the feed consumed to the received products in relation to ...input / output ..., expressed by the conversion coefficient (CC) or the inverse ratio ... output / input ..., expressed by the degree of conversion (SC) of feed nutrients. The CC correlating with the feed conversion rate (FCR) is a generalizing indicator of the efficiency of feed use for the synthesis of products in dairy cattle breeding, which really reflects the relationship between feed costs and milk production (Connor et al., 2019). The degree of transformation of the nutrients of the consumed feed into the compounds of the manufactured products is a key factor of cost-effective dairy production, which determines the efficiency of utilization of the consumed feed nutrients for the synthesis of milk and its components. The task of establishing the QC is to identify animals that can give more milk at lower feed costs. An increase in the value of CC and a decrease in SC occurs with low feed quality and incorrect feeding organization, and vice versa (Zhang et al., 2012).

To increase the nutritional value of feeding diets, the use of feed additives balancing individual parameters is practiced. Which can lead to a general imbalance and, as a result, to a decrease in the productive potential of feeds. For a complex balance of diets, the introduction of feed additives with a synergistic nutritional effect is recommended. Such additives include natural mineral organic compounds based on aluminosilicates and bentonites. Their introduction into the feeding diets of dairy cows can increase the productive effect of feed, optimize digestion and normalize metabolism. So, in the experiments of P. Shobel, against the background of stabilization of the physiological state, even with a decrease in the daily yield of concentrates by 0.5-1.5 kg/head, an increase in milk yields by 10-12%, milk fat content by 2%, with a decrease in feed consumption by 10.7%, which increased the profitability of production by 10.8% was obtained (Shobel, 2021).

2. Material and Methods

In the scientific and economic experience, the effect of mineral-vitamin feeding based on natural zeolites on the productive effect of feeding diets and digestive metabolism of dairy cows was studied. To conduct the experiment by the method of analog groups, analog groups of cows of the Simmental breed of the East Kazakhstan region were formed, leveled by breed, age, live weight and lactation period. Zeolite-chlorella premix (CPX) was introduced into the feeding ration of cows of the experimental group according to the following scheme (Table 1).

In Table 1, the main feeding ration of dairy cows-analogues of experimental groups, consisting of 10-12 kg of mixed grass hay, 24-28 kg of corn silage, 3-4 kg of a mixture of concentrates, contained in 1 kg: dry matter 0.7-0.8 feed units, 7.8-8.2 MJ of exchange energy, 113-115 g of "raw" protein, 33-35 g of "raw" fat, 240-250 g of "raw" fiber, 73-75 g of starch, 18-20 g of sugars satisfied their feeding rate with a daily intake of 17.8-19.6 kg of dry matter. The cows of the experimental groups were kept under equal conditions of feeding and maintenance, with the exception of the studied factor – CCP, introduced into the diet of the experimental group instead of the nutritionally equivalent amount of concentrates in the dose optimal for dairy cows established in previous studies (1% zeolite per dry substance) (Zarrin et al., 2013).

The control of the influence of the studied factor on the digestion and milk production of cows was carried out according to the following indicators:

1 Feed consumption – by consumption of dry matter of rations, kg / head. /day;
2 Average daily milk yields – according to the data of the weekly control milking, kg / head / day;
3 Chemical composition of milk – according to laboratory studies of average milk samples for fat (%), protein (%), somatic cells (thousand/ml);
4 According to feed consumption and milk yield, feed costs per 1 kg of milk and the conversion of energy and feed to milk biosynthesis were calculated.

The selection of average feed samples was carried out according to GOST 27262-87 (RussianGost, 1987); accounting for dairy cows - according to control milkings; milk quality assessment by analyzing milk samples taken according to ST RK ISO 707-2011 (ISO, 2011) for protein, fat, SOMO and density on express analyzers "Lactan-1M" and "Clover-2M", counting the number of somatic cells on "Somatos-mini" analyzers. The analysis of feed and milk samples was carried out according to end-to-end methods of chemical and biochemical analysis in accredited laboratories of Semey Scientific Agricultural Center LLP and "Feed and Milk Quality Assessment" of Seifullin KazATU.

Table 1. Scheme of scientific and economic experience.

