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KOŠICE 2014

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ORIENTATION OF THE UNIVERSITY OF VETERINARY MEDICINE AND PHARMACY (UVMP) IN KOŠICE IN THE EDUCATION AND IN SPECIALIZATION OF VETERINARY PROFESSION

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The wide biological basis of profile in the undergraduate education of veterinary surgeons, the historically verified irreplaceability of the profession in the area of health, production and reproduction of animals, a key position in the field of environmental control, protection of population against foodborne diseases and dissemination of anthropozoonoses provide the basis for establishment of scientific branches within interdisciplinary specialization. The manufacturing practice and social requirements determine the need for internal specialization within the veterinary science and profession as well as expansion and direction beyond the basic core of veterinary activities. A priority task of veterinary profession is the orientation onto the following fields: animal sciences specializing in animal husbandry, organic food and food research branches; biochemical and biomedical sciences focusing on analytical, laboratory, and technological practice with a wide application in the biological interpretation of results; ecology and animal welfare as a part of protection of the environment from the point of view of macroclimate effects. A part of the modern veterinary science and practice is the influence on animal care in terms of microclimate and technological conditions of housing, treatment, nutrition and feeding, and the derived metabolic and production diseases of animals.

The analysis of contemporary status and profiling of the current trends in veterinary science and veterinary profession requires the identification of conditions and considering the effects in which the veterinarians follow their specific mission.

The priority requirements under the current circumstances of **veterinary medicine for food-farm animals** are the following:

- The shift from medical practice (diagnostic and treatment) oriented on individual animals to the group approach in the context of age, production and reproduction categorization.
- The biological approach with emphasis on more effective implementation of preventive and prophylactic measures in prevention of diseases rather than on treatment and chemotherapeutic procedures keeping in mind the significant aspect of economic efficiency.
- The programme of health control of herds of food animals with the exact definition, analysis, identification and the management of risks of critical control points for assurance of hygiene and safety of food s and raw materials of animal origin.
- The implementation of systems of nutritional prevention of health disorders based on the quality control and wholesomeness of feedstuffs, control of diet and feeding practices according to productive and reproductive phases, along with the legislative requirements on registration and traceability of feeds, integration of practical veterinary activities into a comprehensive system for generation of production health of livestock at farm level.

The **veterinary medicine for companion animals** focuses on the individual animal and, as a model, it is very close to clinical, diagnostic, therapeutic and preventive procedures in human medicine. The clinical practice of small animals, the research activities and obtaining new knowledge within the scope of species and the system specialization based on the knowledge of theoretical disciplines in terms of cell-organ-system studies support the development of medicine of companion animals towards improved animal health and improved quality of life.

The veterinary medicine in the field of food hygiene involving veterinary supervision of hygiene and wholesomeness of foods as a part of the protection of population against foodborne diseases together with the control of anthropozoonoses is an important part of public veterinary medicine.

The project of diversification of the university education is partially completed in these intentions considering interdisciplinary specialization of the University of Veterinary Medicine and Pharmacy in Kosice to accredited study programmes at all three levels of higher education.

The study programme "Cynology" in the full-time and part-time forms lasts for the standard length of 3 years (6 semesters). The graduate is awarded the degree *"Bachelor"* (Bc.). The teaching focuses on professional activities associated with the service, social and hunting cynology in the various professional spheres of society and covers all aspects of cynology utilization, i. e. professional, interest (free-time) and social. The students acquire knowledge in the field of biology, basics of ecology, ethology, morphology and physiology, ethics, nutrition, dietetics, genetics, breeding and keeping of dogs. The integral and profiling part of study is the direct knowledge of canine training and performance of dogs, appraisal of the exterior, special dog training and the related legislation, basic knowledge of diseases of dogs and exploitation of this knowledge in prevention of problems and protection of animal and human health.

The study programme "Safety of Feeds and Foods" is a study with standard length of 3 years (6 semesters). By graduation the graduate is awarded the degree *"Bachelor"* (Bc.). The graduate is capable of managing basic analytical procedures, and has adequate knowledge of biological standards and legislation related to the quality and wholesomeness of foods and feeds. He/she understands the basic technology of feed and food production and the primary basis for the implementation of security systems in the production and handling of feeds and foods. The graduate of bachelor›s study has the opportunity to continue with the study within one of two subsequent master›s degree programmes, the "Production, Animal Health and Environmental Protection" or "Market and Food Quality". By completion of these studies the graduates acquire the latest knowledge in the field of chemical and biological analyzes of feeds and foods. The graduate can use this knowledge in the analysis of foods and feeds with the focus on quality and safety.

The curriculum of the three-year study in the study programme "Animal-human relationship and its utilization in canine therapy and hippotherapy" focussed on the basic knowledge and principles of biological functions of humans and animals, the knowledge of behavioral biology, nutrition, animal husbandry and welfare, communication between man and animal, psychological therapy, pedagogy, developmental psychology, medical therapy and prophylaxis, assessment of health state, stress of animals, problems in human-animals relationship and related basic legislative provisions.

The study programme "General veterinary medicine" is implemented at the university in full-time study form at a standard length of 6 years (12 semesters). After successful graduation of this study programme the graduate is awarded the degree *"Doctor of Veterinary Medicine"* (abbreviated as "DVM."). The study programme is implemented in Slovak and English. The profile of the graduate involves professional activities in the field of state administration, within the Chamber of Veterinary Surgeons as a private veterinarian, in the field of laboratory practice, in the private sector of agriculture, in food and pharmaceutical industry, education, science and research and environmental protection. The study is aimed at understanding of biochemical processes in a complex with physiology of organs and systems considering the differences of individual animal species taught by theoretical and pre-clinical disciplines. The basic medical knowledge focuses on anatomy, histology, nutrition and dietetics, physiology and pathological physiology, pharmacology, toxicology, laboratory and clinical diagnostic. The theoretical and practical training in vocational subjects directed on veterinary therapy and especially on prevention with focus on environmental protection, deals with ecology and production of safe foods and raw materials of animal origin and application of the relevant knowledge in practice. The priority of study is the theoretical and practical training in vocational subjects according to animal species from the aspects of internal, infectious, invasive and toxic diseases. In the course of study the student gains knowledge about diseases common to humans and animals. He/she will be able to contribute to protection of human health and to decreased incidence of zoonoses in human population.

The five-year masters study programme "Pharmacy" leads to a graduate with competences in the health care branch, specifically in the field of pharmacy, research and quality control of drugs and medicines.The priority of the mentioned study programme is the knowledge about production of drugs and medicine, control of their quality, distribution, obtaining, storage and utilization of documents in this sector in the past and present. The graduate-pharmacist is a part of a team caring for health of humans and animals, actively contributing to the health by recommending drugs important for therapy within the system of care of individual patient›s health. They students gain knowledge about the effects of drugs on living organisms, their metabolism, biodegradation and elimination, adverse effects on the body and environment, drug residues and their impact on food quality, resistance and addiction to drugs or excipients.

The university also provides **higher education of the third level** in 17 accredited programmes in the full-time and part-time forms with the standard length of study 4 or 5 years (8 or 10 semesters). After successful completion of the study programme of the third level of higher education in one of the accredited branches of study, the student will obtain the title of "Doctor" ("Philosophiae Doctor" abbrev. "PhD.").

Evaluation of the effectiveness and quality of education and research at UVMP

The veterinary medicine and pharmacy belong to regulated professions in the European Union which have to meet the conditions specified by the EU Directive 2005/36/EC. For this reason, the efficiency and quality of education and research at the University of Veterinary Medicine and Pharmacy in Košice is evaluated at

national and international levels. It is evaluated by the Accreditation Commission of the Slovak Republic at the national level. The results of a comprehensive accreditation classified the university in the highest category of universities, to the category of university colleges. The UVMP was granted the right to provide study in the accredited study programmes, to perform habilitation procedures and procedures for appointment of professors, and according to evaluation of research activities the university is obliged to guarantee, to carry out and to develop research in the field of veterinary medicine, food and feed safety, environment and pharmacy.

The University of Veterinary Medicine and Pharmacy in Košice was subjected to the following evaluations:

- Evaluation by the Educational Commission of the European Association of Institutions for the Veterinary Education in Brussels (EAEVE — European Association Establishments for Veterinary Education) in 1996/1997,
- Evaluation of education approximation in the field of veterinary medicine between the Slovak Republic and the Commission of EU — TAIEX (2002),
- Re-evaluation by the Educational Commission of the European Association of Institutions for Veterinary Education with the location in Brussels (EAEVE — European Association Establishments for Veterinary Education) (2005—2006),
- Institutional assessment of the University by the European University Association (EUA — European University Association) (2006—2007).

According to results of evaluation of education approximation in the field of veterinary medicine between the Slovak Republic and the EU, the Commission of EU-TAIEX, based on the evaluation which was performed at the university in 2002, released a document confirming that the University of Veterinary Medicine in Košice meets the required EU standards and the diploma issued by The University of Veterinary Medicine and Pharmacy in Košice is accepted in the EU member states. Based on the decision of the European Commission for Veterinary Education of April 4, 2011, the University of Veterinary Medicine and Pharmacy in Košice was put on the list of „visited and approved establishments" which meet conditions specified by the Directive of the European Parliament and Council 2005/36/EC about the recognition of professional qualifications.

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VETERINARY CONTROL OF HEALTH, QUALITY OF PRODUCTION AND ECOLOGY OF DAIRY COW BREEDING

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ABSTRACT

The paper presents results of the official inspection of feeds in Slovakia for the year 2013, performed by the State Veterinary and Food Administration of the Slovak Republic (hereinafter referred to as the "SVFA SR") from the point of view of feed safety and compliance with the feed law. In the period under observation, totally 4739 official veterinary inspections for the purpose of evaluation of feed safety in the process of production, storage, distribution, trade and feeding on the farms were performed. Results of analyses showed that 1.45% of the total of examined feeds were not compliant. The most deficiencies (225) were found in animal products processing establishments.

Key words: feeds; official inspections; safety

INTRODUCTION

The SVFA SR develops methodical instructions in the field of feed hygiene for the unified procedures of respective authorities in order to ensure an effective functioning of veterinary administration authorities. The methodical instructions are directed at execution of official veterinary inspections, collecting of official samples for analyses and state the tasks and duties of the state administration authorities in the field of feed safety.

Each year the plan for taking of official samples is updated on the basis of results from the previous year, new legislation and according to the current situation. According to the need, also the plan of official inspections is updated.

MATERIAL AND METHODS

Official inspections

In the year 2013, the official inspections in the field of feed hygiene were performed by the DVFAs based on the methodical instructions issued by the SVFA SR Methodical Instruction — Taking of official feed samples in the year 2013 (Veterinary Prevention and Protection — VPP) and the Methodical Instruction — Official feed inspections. Official inspections were governed by the relevant legislation of the SR and legal EC standards.

The official veterinary inspections performed by the DVFA inspectors in the field of feed hygiene focused on the following:

- safety of feed and drinking water used for feeding of animals on farms,
- safety of feed in the process of production,
- safety of feed during storage and placing on the market, mainly feed materials of animal origin,
- safety of feed at trade within EC and export into third countries and
- a ban on feeding kitchen waste to food-producing farm animals.

In the year 2013 totally 4739 official veterinary inspections were carried out. They were performed in the following forms:

- routine planned veterinary inspections — 2985 inspections,
- planned inspections oriented only on taking official samples for analyses —1 300,
- veterinary inspections during trade and export related to certification — 388,
- dealing with impulses from the system RAPID ALERT — 2,
- target controls — 20,
- investigation of impulses and complaints — 5 and
- additional — subsequent inspections — 28.

RESULTS AND DISCUSSION

The complete overview of official veterinary inspections for the year 2013 by individual forms is shown graphically in Fig.1.

Taking of official feed samples (VPP)

Totally 1 582 official samples in the field of feed hygiene were taken. Totally 23 taken and examined official samples were non-compliant. Out of the total number of non-compliant samples 8 were samples of water used for watering of animals and 15 were feed samples.

The 8 non-compliant samples of water intended for watering of animals non-compliance was determined for the following parameters:

- 6× bacteriological indicators,
- 1× higher content of NO_2 and NO_3 and
- 1× exceeding the limit for heavy metals.

Fifteen samples of all examined feed samples, mainly compound feedstuffs, failed to meet the following required parameters:

- 2× fat acidity number and peroxide number — feed materials of animal origin,
- 2× processed feed — chewing gum — salmonella and Enterobacteriaceae,
- 1× prohibited substances — tetracyclines in compound feedstuffs for poultry, fish and pigs,
- 1× prohibited substances — tylosin in compound feedstuffs for poultry, fish and pigs,
- 2× coccidiostats — in complete compound feedstuffs for poultry and rabbits,
- 2× feed safety (salmonella, yeasts, moulds),
- 1× exceeded limit of Zn in compound feedstuffs for pigs,
- 3× concentration of medicaments in medicated feedstuff,
- 1× toxic substances — feed in case of suspicion of poisoning resulting in animal death.

The complete overview of taking of official feed samples according to commodities and targets of examination for the year 2013 is shown in Table 1 and graphical description of division of non-compliant results for the year 2013 is shown in Fig. 2.

Outside the plan totally 62 official samples were taken, out of these 3 samples were non-compliant.

Upon comparison with the year 2012, when there were 1.76 % non-compliant results from examination of official samples, in the year 2013 the proportion of non-compliant samples decreased to 1.45 %. As in previous year some samples of drinking water for animals were non-compliant.

Control of the ban on feeding of processed animal proteins

In the field of BSE prevention, concerning the requirements of Article 9 and Annex IV of Regulation 999/2001/EC, totally 775 veterinary inspections focused on observation of the ban on feeding of processed animal proteins to ruminants and on feeding of permitted animal feed materials to monogastric animals.

Totally 392 official samples were taken for the presence of mammalian proteins and out of these totally 78 samples were tested for the presence of bovine protein in feedstuffs for food-producing animals. All the samples were in compliance with the requirements of the relevant legislation.

The overall conformity in operators and products

Within routine planned veterinary inspections, 23 official inspections focused on violation of the relevant rules identified totally 28 deficiencies. As a follow-up 28 additional, inspections were performed focused on fulfilment of issued measures. The DVFAs issued 10 measures according to Article 8 and 7 measures according to Article 14 of the Act No 39/2007 Coll. by the DVFA inspectors for its removal. Totally 2 on-the-spot fines in the amount of 120 € were imposed. Totally 6 identified deficiencies were referred to another competent authority for resolving. In the year 2013, the official inspections were carried out by 51 DVFA inspectors.

Due to non-compliant results of analyses of official samples in 23 sample, totally 20 measures were issued and 9 non-compliant results of analyses were referred to another objectively and locally competent authority for investigation, or issuing of measures or sanctions.

The following deficiencies were identified upon official inspections:

- insufficient hygiene and improper storage of feeds,
- insufficient documentary evidence,
- non-compliant officially taken samples,
- incorrect marking of intermediate product of medicated feedstuff,
- the accompanying certificate for trade in medicated feedstuff was missing,
- the use of non-registered premix for the production of medicated feedstuff,
- non-submitted delivery notes for raw material and finished products,
- insufficient feeding of cattle in holding identified
- marking of feed not ensured,
- the permission from the DVFA for the use of feeds with the content of animal proteins was not issued.

Table 1. Official feed examination in 2013 — sampling according to commodities and targets of examination

Commodity/target of examination	Number of samples planned	Number of samples taken	Number of non-compliant samples
Drinking water — microbiological (*E. coli*, coliforms, TNM mesophiles)	39	39	6
Drinking water — NO_2 and NO_3	33	33	1
Drinking water — heavy metals (Cd, Pb, Hg, As, Ni)	40	40	1
Animal protein — cross-contamination — feeds for farm animals	315	314	0
Processed animal protein — generic representation — feeds for farm animals	80	78	0
Fat acidity number + peroxide number — feed materials of animal origin	34	34	2
NH_3 — feed materials, animal proteins as feed materials	34	34	0
Processed animal protein (PAP) — salmonella and Enterobacteriaceae	9	9	0
Blood products, blood meals, blood derivates — salmonella and Enterobacteriaceae	8	7	0
Rendered fat 3, fish fat — salmonella and Enterobacteriaceae	3	4	0
Milk compound feedstuffs — Salmonella and Enterobacteriaceae	20	20	0
Fish meal — salmonella and Enterobacteriaceae	14	11	0
Processed pet food (salami) – salmonella and Enterobacteriaceae	60	61	0
Processed feed — chewing gums – salmonella and Enterobacteriaceae	69	68	2
Canned pet food (cans) — anaerobic spore-forming microbes	40	40	0
Mycotoxins — aflatoxin B_1 — feed materials, complete compound feedstuffs and feeds	72	72	0
Mycotoxins — ochratoxin A — complete compound feedstuffs	30	30	0
Mycotoxins - DON (deoxynivalenol) — feed materials, compound feedstuffs, roughages	24	24	0
Mycotoxins — fumonizines B_1,B_2 — raw materials, suppl., compl. Roughages	20	20	0
Mycotoxins — zearalenon — feed materials and compound feedstuffs	28	28	0
Mycotoxins — T-2 and HT-2 toxin — compound feedstuffs, cereals and by-products thereof	20	20	0
Dioxins — roughages, compound feedstuffs for poultry and pigs	42	41	0
PCB — roughages for ruminants	40	41	0
Chlorinated hydrocarbons — DDT, HCH, HCB — all kinds of feeds	25	26	0
Organophosphates — all kinds of feeds	20	20	0
Prohibited substances — sulphonamides — compound feedstuffs	20	19	0
Prohibited substances — avilamycin — complete compound feedstuffs	20	20	0
Prohibited substances — tetracyclines — compound feedstuffs for poultry, fish, pigs	24	24	1
Prohibited substances — tylosin — compound feedstuffs for pigs, poultry, fish	20	20	1
Prohibited substances — β agonists — complete compound feedstuffs for food-producing animals	30	30	0
Prohibited substances — thyrostatics — compound feedstuffs for food-producing animals	20	20	0
Coccidiostats — compound feedstuffs	60	58	2
Feed safety — salmonella, yeasts, moulds,	130	131	2
Micro-elements — Cu — compound feedstuffs for sheep	28	28	0
Micro-elements — Zn — compound feedstuffs for pigs	31	31	1
Heavy metals (Cd, Pb, Hg, As, Ni) – roughages, feed materials	50	50	0
Medicament concentration (medicated preparations) — medicated feedstuff	34	28	3
Toxic substances — feed in case of suspicion of poisoning, animal death	0	1	1
Radioactivity — all kinds of feed	8	8	0
Total	**1 594**	**1 582**	**23**