Experimental groups	Indicators of cows-analogues	Composition of feeding rations by lactation periods
I-control	10 head. w.m.500-510 kg, day. milk yield - 12-14 kg	OR - the main (household) ration of 10-12 kg of hay, 24-28 kg of silage, 3-4 kg of animal feed
II-experimental	10 head. w.m.500-510 kg, day. milk yield - 12-14 kg	OR + zeolite top dressing of CCP in a dose 1% zeolite per kg of ration dry matter

3. Results and Discussion

Maintaining a directed and intensive metabolism in the body of dairy cows to ensure high milk production provides for rationing of feeding with full consideration of energy and nutrient needs, depending on the physiological state, productivity level and lactation period, body weight, fatness, age and maintenance system. This is done by feeding them with balanced diets, taking into account not only the content of energy, structural, mineral and biologically active substances, but also the interaction of organic and mineral substances with each other and the animal's body, their barotrophic and mechanical effects. For mineral and vitamin enrichment of the feeding ration of dairy cows, a CCP was made, consisting of 28-29% zeolite, 1.5-2% dry chlorella powder and 75-76% salted cake as a filler. Zeolites of the local deposit belong to clinoptielite frame aluminosilicate sorbents with high adsorption and ion exchange properties of the following chemical composition (Table 2).

According to Table 2, the zeolites of the Mitrofano deposit are open tetrahedral frame—hollow crystals SiO2/4 and AlO2/4 with a diameter of internal channels 4-10 Å with the formula: (Na, K2) O•Al2O3•10SiO2•8H2O, adsorb: H2O, CO2, O2, SO2, H2S, NH4, NH3, N2 and others . organic molecules whose negative charge is balanced by the positive charge of metal cation ions, ammonium, water, etc. Selectively adsorbing and ion-filtering properties, the ion-exchange volume of which is determined by the diameter and sum of the windows of organic molecules and cations and the shape of crystals. Vitamin enrichment of CPH was provided by the introduction of Chlorella vulgaris dry powder into its composition - a natural product easily digested by the animal body, which, along with essential amino acids and polyunsaturated fatty acids, contains in 1 g: carotene - 1000-1600; vitamins B1 - 2-18, B2 - 21-28, B6 - 9, B12 - 0.025-0.1, C - 1300-5000, D - 1000, K-6, PP - 110-180, E - 10-350, B3 - 12-17, folic acid - 485, biotin - 0.1 mcg.

The introduction of CCP into the diet of cows of the experimental group increased the mineral and vitamin balance and positively affected the metabolism of scar digestion of dairy cows (Table 3).

As can be seen from Table 3, the mineral and vitamin enrichment of the feeding diet of dairy cows by the management of CPH caused positive shifts in microbiological and synthetic processes in the contents of the rumen. The change in the acidity of the contents of the rumen of cows of the experimental group to pH = 6.17 compared with pH = 6.14 in cows of the control group activated the activity of the ecosystem of microflora and microfauna of the pre-ventricles. This increased the content of the amount of infusoria in the rumen chyme by 41.1 thousand/ml, the synthesis of LVH by 0.79 mmol/100ml compared to these indicators of cows in the control group. An increase in the number of microorganisms in the rumen content, combined with the regulation of the development of the released ammonia by absorption and subsequent slow release from zeolite crystals, increased the specific gravity of the synthesized microbial protein in cows of the experimental group to 94.8% versus 87.5% in the control. The positive effect of enhancing the synthesis of LFA by premix is an increase in the specific volume of acetates from 54.1 ± 3.0 to 57.2±2.2 mmol/100ml, which are precursors of milk synthesis, with a decrease in the specific volume of propionic and butyric acids.

The intensification of microbiological processes activated the enzymatic activity of the contents of the rumen chyme of cows of the experimental group, surpassing the corresponding indicators of cows of the control group in amylolytic activity by 2.8 mg/starch, in cellulolytic activity by 2.8%. The strengthening of the microbiological and synthetic processes of scar digestion by zeolite-chlorella fertilization affected the digestibility and assimilation of

Table 2. Chemical composition of bentonites and zeolites, % in absolute dry matter.