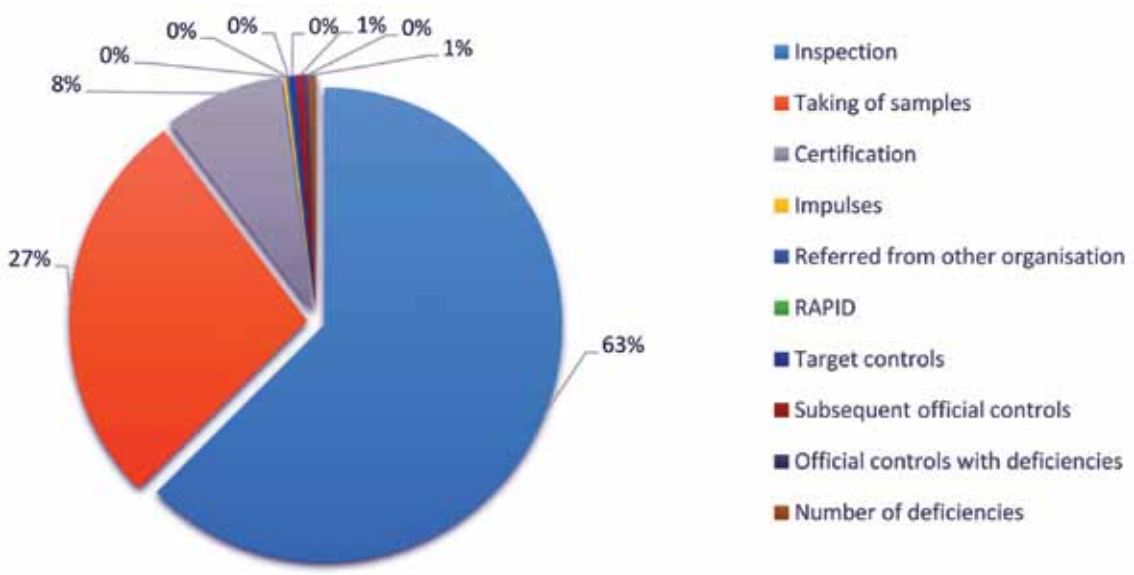

Fig. 1. Graphical presentation of official veterinary inspections conducted in 2013 according to individual forms of official inspections

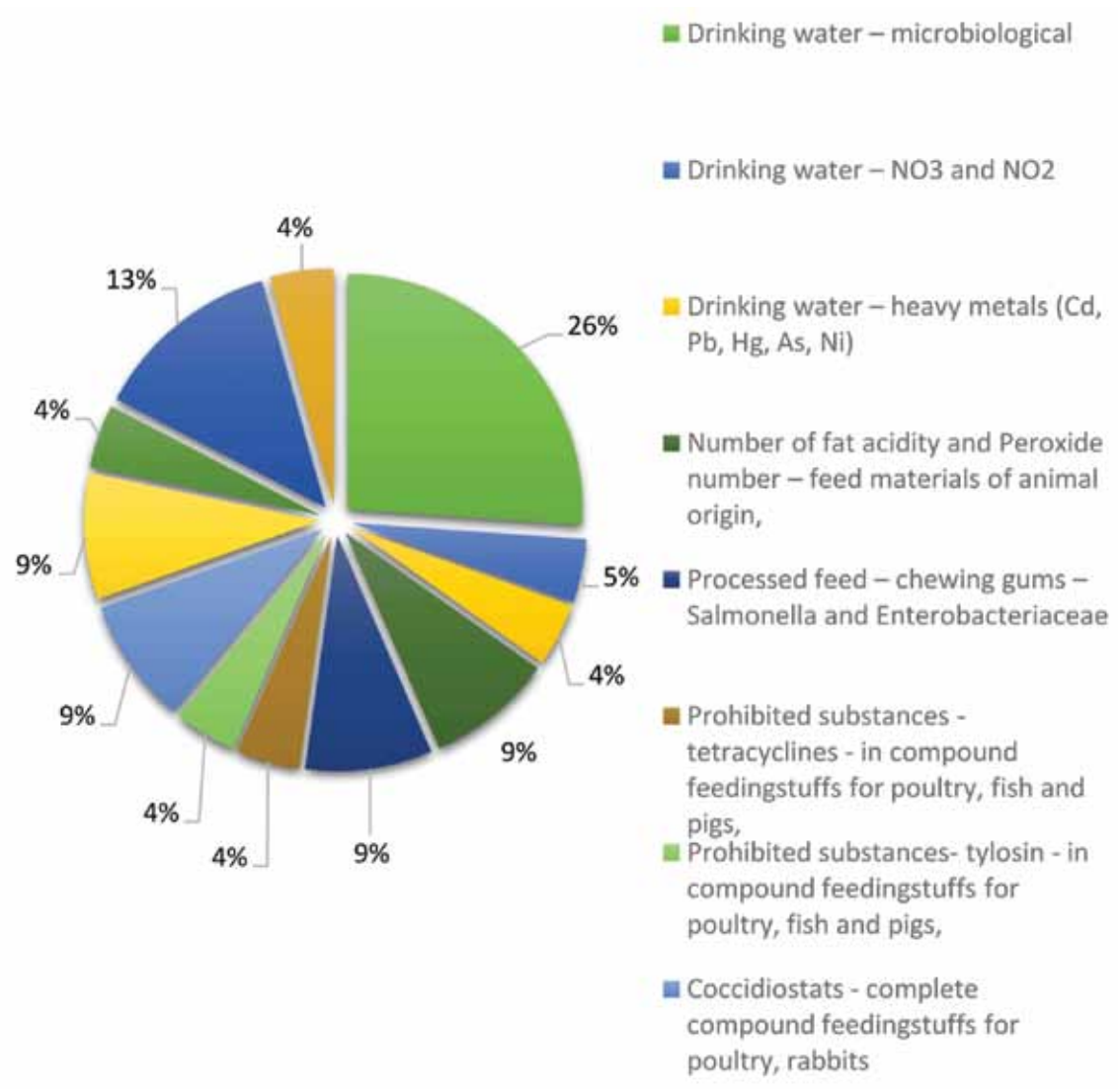

Fig. 2. Graphical presentation of proportions of non-compliant findings in 2013

Table 2. Results of the state supervision and official inspection in the field of ABP in 2013

2013	Total official inspections	Official inspections with deficiencies	Referred to another authority for resolving	Sanctions		
				Fines		Measures
				On-the spot fine	Administrative procedure	Art. 8, Art. 14
DVFA	10 140	169	3	17	10	68

Table 3. Results of official samples taken with respect to ABP in 2013

Target of examination	Number of samples planned	Number of samples taken	Number of non-compliant samples
Control of the processing process – (processing method 1 +7)	20	20	0
Egg products, processed shells, blood meals, blood derivates – salmonella and Enterobacteriaceae	5	2	0
Processed animal protein (PAP), hydrolysed proteins, gravies – salmonella and Enterobacteriaceae	18	17	0
Rendered fat 3, fat derivates – salmonella and Enterobacteriaceae	17	15	0
ABP from processed milk intended for direct feeding (raw whey, white water, slug from centrifugal machines and separators, colostrum, milk) – salmonella and Enterobacteriaceae	61	61	5
Raw feed for animals, intermediate product to feeds (chilled, frozen) – salmonella and Enterobacteriaceae	19	18	1
Processed pet food (salami, headcheese..), maggots and feed for fish – salmonella and Enterobacteriaceae	4	3	0
Processed feed (chewing gums, flavourings, granules) – salmonella and Enterobacteriaceae	15	10	1
Canned pet food (cans) – thermostat examination – salmonella and Enterobacteriaceae	1	0	0
Processed manure, organic manures (compost,…), soil improvers – salmonella and *E. coli*	20	18	2
Residues of digestion and compost – salmonella and *E.coli*	38	36	6
Rendered fats — remaining total insoluble impurities	7	7	0
Waste water from processing plants	6	6	0
Control of the disinfection effectiveness	113	111	0
Rendered fat 1,2/MBM 1,2-GTH	10	10	2
Rendered fat 3/PAP3-GTH	11	10	0
Organic manures, soil improvers from MBM2-GTH	8	8	0
Dioxins — rendered fats and fat derivates intended into feeds; PAP-production	8	4	0
PCB — rendered fat, fat derivates intended into feeds; PAP- production	8	7	0
Total	**389**	**363**	**17**

ANIMAL BY-PRODUCTS

Official inspections

In 2013 official inspections were performed also in the field of animal by-products (hereinafter referred to as "ABP") according to the methodical instruction on official inspections for the year 2013, plan for taking official samples — Veterinary Prevention and Protection 2013 and relevant legislation:

The subject of official veterinary inspections is compliance with conditions of handling, storage, disposal, processing, trade, collection, transport of ABP, usage in pursuance of the current legislation. The following approved subjects and activities are subject to veterinary inspection: processing plants, incineration plants, co-incineration plants, intermediate plants, collection centres, warehouses, technical plants, oleo-chemical plants, producers of pet food, treatment of game trophies, composting, manure processing, biogas plants, blood processing, plants for processing of hides, wool, feather. Registered activities such as collection, transport, placing on the market of animal by-products from dairy industry for feeding and trade are also subject to veterinary inspection. Among the permitted exceptions of users according to Article18 of Regulation No 1069/2009/EC it concerns mainly feeding of animal by-products to dogs from recognised kennels or packs of hounds, dogs and cats in shelters, zoo animals, pet animals and fur animals.