In the components of bentonite clays		Gross content in zeolites	
$A1_2O_3$	21.19	A1	44.2 g/kg
SiO_2	57.86	Si	62.4 g/kg
CaO	2.09	Ca	22.12 g/kg
P_2O_5	0.15	P	1.44 g/kg
Na_20	1.45	Na	4.37 g/kg
K_20	3.20	K	10.67 g/kg
Mg_2O_3	2.30	Mg	7.54 g/kg
SO_3	0.99	S	2.22 g/kg
Fe_2IO_3	2.44	Fe	289.4 mg/kg
MnO	0.01	Mn	88.42 mg/kg
F_2	0.005	F	0.001 mg/kg
Cu	0.0047	Cu	32.70 mg/kg
Zn	0.0064	Zn	99.40 mg/kg
Co	0.0001	Co	10.50 м mg/kg

nutrients in feeding diets. The dynamics of consumption of dry matter of feeding rations and milk yields of cows of experimental groups is presented in Table 4.

The introduction into the feeding diets of dairy cows from the first month of lactation of the CCP increased the feed intake, as can be judged by the increase in their consumption of dry matter for 9 months of lactation by an average of 0.48 ± 0.06 kg per head per day, which increased their milk productivity. This can be seen by the increase in the average daily milk yields of cows of the II-experimental group compared with cows of the I-control group by 1.06 ± 0.03 kg. Increase with milk yield is an increase in the protein content in milk by 0.14 ± 0.02% and fat by 0.05 ± 0.01%, which indicates an increase in fertility, and a decrease in the number of somatic cells in milk by 32.8 ± 6.03 - about strengthening the health and immunity of cows of this group. This can be seen from the dynamics of the blood pattern of cows of the experimental groups (Table 5).

The improvement of the mineral and vitamin nutrition of the diet had a positive effect on the physiological state of cows and activated their immune and hormonal systems. This can be judged by the increase in the blood of cows of the experimental group of the level of erythrocytes by 15.2% and hemoglobin by 13.5% higher compared to these indicators of the blood of cows of the control group. The acceleration of redox reactions by fertilizing enhanced the processes of biosynthesis and increased the conversion of feed into dairy cow products (Table 6).

Enrichment of the feeding ration of cows of the II-experimental group of CCP increased, in comparison with the I-control group, the average daily consumption of dry matter from 19.02 to 19.50 kg/head, which increased their average daily milk yields from 13.06 to 14.20 kg/head. or by 8.72%. The increase in milk production of cows is caused by increased utilization of the consumed nutrients of the feeding diet, which is expressed by a decrease in feed consumption for milk synthesis, expressed in conversion

Table 3. Dynamics of scar digestion of cows of experimental groups.

Indicators	Experimental groups	
	I-control	II-experimental
Metabolic processes in the scar fluid		
Active acidity, pH	6.14±0.02	6.17±0.10
Number of infusoria, thousand/ml	153.1±32.0	194.2±42.1
Synthesis of volatile fatty acids, mmol/100ml	6.12±0.60	6.91±0.35
including: - acetate	54.1±3.0	57.2±2.2
- propionate	21.2±0.6	19.67±1.1
- butyric acid	17.8±2.3	15.6±1.1
Enzymatic activity of scar chyme		
Amylolytic, mg/starch	8.1±0.85	10.9±1.20
Cellulolytic, %	12.05±3.1	14.85±2.1
The content of nitrogen fractions in the scar fluid		
Total nitrogen, mg %	122.3±2.1	128.8±3.5
incl.: - protein / in % of total	87.5±2.3 / 71.6	94.8±4.1 / 73.6
- non-protein/ in % of total	34.8±3.0 / 28.4	34.0±3.1 / 26.4

Table 4. Feed consumption, milk yield and cow milk composition by experience periods.

Experimental groups	Dry matter consumed, kg/ head/ day	Milk yield. kg/ head /day	Milk composition		
			protein, %	fat, %	somatic cells, thousand/ml
In the preliminary period (1 month)					
I	17.73	13.92±0.9	3.11±0.03	3.98±0.03	369±28.75
II	17.75	13.94±0.7	3.12±0.02	3.99±0.02	352±57.05
During the trial period (in MS. for 9 months)					
I	19.02	13.06±0.35	3.14±0.03	3.94±0.02	352.6±19.03
II	19.50	14.20±0.25	3.28±0.02	4.09±0.03	229.8±19.40

Table 5. Dynamics of hematological parameters of cows of experimental groups.