By the amendment of the Act on Waste as from 01. 01. 2013, separation of kitchen waste became compulsory and subsequently its further use. Thus the kitchen waste and its further handling (transport, storage, processing) falls into ABP and the number of operators and official inspections was increased. The SVFA SR keeps the list of approved, authorized, and registered operators handling ABP or derived products in a prescribed form at www.svssr.sk. In the year 2013, based on the data provided by DVFAs, totally 241 subjects were approved and authorized by administrative procedure. Totally 54 binding opinions and 52 standpoints were issued. In this relation the SVFA SR allocated or withdrew official numbers for approved subjects for the year 2013 in number of 90. It issued the confirmation on registration for 95 subjects and all subjects were at the same time included in the list. By way of derogation in respect of feeding, totally 118 new subjects were recorded in the list.

The SVFA SR within its approval activity performed 11 veterinary inspections, issued 6 decisions within approval procedure of processing plants, biofuel production and incineration plants. Based on 8 decisions, the derogation in respect of the use of ABP for diagnostic and scientific research was permitted. For the trade in ABP material of Category 1 a 2, totally 27 decisions on permission for consignments from Italy, Croatia and Hungary were issued.

The total number of subjects that were subject to inspection in the year 2013 was 936, the number of performed official inspections in these subjects was 1 932.

A separate field of veterinary control is the official control in ABP producers, among which belong all animal keeping farms and their owners, all establishments processing animal products (the number of ABP producers in the year 2013 was approx. 20 154 including trade network, where foods of animal products are sold). In this field totally 8 108 official inspection focused on requirements with respect to ABP handling were performed.

Occurrence of discrepancies

In 2013 totally 225 deficiencies were detected during 169 inspections. In this relation totally 68 measures for removal of deficiencies were issued and in 27 cases fines were imposed. In 2013 there were 34 impulses related to reporting non-compliance with ABP handling (waste from slaughtered animals, dead animals, FBO) in a forest, behind a village and the like. The extent and the nature of identified deficiencies in the ABP field in 2013 did not pose serious risk for animals and humans. The measures issued were observed and deficiencies removed.

The reasons for identified deficiencies were mainly ignorance of legislation, however, also deficiencies arising from non-settlement of financial obligations towards the processor who subsequently refused the collection and transport of ABP were found. To achieve compliance of producers and processors of ABP, various sanctions adopted within official inspections in compliance with the relevant legislation in the respective field were imposed.

Taking of official samples

Totally 363 official samples were taken within VPP 2013 by DVFA veterinary inspectors for analyses by which the compliance with rules and safety of products placed on the market were verified. In 17 cases discrepancies were identified and totally 17 measures for their removal were adopted, 2 non-compliant results were referred for further investigation to Italy.

CONCLUSION

The paper presents analysis of the results from official inspections carried out in 2013 with respect to feed safety at all stages of the feed chain. Most deficiencies were identified at operators who produce or process animal feeds.

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ILEAL DIGESTIBILITY OF PROTEIN AND AMINO ACIDS OF PROTEIN FEEDSTUFFS

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ABSTRACT

Knowledge of the profile of amino acids of rumen-undegradable protein can help to formulate diets to provide amino acids that complement microbial protein as well as supply amino acids which are most limiting for milk production. The obtained values of rumen degradability of crude protein with significant difference (P < 0.001) between feeds ranged from 20.3 to 76.3 % (mean 62.0 ± 17.9 %) and values of total amino acids ranged from 30.9 % in Albumex to 83.8 % in Amygold (mean 67.5 ± 16.4 %). Intestinal digestibility of undegraded proteins varied from 54.5 % in raw soybean to 95.2 % in Amygold. The absorbable amino acid profile of rumen-undegraded protein for each feedstuff was compared with profiles of the original feedstuff and the rumen-exposed undegraded proteins.

Key word: absorbable; intestinal; lysine; methionine; protein

INTRODUCTION

Total milk yield and milk protein production by high-yield dairy cows is limited due to inadequate intake of certain amino acids.The amino acid profile of the intestinal contents in dairy cows depends on the amino acid (AA) content of microbial as well as rumen undegradable protein (RUP) and their intestinal digestibility [6]. The amino acid profile and intestinal digestibility of individual AA of RUP vary widely among and within feedstuffs [3], [5]. Therefore, intestinal digestibility of RUP has become an important variable in recent protein evaluation systems for ruminants [2]. Current feed evaluation and formulation is generally based on mean tabelated values for the content and digestibility of amino acids of the individual feedstuffs. New approaches for analysis of digestible AA based on rapid *in vitro* and in situ analysis technique appear to result in more correct estimates of the relevant nutritional needs.

The main objectives of this study were to determine intestinal digestibility of crude protein, amino acid composition of rumen-undegradable protein, and intestinal digestibility of amino acids in rumen undegradable protein from several feedstuffs with high crude protein concentration.

MATERIAL AND METHODS

Feed samples were analyzed for dry matter (DM), crude protein, crude fibre, and ether extract according to conventional methods (Committee regulation ES No.152/2009 of 27. 1. 2009).

Parameters of rumen degradation of crude protein (CP) were determined, using methods in situ [4]. After ruminal degradation, bags were rinsed with cold water to remove particulate matter. The intestinal digestibility of RUP of selected protein feeds was performed by a modified three-step method (MTSP) [1]. Samples were incubated in a Daisy^{II} incubator in 0.1 N HCl solution (pH 1.9) for 1 h. After pepsin digestion, the samples were incubated for 24 h in a pancreatin solution (pH 7.75). Samples of feeds and bags residues after ruminal degradation and ileal digestion were analyzed for AA

using an amino acid analyser AAA 400 (INGOS, Czech Republic). The methods incorporated an ion-exchange column, multiple sequential sodium-based eluents, and sodium hydroxide for column regeneration.

RESULTS AND DISCUSSION

The DM content ranged from 864 to 953.9 g.kg^{-1}. The CP content of selected feeds varied from 205.7 to 748.4 g.kg^{-1} DM with different amino acid profile among feedstuffs. Intestinal digestibility of CP (IDP) of RUP (Table 1) was estimated by a modified method described by Gargallo et al. [1]. The mean intestinal digestibility of CP was 78.4 ± 13.0 %. The rumen degradability of CP, as well as the intestinal digestibility of CP of RUP in experimental protein feeds showed much higher variability ($P < 0.01$). Effects of thermal treatment on rumen degradability of CP and intestinal digestibility of RUP that were observed in this study are consistent with the findings of several studies which evaluated protein feeds. Stern et al. [7] estimated RUP of processed products of soybean from 23.2 to 68.3 % and intestinal digestibility of protein for non-enzymatically browned soybean meal ranged from 57.7 % to 83.8 %, respectively. Intestinally absorbable digestible protein (IADP) is defined as the amount of protein from a specific feed that is available for absorption in the small intestine. The mean IADP reached 30.1 ± 15.7 % (Table 2), with more variable values of IADP found between feeds. Values of IADP ranged from 13.1 ± 4.2 to 67.5 ± 6.4 % for RS and CGM. Total tract digestibility of crude protein (TDP) was calculated as a sum of RDP and IADP. The mean of total digestibility in the tested feeds was 92.1 ± 5.3 %. There was a small but significant difference in total digestibility of protein of feedstuffs (Table 2). TDP of Soypass was lower than 85 %; it is the

Table 1. Protein digestibility of experimental feeds

Feedstuffs	RDP (%)	IDP % of CP	IADP % of CP	TDP % of CP
Raw soybean (RS)	76.0 ± 8.8	54.5 ± 1.4	13.1 ± 4.2	89.1 ± 4.6
Soybean meal (SM)	71.0 ± 1.8	90.1 ± 0.6	26.1 ± 1.4	97.1 ± 0.4
Hyterso (TS)	66.8 ± 5.6	80.9 ± 0.4	26.9 ± 5.3	93.7 ± 0.3
Soypass (SP)	46.5 ± 1.7	62.8 ± 0.1	33.4 ± 1.6	80.2 ± 0.1
Sunflower cake (SC)	53.1 ± 0.8	90.2 ± 0.1	42.3 ± 0.6	95.4 ± 0.1
Rapeseed cake (RC)	60.5 ± 3.1	81.3 ± 1.4	32.1 ± 1.9	92.6 ± 1.2
Malt culms (MC)	76.3 ± 2.4	74.0 ± 4.0	17.5 ± 0.1	93.8 ± 2.4
Brewers grains (BG)	74.5 ± 1.4	70.2 ± 1.8	17.9 ± 0.1	92.4 ± 1.2
Corn gluten feed (CGF)	74.8 ± 0.1	95.2 ± 1.9	24.0 ± 0.7	98.8 ± 0.4
Corn gluten meal (CGM)	20.3 ± 0.5	84.7 ± 7.3	67.5 ± 6.4	87.8 ± 8.3
X ± SD	62.0 ± 17.9	78.4 ± 13.0	30.1 ± 15.7	92.1 ± 5.3
SEM	**5.662**	**4.101**	**4.969**	**1.685**

Table 2. Intestinally absorbable lysine and methionine supplied by the rumen undegradable proteins of feedstuffs

AA g.kg^{-1} of CP	RS	SM	TS	SP	SC	RC	MC	BGD	CGF	CGM
Lysine (Lys)	10.5	10.1	9.5	8.5	8.0	6.0	7.6	7.4	5.6	4.2
Methionine (Met)	1.8	2.2	1.7	2.0	2.5	1.3	1.7	2.0	3.3	3.9
Lysine : methionine	5.8	4.7	5.9	4.3	3.2	4.6	4.4	3.8	1.7	1.1
EAA	61.5	71.7	63.7	57.9	62.0	43.5	40.1	57.8	66.0	44.1

only one from all selected feeds. Total digestibility of protein varied from 80.2 % for Soypass to 98.8 % for CGF.

The estimated intestinally absorbable amount of lysine and methionine (g.kg^{-1} of CP) supplied by the RUP fraction of protein feeds is presented in Table 2. Absorbable Lys was greatest for products of soybean, ranging from 8.5 to 10.5 g.kg^{-1} of CP (Table 2). The remaining feeds (SC, RC, MC, BGD, CGF and CGM) had values of absorbable Lys in range of 4.2—8.0 g.kg^{-1} of CP. CGF and CGM supplied more absorbable Met (3.6 ± 0.4 g.kg^{-1} of CP on average) than products of soybean and the other analysed feeds. RC and MC supplied less absorbable EAA compared with other feeds. Difference in absorbable AA among feedstuffs resulted mainly from differences in rumen degradability and degree of digestion in the small intestine.

CONCLUSIONS

The values of IADP of evaluated feeds will help to control of the quality of protein feeds as sources of RUP for ruminants.Value of IADP or absorbable AA can be used as a guideline to select protein supplements for high producing dairy cows. Such information concerning intestinal digestibility of AA of RUP and absorbable EAA is needed for the development of diet formulation models to optimize the AA nutrition of dairy cows.

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CONCENTRATIONS OF ZINC, SELENIUM AND COPPER IN BLOOD OF GOATS AND THEIR KIDS AFTER FEEDING INORGANIC OR ORGANIC FORMS OF THESE ELEMENTS — PRELIMINARY REPORT

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ABSTRACT

The aim of the study was to compare blood Zn, Se and Cu concentrations of goats and their kids and the effect of supplementation of inorganic and organic forms of these trace elements on metabolism of the microelements in the mother and it's young. Blood was collected from goats and their kids before first intake of colostrum on the day of parturition (day 0) and days 2 and 7 postpartum. Blood of kids before the first intake of colostrum was characterized by a significantly lower mean concentration of Zn (percentages of Zn concentration in blood of kids were 62—68 % of that in the maternal blood), Se (51—57 %) and Cu (32—43 %) compared with the mothers. A significant increase in blood Zn and Cu concentrations of the kids and significant decrease in the mean Se concentration occurred during the experimental period. The results of Zn concentration in blood of goats and their kids showed no significant differences between groups. Our results are suggesting that the inorganic form of Se and Cu is more efficient than organic one in influencing the Se and Cu metabolism in goat — kid relationship.

Key words: metabolism; nutrition; ruminants; trace elements

INTRODUCTION

Trace minerals are supplied to the animal's body mainly by feed but also may come by transplacental way during pregnancy. Deficiencies of trace minerals in animals are quite common in the Czech Republic [6]. Recently the research was aimed at supplementation of different chemical forms of trace elements to animals, especially to cattle [1], [4]. However, nutrition and metabolism in different species have to be studied individually in different animal species as the results differ even between different species of ruminants [2], [3].

The aim of our experiment was to study trace mineral metabolism in goat — kid relationship supplemented with inorganic and organic forms of microelements.

MATERIALS AND METHODS

The study was carried out as three experiments that were a part of the project MSM6215712403. The experiments involved pregnant goats 6—8 weeks before expected date of delivery. Animals were divided into 3 groups (one control group — not supplemented; two groups supplemented with inorganic and organic forms of microelements). All goats received the same feed rations that differed only by the content or by the form of the added microelement (Zn, Se or Cu). Goats in the Zn trial received supplemented feed mixture (FM) to which Zn (60 $mg.kg^{-1}$) was added in either inorganic (zinc oxide — group Zn-AN) or organic form — zinc lactate (Zinc Chelate, Agrobac, CR — group Zn-OR). Control group (Zn-C) received unsupplemented FM with natural content of Zn 21 $mg.kg^{-1}$. Goats in Se trial received FM with Se (0.9 $mg.kg^{-1}$ DM) added in either inorganic (sodium selenite; group Se-AN) or organic form (lactate-

protein complex; Selene chelate, Agrobac, CR; group Se-OR). Control group (Se-C) received unsupplemented FM with natural content of Se 0.15 mg.kg^{-1}. Goats in the Cu trial received FM with Cu (30mg.kg^{-1}) added in either inorganic (cooper sulphate; group Cu-AN) or organic form (Cu chelate, Bioplex Cu, Alltech, USA; group Cu-OR). Control group (Cu-C) received unsupplemented FM with natural content 10 mg Cu.kg^{-1}. Blood samples from all goats and their kids were collected on the day of parturition — Day 0. Other samples were collected from kids 2 and 7 days after delivery. The results were statistically evaluated by *F*-test and Student *t*-test.

RESULTS AND DISCUSSION

The blood concentrations of Zn, Se and Cu in goats and their kids are presented in Tables 1 to 3. All trace minerals concentrations were significantly higher in goat's blood in comparison with their kids. The values of blood Zn concentration in kids reached on average 62—68 % of their mother's values, while with Se it was 51—67 % and with Cu only 32—43 %. Blood Zn and Cu concentrations in kids increased rapidly and 2 days after delivery the Zn values in kids reached

Table 1. Concentrations of Zn (μmol.l^{-1}) in blood serum of goats and their kids in individual groups of animals

Group	Goat day 0	Kids day 0	Kids day 2	Kids day 7
Zn-C (n = 10)	9.2 ± 1.9^{+}	5.8 ± 2.5	15.3 ± 4.5**	16.7 ± 2.0
Zn-AN (n = 9)	9.0 ± 0.8^{+}	6.1 ± 1.5	16.0 ± 6.4**	17.2 ± 2.7
Zn-OR (n = 8)	10.5 ± 2,0^{+}	6.1 ± 1.5	13.6 ± 5.5**	16.0 ± 3.6
Differences between groups	ns	ns	ns	ns

$^{+}$ — P ≤ 0.01 compared to Zn in blood of goats and kids on day 0 (in one row
** — P ≤ 0.01 compared to Zn concentrations in kids (day 2 vs. day 0); ns — (P > 0.05) in comparison to values in one column

Table 2. Concentrations of Se (μg.l^{-1}) in whole blood of goats and their kids in individual groups of animals

Group	Goat day 0	Kids day 0	Kids day 2	Kids day 7
Se-C (n = 8)	111.1 ± 36.0^{+}	60.2 ± 23.7	55.3 ± 21.9	53.9 ± 21.1
Se-AN (n = 9)	155.2 ± 41.1^{+}	99.7 ± 32.6	96.8 ± 37.8	77.4 ± 37.3**
Se-OR (n = 8)	155.9 ± 30.6^{+}	74.3 ± 26.5	69.4 ± 10.0	52.5 ± 21.0*
Differences between groups (in one column)	C : AN p = 0.03 C : OR p = 0.02 AN : OR ns	C : AN p = 0.01 C : OR ns AN : OR ns	C : AN p = 0.01 C : OR ns AN : OR ns	ns

$^{+}$ — P ≤ 0.001 compared to Se in blood of goats and kids on day 0 (in one row)
** — P ≤ 0.01; * — P ≤ 0.05 compared to Se in kids (day 7 vs. day 2); ns — (P > 0.05)

Table 3. Concentrations of Cu (μmol.l^{-1}) in blood serum of goats and their kids in individual groups of animals

Group	Goat day 0	Kids day 0	Kids day 2	Kids day 7
Cu-C (n = 8)	15.2 ± 4.7^{+}	5.9 ± 1.1	7.7 ± 1.5*	13.9 ± 2.9***
Cu-AN (n = 8)	19.5 ± 1.8^{+}	6.5 ± 1.0	9.2 ± 1.4***	15.1 ± 1.7***
Cu-OR (n = 6)	18.5 ± 2.7^{+}	5.9 ± 0.5	8.7 ± 1.6**	16.1 ± 2.9***
Differences between groups (in one column)	C : AN p = 0.04 C : OR ns AN : OR ns	ns	C : AN p = 0.05 C : OR ns AN : OR ns	ns

$^{+}$ — P ≤ 0.001 compared to Cu in blood of goats and kids on day 0 (in one row); *** — P ≤ 0.001
** — P ≤ 0.01; *P ≤ 0.05 compared to Cu of kids (in relation to the previous day); ns — (P > 0.05)

133—180 % of mother's values on the day of parturition. The increase in blood Cu concentration in kids was not as rapid. On the day 2 it reached 47—55 % of their mother's values and on day 7 the levels of blood Cu in mothers and the kids were similar. Blood Se concentration did not increase in the kids and there was even some decrease on days after the delivery.

The above results clearly show the difference between ruminant species for the mother — young relationship. Unlike the goats, there are significantly higher values of Zn in the blood of calves compared to their mother's values while the opposite is true for Cu values. Blood Se concentrations in calves did not differ from those of their mothers [5].

When comparing the effect of supplementation of inorganic and organic forms of trace elements we found no difference in the case of Zn while for Se and Cu we better results were obtained with the use of inorganic forms used for Se and Cu supplementation (Tables 1 to 3).