Blood counts	Units of measurement	Milk composition	
		I-control	II-experimental
Before feeding with premix			
Red blood cells	10^{12}/l	5.02±0.01	5.01±0.01
Hemoglobin	r/l	108.2±0.11	110.1±0.13
White blood cells	10^{9}/l	5.40±0.02	5.46±0.02
Calcium	mMol/l	2.54±0.01	2.48±0.01
Phosphorus	mMol/l	1.31±0.01	1.29±0.01
Vitamin A	mkMol/l	2.50±0.02	2.48±0.01
Vitamin C	mkMol/l	32.0±0.06	33.1±0.09
After feeding with premix			
Red blood cells	10^{12}/l	5.22±0.02	6.01±0.03
Hemoglobin	r/l	106.8±0.11	121.2±0.14
White blood cells	10^{9}/l	5.47±0.01	5.66±0.02
Calcium	mMol/l	2.51±0.01	2.98±0.01
Phosphorus	mMol/l	1.37±0.01	1.68±0.01
Vitamin A	mkMol/l	2.51±0.01	3.34±0.02
Vitamin C	mkMol/l	32.2±0.09	45.7±0.10

Table 6. The effect of CCP on the productivity and conversion of dairy cows' feed.

Experimental groups	Dry matter consumed, kg/head/ day	Milk yield. kg/head /day	Conversion rate	Conversion degree
In the preliminary period (1 month)				
I	17.73	13.92	1.27	0.78
II	17.75	13.94	1.27	0.78
During the trial period (cf. for 9 months)				
I	19.02	13.06	1.45	0.68
II	19.50	14.20	1.37	0.72

coefficients (a decrease in KK by 0.08) and the degree of conversion (an increase in SK by 0.04). An increase in the mineral and vitamin nutritional value of the diet of dairy cows of the agricultural complex provided an increase in the key factor of dairy production - the conversion of energy and nutrients from feed into milk (Table 7).

Strengthening of milk biosynthesis and improvement of its component composition by premix top dressing increased the gross yield of protein in the milk of cows of the experimental group during the lactation period - up to 4.19 kg/head, fat - up to 5.22 kg/head. more than in the milk of cows of the control group. This increased the conversion rate of the "raw" protein of the feeding diet from 17.0% to 18.9%, which is a determining factor in the effectification of structural metabolism in the body of lactating cows. An increase in the degree of conversion of metabolic energy at the same time from 22.2% to 23.7% indirectly indicates an increase in the conversion of fats and carbohydrates in the diet.

Thus, zeolite-chlorella top dressing had a complex effect on the nutrition and productivity of dairy cows, enriching, on the one hand, their diets with natural and microbiological micronutrients, increasing the suction surface of the mucus of the rumen and intestines, on the other, which affected the directed adsorption and exchange of nitrogen, mineral and biologically active substances. Zeolites regulate the humidity and acidity of the chyme, providing selective hydration of water and decomposition products, affect the direction and speed of gas-ion exchange (Sarsembayeva et al., 2008; Yarovan, 2018).

The biostimulating and biosynthetic effect of the premix is enhanced by the vitamin composition of chlorella, which increases the biological value of the diet of cows of the experimental group. This can be judged by the generalizing indicators of the efficiency of converting energy and protein from feed into products in the form of the coefficient and the degree of conversion of the consumed nutrients into the constituent components of milk. The use of biologically

Table 7. The effect of CCP on the conversion of feed, energy and protein of the diet.