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NUTRITIONAL VALUE AND THE DIGESTIBILITY OF ALFALFA IN DEPENDENCE ON GROWING CONDITIONS

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ABSTRACT

Stands of alfalfa (*Medicago sativa*) cultivated under two different soil-climatic conditions in the production zone of lowland (A) and in the higher-elevated submontane production zone (B), were monitored for their nutritional value. The parameters in the A lowland production zone were as follows: crude protein (CP) 340.07—197.39 g.kg^{-1} dry mater (DM), neutral detergent fibre (NDF) 207.96—449.81 g.kg^{-1} DM, acid detergent fibre (ADF) 161.19—359.56 g.kg^{-1} DM. The ash content varied from 107.46 to 88.8 g.kg^{-1} DM with a declining tendency depending on the aging of stand. The weight ratio of leaves and stems was 39.3 %: 60.7 %, digestibility of NDF in the rumen at harvest 44.3 % and degradability of CP 81.7 %. In the alfalfa grown in production area B, CP reached 286.8 g.kg^{-1} DM at first sampling and gradually decreased to 138.5 g.kg^{-1} DM when the alfalfa crop was at the stage of full flowering. The contents of NDF were increasing from 244.9 to 532.5 g.kg^{-1} DM, and the ADF from 217.9 to 423.7 g.kg^{-1} DM.

Key words: alfalfa; climatic conditions; digestibility; nutritional value

INTRODUCTION

The soil and climatic conditions, the vegetation stage and a harvesting technique significantly affect the production of alfalfa. The pH value of soil should be higher than 5.7 in sandy soils and higher than 6.2 in heavier soils [2]. The alfalfa is a fodder plant that requires enough moisture especially in the initial stages of development [4]. Temperature, shortage of water and soil fertility are the most important environmental factors affecting the yield and quality [3]. Lowland is the area most suitable for alfalfa [1]. The optimal harvest time of alfalfa depends on its vegetation stage, but it is significantly influenced by weather. Rajčáková et al. [5] stated that in the year with the lack of humidity a faster lignification and higher content fibre are observed in alfalfa in the case of an earlier harvest dates too. At the beginning of flower buds formation, the concentration of nutrients in alfalfa feed is the highest so is the feed digestibility. The further aging leads to degradation of alfalfa quality, decline in overall digestibility and energy value of the feed [6].

The aim of the study was to observe the content of nutrients and their digestibility in alfalfa from two localities with the different soil and climatic conditions.

MATERIAL AND METHODS

Samples of alfalfa were collected from lowland production area (A) between April 21 and May 15, 2013. The alfalfa stand was in the vegetation stage before creation of flower buds at the beginning of sampling and the vegetation stage reached the beginning of flowering at the time of last sampling.

Samples of alfalfa were taken also from foothill production area (B) between May 1 and June 6, 2013. The sampling began when the

flower buds started to form and continued until the vegetation stage of full flowering of the stand. We measured heights of stands and the ratio of weights of leaves and stems at sampling in both localities. The samples were analysed for the content of dry matter (DM), crude protein (CP), acid detergent fibre (ADF), neutral detergent fibre (NDF) and ash.

The degradability of crude protein in the samples was observed *in vivo* in a cannulated cow. Bags with samples were inserted into the rumen for 16 h for determination of rumen digestibility and for 30 h for determination of NDF.

RESULTS AND DISCUSSION

The content of CP in the alfalfa stand samples from the lowland area (A) reached 340.07 g.kg^{-1} DM at the beginning of sampling and decreased to 197.39 g.kg^{-1} DM by the end of sampling. The aging of alfalfa caused increase in NDF content from 207.96 to 449.81 g.kg^{-1} DM and ADF content from 161.19 to 359.56 g.kg^{-1} DM.

The weight ratio of leaves and stems was 39.3 % : 60.7 %. At the time of harvest the crop height was 82.4 cm. The NDF digestibility and the CP degradability in the rumen at the time of harvest was 44.3 % and 81.7 %, respectively. The sampling of alfalfa from the second plot (B) in higher-elevation area began on May 1. DM content in the analysed samples ranged from 18.3 to 19.3 %. The highest content of CP was detected at the first sampling (286.8 g.kg^{-1} DM) and gradually decreased down to 138.5 g.kg^{-1} DM at the final sampling when the stand of alfalfa crop was in full flowering stage. The content of NDF increased with aging from 244.9 to 532.5 g.kg^{-1} DM and the content of ADF from 217.9 to 423.7 g.kg^{-1} DM. The mean degradability of CP in the rumen was 79.6 % and digestibility of NDF reached 36.5 %. The proportion of leaves to stems was 31.4 % : 61.6 %. The CP content in alfalfa leaves was higher by 43.3 % than in stems (366.7 versus 208.1 g.kg^{-1} DM) at the beginning of sampling period and in the a fully flowering stand it was increased by 61.3 % (265.4 versus 102.8 g.kg^{-1} DM). Porvaz et al. [4] confirmed that the variability of weather conditions greatly affects the economic production of alfalfa. The sensitivity to precipitation intensity was ascertained mainly in the first mowing. We observed an increase in production in the stand which was in the fourth year of cultivation in the locality (B) where it was raining heavily in the growth period.

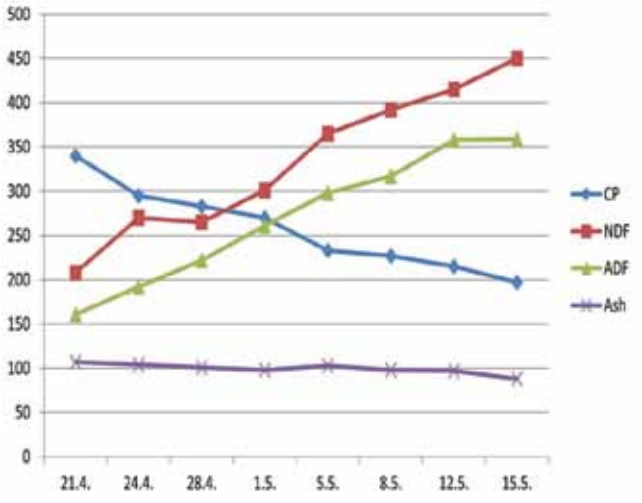

Fig. 1. Content of nutrients in alfalfa from the locality A [g.kg^{-1} DM]

The alfalfa stand A was cut in the stage of bud formation with the content of CP almost 20 %, NDF above 45 % and mean height of plants 82.4 cm. CP degradability in the rumen reached 78 % and NDF digestibility 45 %. The mentioned parameters indicate a slightly shifted term in comparison to optimal harvest time. The alfalfa stand B which was mowed in the late vegetative stage at the time of full flowering exhibited worse nutritional values — CP 13.8 %, ADF 39 % and NDF 49.5 %. The mean height of this stand was of 105 cm. The late harvest was caused by intensive precipitation activity. The digestibility of NDF and degradability of CP in the rumen for both observed stands was equal to approximately 33.5 % or 37.3 % and 78.2 % or 78.6 % of those harvested in the optimum vegetation stages. Despite the late beginning of vegetation period, the optimum stage for harvest for both observed stands was in the period of usual agrotechnical term for the first mowing, i. e. in the half of May. The mean daily decrease in CP content in stand A was 5.7 g.kg^{-1} DM and 4.0 g.kg^{-1} DM in stand B. The climate had minimum influence on maturation and nutritional quality of alfalfa. The intensive precipitation significantly increased production of plant biomass in the locality B where some individual plants reached height of 140 cm. However, the precipitations caused harvest delay and caused decline in nutritional and dietary characteristics of alfalfa plants.

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EFFECT OF SOURCE OF STARCH ON DIGESTIBILITY OF NUTRIENTS IN SHEEP

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ABSTRACT

The aim of the study was to determine the effect of different sources of concentrates on digestibility of nutrients in sheep. The first diet contained meadow hay, pea seed, oat and barley grain (Diet A). The second diet consisted of meadow hay, pea seed, oat and corn grain (Diet B). The concentrates were ground. The study was performed on six castrated male Tsigaia sheep. They were castrated at about one month of age. Animals were fed twice a day, at 06 : 30 a. m. and 07 : 30 p. m. An 11-day adaptation period was followed by a 5-day experimental period. During the experimental period faeces and urine were collected per 24 hour and mean samples were examined chemically. Higher digestibility of dry matter (78 %), crude protein (78 %), crude fat (70 %), nitrogen free extract (85 %) and organic matter (80 %) was detected for Diet A. In comparison with Diet B the difference in digestibility of crude protein was 1 %, crude fat 2 %, nitrogen free extract 2 % and organic matter 1 %. In Diet B we found significantly ($P < 0.05$) higher crude fibre digestibility coefficient (65 %) in comparison with Diet A (63 %).

Key words: barley; corn; digestibility of nutrients; sheep

INTRODUCTION

In terms of subsidies of metabolic processes the energy utilization of starch in cereals is important in all species [9]. Except for corn, 95 % of starch of other cereals is degraded in the rumen. This means that only small amount of glucose is available for digestibility and resorption in the small intestine. During feeding of slowly degraded starch (for example corn) and higher intake of feeds it is possible to affect the rumen fermentation and increase transport of by-passing starch into the small intestine, but production is not proportional to that [10]. According to the source of starch and level of starch intake 50 % to 95 % of starch is degraded in the rumen and incoming amounts to the small intestine are variable. The digestion of starch in the small intestine is by 42 % more effective than its degradation in the rumen. Between individual feeds there are differences not only in the starch content, but also in the starch quality according to which there are differences in the range and rate of starch degradability in the rumen [1], [3], [5].

The aim of this study was to find the impact of feeding different sources of starch (barley and corn starch) on digestibility of nutrients in sheep.

MATERIAL AND METHODS

The experiment was performed on six castrated male Tsigaia sheep with mean live weight 43.3 kg. The animals were housed individually in balance cages. The feed was served twice a day at 6 : 30 a. m. and 18 : 30 p. m. Water was available *ad libitum*. The adaptation period was 11 days and the experiment lasted 5 days. The base of daily diet was meadow hay. Barley, peas and ground oat were added into rations (Diet A). Ground corn which substituted

barley was added into the Diet B. Hay was served at first and after that we added feed grains.

Table 1. Composition of daily diets in kg.day^{-1} dry matter

	Meadow hay	Peas seed	Barley grain	Oat grain	Corn grain
Diet A	0.36	0.30	0.17	0.18	–
Diet B	0.36	0.30	–	0.18	0.16

Starch concentration was determined polarometrically and organic analysis of feeds was carried out according to the Act MPSR 2145/2004-100. The calculation of energy concentration and PDI was made according to digestibility coefficients [6]. During the experiment we collected excrements and urine eliminated for 24 h periods, pooled them, weighed, homogenized and examined chemically the mean samples. The significance of differences between daily diets was evaluated by Fisher LSD test with Statgraphics, ver. 5.0.

RESULTS AND DISCUSSION

Digestibility coefficients of dry mater and nutrients are presented in Table 2. Higher digestibility of dry mater (78 %), crude proteins (78 %), fats (70 %), nitrogen free extracts (85 %) and organic matter (80 %) was found in animals fed Diet A. In comparison with Diet B there were differences in digestibility of crude proteins (1 %), fats (2 %) and organic matter (1 %). In Diet B group the digestibility coefficient of fibre was significantly ($P < 0.05$) higher (65 %) compared to Diet A group (63 %). Digestibility of starch reached 99 % in A group and 98 % in B group. Our previous research showed that apparent digestibility of starch is not significantly influenced by diet in the case of low starch levels. The same was indicated also by other authors [7]. In the case of high starch content in daily rations the digestibility of organic matter and crude proteins was higher [2], [4], [8].

CONCLUSION

In conclusion we can state that we found differences in digestibility coefficients depending on feeding different starch sources.

ACKNOWLEDGEMENTS

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Table 2. Digestibility of nutrients (means and SD)

Nutrients	Group						Significance of differences $^{+}$ — P ≤ 005 $^{++}$ — P ≤ 0.01
	A (ground barley)			B (ground corn)			
	$\bar{x}$	SD	%	$\bar{x}$	SD	%	
DM	78	2.65	3.39	76	2.86	3.76	+
CP	78	3.12	4.00	77	3.76	4.88	–
Fat	70	2.97	4.24	68	2.65	3.89	+
NFE	85	3.28	3.86	83	3.46	4.17	+
Starch	99	0.97	0.98	98	0.82	0.84	–
Fiber	63	2.13	3.38	65	2.27	3.49	+
OM	80	3.28	4.10	79	3.84	4.86	–

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CONCENTRATIONS OF MACROELEMENTS IN BLOOD SERUM AND FEED OF DAIRY COWS

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ABSTRACT

In the years 2011—2013 we determined content of calcium and magnesium (Ca, Mg) in feed and blood serum of dairy cows using methodology specified by the Official list of methods and laboratory diagnosis of food and feed. Samples of blood serum and total mixed rations (TMR) originated from dairy farms from various regions of Slovakia. At the peak of lactation in 2012 we observed a decrease in serum Ca in 33.8 % of cows and in 2013 decrease in 17.64 % of cows. In the ante-partum and postpartum periods the decrease in serum Ca was detected in 20.75 % and 31.90 % of cows, respectively. The serum Mg in the ante-partum period in 2012 was decreased in 38.03 % of cows. Also in 2013 a decrease in Mg in 8 % of cows was detected at the peak of lactation.

Key words: AAS; blood serum; calcium; cows; mangnesium; TMR

INTRODUCTION

Minerals in feed vary depending on environmental conditions, vegetation composition, content of accessible soil nutrients and fertilization intensity. Usability of minerals from the diet may be affected by combining feeds, soil fertilization method and proportions of grasses, clover and herbs [3]. A TMR or total mixed ration is a method of feeding cows that combines forages, grains, protein feeds, minerals, vitamins and feed additives into a single feed mix [7]. Alfalfa, clover and grass hay are very rich in calcium. High level of calcium is found in clover and alfalfa silage while the content of this element in corn silage is very low. Magnesium content in fodder depends on the content of magnesium in the soil, soil pH and the method of application of magnesium fertilizers [4]. Feed for dairy cows is composed of high-quality forage.

The aim of this study was to analyze the level of calcium and magnesium in feed and blood serum of dairy cattle.

MATERIAL AND METHODS

In 2011—2013 we determined Ca and Mg in TMR and blood serum of dairy cows (n = 24) from farms from various regions of Slovakia. Samples of TMR (n = 30 in 2011; n = 36 in 2012; n = 36 in 2013) and blood serum (n = 180 in 2011; n = 216 in 2012; n = 216 in 2013) were divided according to production phases as follows: 21 days before calving, 21 days after calving and at the peak of lactation. Minerals in samples of plant material were determined according to Official list of methods and laboratory diagnosis of food and feed [2]. Samples of feed were digested in a digestion system MLS-1 200 MEGA (Milestone). Ca and Mg were analyzed by AAS, model Solar 939 (fy Unicam).

Table 1. Mean levels of Ca and Mg [g.kg^{-1}] in TMRs for dairy cows

		Before calving x ± SD	After calving x ± SD	Peak of lactation x ± SD
2011	**Ca**	5.49 ± 1.97	6.52 ± 0.59	6.93 ± 1.16
	Mg	3.17 ± 0.76	3.62 ± 0.64	3.87 ± 1.17
2012	**Ca**	6.00 ± 0.59	6.75 ± 1.38	5.93 ± 1.34
	Mg	4.12 ± 0.77	4.07 ± 0.53	4.10 ± 0.75
2013	**Ca**	6.45 ± 2.69	6.72 ± 2.9	7.47 ± 2.09
	Mg	3.94 ± 1.49	3.87 ± 1.41	4.18 ± 0.62

Table 2. Mean levels and standard deviations (SD) of Ca and Mg [mmol.l^{-1}] in blood serum of investigated dairy cows

		Before calving x ± SD	After calving x ± SD	Peak of lactation x ± SD
2011	**Ca**	2.21 ± 0.30	2.28 ± 0.31	2.35 ± 0.38
	Mg	0.81 ± 0.08	0.78 ± 0.10	0.84 ± 0.13
2012	**Ca**	2.39 ± 0.27	2.70 ± 0.72	2.41 ± 0.41
	Mg	0.87 ± 0.28	0.80 ± 0.16	0.87 ± 0.19
2013	**Ca**	2.42 ± 0.46	2.34 ± 0.4	2.40 ± 0.30
	Mg	0.87 ± 0.14	0.88 ± 0.15	0.90 ± 0.10

RESULTS AND DISCUSSION

The levels of calcium and magnesium in the samples of TMR determined during the study are summarized in Table 1, and the mean levels of calcium and magnesium in the blood serum are presented in Table 2.

The mean Ca content in TMR for dairy cows before calving in years 2011 and 2012 was within the tolerance range (4.00—6.00 g.kg^{-1}), as reported by NRC [6]. In the year 2013, the mean Ca content in TMR was slightly higher and reached 6.45 ± 2.69 g.kg $^{-1}$. Reduced Ca content was recorded in TMR after calving in each reporting year and at the peak of lactation in years 2011 and 2012. According to Kumaresan et al. [5], mean Ca level in rations for dairy cows in India was 0.63 %, which was similar to our values. The authors pointed to a strong correlation between the content of Ca and Mg in plants and the content of these elements in blood serum of dairy cows.

Mg content of the TMRs observed was increased compared with the NRC values [6]. An increased level of Mg was found in the TMRs after calving in all 3 years of observation. Ashraf et al. [1] reported low Ca and high Mg levels in feed produced on soils with adequate amounts of Ca and low concentrations of Mg.

The mean levels of Ca in the serum from groups of dairy cows before calving, after calving and at the peak of lactation were within the reference range (2.25—3.00 mmol.l^{-1}). In 2011, in groups of cows before calving, we observed an individual slight decrease in serum Ca in 31.9 % of cows, in 30.9 % of cows after calving and in 25.72 % at the peak of lactation. In 2012, individual reductions in serum Ca were observed in 28.16 % of dairy cows before calving, 23.4 % after calving and in 33.6 % at the peak of lactation. Slight reductions in serum Ca was observed also in 2013 and in various stages of production of dairy cows they occurred in 17.64 % to 24.07 % of cows.

The mean serum Mg levels in dairy cows ranged within the reference range (0.74—1.23 mmol.l^{-1}). The reduction in serum Mg was recorded in dairy cows in years 2011 and 2012 in each production stage, before calving in 35.2 % and 38.03 % resp., after calving in 29.55 % and 37.41 %, resp., and at the peak of lactation in 22.72 % and 19,12 %, resp. In 2013 the decrease in serum Ca was detected only in 8 % of cows.