Indicators	Consumed, kg/head	Produced in milk, kg/head	Conversion	
			coefficient	degree
Control group, Weight 3174 kg 2.88 OE 3.14% protein 3.94% fat				
Dry matter, kg	5135	412.6	12.45	0.080
Metabolic energy, MJ	41080	9141.2	4.49	0.222
"Crude" protein, kg	585.4	99.7	5.87	0.170
"Raw" fat, kg	169.5	125.0	-	-
Experimental group, Weight 3450 kg 2.90 OE 3.28% protein 4.09% fat				
Dry matter, kg	5265	448.5	11.74	0.085
Metabolic energy, MJ	42120	1000.5	4.21	0.237
"Crude" protein, kg	600.2	113.2	5.30	0.189
"Raw" fat, kg	173.7	141.1	-	-

active substances for ruminants should be known taking into account the microbial fermentation of the rumen, which is provided and confirmed by the results of enriching the diet of dairy cows with a zeolite-chlorella additive (Monnier and Dupont, 1983; Cheetham and Day, 1992).

The control of the utilization of consumed feed by dairy cows for the maintenance of vital activity and biosynthesis of products can be carried out according to the generalizing indicator of digestion and assimilation of nutrients in the form of conversion. Feed conversion in dairy cattle breeding varies according to lactation periods. Focusing on feed conversion in dairy cows is very important to optimize the use of consumed dry matter in order to increase the profitability of milk production on a long-term basis. The conducted scientific and economic experience in enriching the diet of dairy cows with zeolite-chlorella top dressing made up of natural compounds stimulates metabolic and microbiological processes in the rumen, which have a beneficial effect on the health and fertility of the body, the assimilation of consumed feed and increased milk productivity (Mumpton, 1999; Kleen et al., 2003).

4. Conclusions

1. The introduction of a complex zeolite-chlorella supplement from natural components into the feeding diets of dairy cows increases the mineral and vitamin nutritional value of feed diets and has a synergistic nutritional effect on scar metabolism and assimilation of feed nutrients;
2. Top dressing shifted the acidity of the contents of the rumen of cows from pH = 6.14 to pH = 6.17, which activated the ecosystems of microflora and increased the content of the amount of nnfusoria in the rumen chyme by 41.1 thousand/ml, the synthesis of LVH by 0.79 mmol/100ml more compared to the control group;
3. The increase in directed metabolism in the rumen of cows of the experimental group was reflected in an increase in the synthesis of acetates from 54.1±3.0 to 57.2±2.2 mmol/100ml and microbial protein 94.8% vs. 87.5% compared with the control, and also increased the enzymatic activity of the rumen chyme by amylases by 2.8 mg/starch, cellulose by 2.8%;
4. Acceleration of cicatricial digestion consumption of dry matter by cows of the experimental group up to 19.5 kg / head / day. against 19.02 kg/ head/day. in cows of the control group, it increased their average daily milk yields to 14.2 kg/head against 13.06 kg/ head and improved the quality of milk in protein content by 0.14± 0.02% and fat by 0.05± 0.01% with a decrease in the number of somatic cells 32.8 ± 6.03 about strengthening the health and immunity of cows of this group;
5. An increase in the level of erythrocytes by 15.2% and hemoglobin by 13.5% with an equal level of leukocytes in the blood of cows of the experimental group indicates an increase in oxidative recovery processes, an increase in milk synthesis with a feed conversion rate of 1.37 and a conversion rate of 0.72 compared, respectively, 1.45 and 0.68 in cows of the control group;
6. Strengthening of milk biosynthesis and improvement of its component composition increased the gross yield of protein during lactation - up to 4.19 kg / head, fat - up to 5.22 kg / head, which increased the degree of protein conversion of the feeding diet from 17.0% to 18.9% and metabolic energy from 22.2% to 23.7%, which indicates an increase in fat conversion and feed carbohydrates.

Acknowledgements

The authors would like to thank the management, specialists and employees of all farms who participated in collecting the necessary data for the study. The research results presented in this paper were carried out within the framework of the program-targeted financing of the program of the Ministry of Agriculture of the Republic of Kazakhstan: BR10764965 "Development of technologies for keeping, feeding, growing and reproduction in dairy cattle breeding based on the use of adapted resource-energy-saving and digital technologies for various natural and climatic zones of Kazakhstan", according to the budget program: 267 "Increasing the availability of knowledge and scientific research", subprogram 101

"Program-targeted financing of scientific research and activities" for 2021-2023 years, by priority: "Sustainable development of the agro-industrial complex and safety of agricultural products" by sub-priority: "Development of intensive animal husbandry".

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