The reduction in serum calcium in the production phases

on some dairy farms investigated in the study indicated hypocalcaemia. Disruption of mutual ratios of minerals, especially calcium and magnesium, causes disorders of CNS, circulation and energy metabolism. Complying with the rules of differentiated nutrition of dairy cows according to production phases and monitoring of minerals in blood serum and TMR can prevent metabolic and productive disorders.

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COMPARISON OF INFLUENCE OF NUTRITION ON PROFIT AND QUALITY OF EMBRYOS IN FEMALE MOUFLONS

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ABSTRACT

In this study the influence of nutrition on the quantity and quality of acquired embryos from female mouflons (*Ovis musimon*), embryo donors, was observed and compared for the first time in Slovakia. Multiple ovulation and embryo transfer (MOET) was performed during the oestrous cycle. Female mouflons (n = 16) were divided to 2 groups (n = 8 in each) with different technology of breeding and feed intake. Group 1 was bred traditionally in a deer park; group 2 were farmed mouflons. The difference in the level of nutrients in feed and feed intake was reflected in weight gain of donors and affected the quantity and quality of obtained embryos in favour of group 2.

Key words: embryo; mouflon female; nutrition; superovulation

INTRODUCTION

Currently in Slovakia, after initial experimental work, the biotechnical method of transfer of early embryos of farmed and wild ungulates undergoes further development. The more extensive use of early embryos transfer in mouflons, fallow deer and deer resulted from the following [1]: commercial and economic aspects; faster production of more abundant gene pool of excellent individuals; import and export of new lines of numerous animals out of season; control of communicable disease; rehabilitation programmes [5], [6]. Basically, animal farming in the Slovak Republic will have mostly intensive character, therefore nutrition, which influences various aspects of farming, will play an important role [3].

MATERIALS AND METHODS

The experimental study included a total of 16 female mouflons (*Ovis musimon*) divided into two groups, 8 animals in each. Group 1 consisted of 4—6 years old, 34 kg weighing females kept in a mouflon game reserve on area of 177 ha. They consumed feed characteristic for this type of game. Group 2 comprised 4—6 years old mouflon females. They were kept on a 17 ha game farm and were provided the best possible welfare. The rations on this game were ensured by grazing on permanent grassland and provision of feed comprising the following components [6]: oats, barley, soybean meal, corn, rapeseed extr. meal, malt flower, alfalfa, feed wheat flour, palm oil, calcium carbonate, dihydrogen phosphate monohydrate, sodium chloride, Mepron, Yea Sacc, Mn chelate, Zn chelate, Fe chelate, vitamin E (alpha-tocopherol), organic Se, Cu chelate, vitamin A, MnO, ZnO, biotin, potassium iodide and cobalt sulphate [3].

The animals had unlimited access to water. Veterinary hormonal preparations were used in the preparatory stage: Veramix sheep sponge a. u. v., containing Medroxyprogesteroni acetas 60 mg (Pharmacia Upjon, Belgium). To induce the superovulation effect, veterinary product Folikotropin inj. Sicc. a. u. v. was used, one ampoule containing: 40 I.U. = 2 mg FSH (Spofa, Prague, CR)

In early October, intravaginal synchronization product Veramix sheep sponge a. u. v. was applied to donors for 13 days [3]. The

Table 1. Declared variables in 1 kg complete concentrated feed

Feed constituents	Weight	Share	Quantity
NL	g	min.	170
Fat	g	min.	53
Fibre	g	max.	80
Methionine	g	min.	6
Minerals			
Ca	g	min.	16.0
P	g	min.	8.0
Na	g	min.	3

Table 2. Superovulation reaction, the total number of obtained embryos and of embryos capable of transfer in Group 1

Mouflon No.	Day of obtaining embryos after the onset of oestrus	The number of corpora lutea				
		Right ovary	Left ovary	Total	Obtained embryos	Embryos capable of transfer
1	5	2	0	2	2	0
2	5	1	1	2	1	1
3	5	0	0	0	0	0
4	5	0	1	1	2	0
5	5	3	0	3	2	2
6	5	0	0	0	0	0
7	5	1	1	2	2	1
8	5	2	1	3	4	1
Total		**9**	**4**	**13**	**13**	**5**
Mean		**1.125**	**0.5**	**1.625**	**1.625**	**0.625**

Table 3. Superovulation reaction, the total number of obtained embryos and embryos capable of transfer in Group 2

Mouflon No.	Day of obtaining embryos after the onset of oestrus	The number of corpora lutea				
		Right ovary	Left ovary	Total	Obtained embryos	Embryos capable of transfer
1	5	2	3	5	2	2
2	5	4	6	10	6	5
3	5	1	0	1	-	-
4	5	3	5	8	5	5
5	5	3	3	6	6	5
6	5	6	3	9	5	4
7	5	5	4	9	7	6
8	5	3	4	7	6	6
Total		**27**	**28**	**55**	**37**	**33**
Mean		**3.375**	**3.5**	**6.875**	**4.625**	**4.125**

superovulation effect in each donor was induced by administering 18 mg FSH. FSH was applied as i. m. injection in 6 individual doses and 12-hour intervals. The intensity of the heat culminated 36 hours after releasing the synchronization product. Obtaining and transfer of embryos was performed by surgical laparotomy procedure [4].

RESULTS AND DISCUSSION

Superovulation reaction, the total number of obtained embryos and the number of embryos capable of transfer are presented in Table 1 and Table 2.

CONCLUSIONS

In terms of mouflon population status in Slovakia, improving the existing populations seems to be a very important issue. In the blood "freshening", it is necessary to ensure, that the original population gets enough of new genes from individuals with genetically high-quality gene pool. For this reason, biotechnical methods of assisted reproduction are increasingly used also in this area.

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EFFECT OF LOW-PROTEIN DIETS SUPPLEMENTED WITH CRYSTALLINE AMINO ACIDS ON THE LEVEL OF BLOOD PARAMETERS AND NITROGEN EXCRETION OF WEANED PIGS

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ABSTRACT

This study was conducted to determine the effect of low-protein diets supplemented with crystalline amino acids (AA) on biochemical and fermentation process in digestive system of 12 weaned piglets The piglets received diets with 20.9 % crude protein (CP) and 17.6 % CP. The low CP diet was supplemented with lysine, threonine and methionine. The decrease in the diet CP content was manifested by a significant ($P < 0.01$) decrease in blood urea (3.65 mmol.l^{-1}, and 5.85 mmol.l^{-1}), which indicated an increase in biological value of feed. The decrease in diet crude protein content reduced level of volatile fatty acids (VFA) (44.07 g.kg^{-1} DM, 49.07 g.kg^{-1} DM) and significantly decreased crude protein (201.1 g.kg^{-1} DM and 252.7 g.kg^{-1} DM; $P < 0.01$) and NH_3 (361.0 mg.kg^{-1} DM, 428.0 mg.kg^{-1}DM; $P < 0.01$). Biochemical indicators of energy were not affected significantly by changes in the feeding of piglets during the experiment.

Key words: amino acids; low-protein diets; nitrogen excretion; urea; volatile fatty acids; weaned piglets

INTRODUCTION

Protein source is a very important factor for growth of weaned piglets, because poor amino acid and protein nutrition have a profound effect on physiology and growth of pigs [6], [9]. Diets for weaned pigs generally contain 200 to 230 g of crude protein (CP) per kg to support maximum rates of lean tissue gain. However, not all dietary protein is available for metabolism [4]. High dietary CP concentration, common in diets for early-weaned pigs, may increase microbial fermentation of undigested protein, and encourage proliferation of pathogenic bacteria in the gastrointestinal tract [5]. Bacterial fermentation of undigested proteins produces VFA and potentially toxic substances, such as ammonia and amines, that can reduce growth [9]. Reducing the dietary CP level and supplementing the diet with limiting crystalline amino acids (AA) can reduce N excretion [2], [5].

The aim of the experiment was to investigate the influence of decreased CP level in the diet of weaned piglets with balanced content of amino acids on metabolic parameters in the blood, and fermentation processes in the large intestine.

MATERIAL AND METHODS

The experiment was conducted on 12 crossbred piglets (Slovakian White × Landrace), with initial mean body weight (BW) 9.5 ± 0.6 and 9.3 ± 0.7 kg, resp. At weaning, they were divided to two groups 1 and 2 (6 animals in each; equal number of females and castrated males). The experimental diets were formulated with 2 levels of CP (20.9 % and 17.6 %). The low CP diet was supplemented with lysine (Lys), methionine (Met) and threonine (Thr). The experiment was carried out at the Institute of Animal Nutrition and Dietetics of the UVMP in Košice in compliance with the EU regulations concerning the protection of experimental animals. The

diets were analyzed for dry mater (DM), crude protein (CP), crude fibre (CF), ether extract (EE) and ash by the AOAC methods (1). The buffering capacity (BUF) titrations were performed by addition of 0.1 N HCl. All pH measurements were made using a laboratory pH meter. Blood serum total proteins, albumin, urea, glucose and total lipids were determined by a biochemical instrument Ellipse and volatile fatty acids by isotachophoresis. Differences between the groups were evaluated by paired *t*-test.

RESULTS AND DISCUSSION

The nutrient content of diets used in experimental periods is shown in Table 1, the metabolic variables in blood serum determined during the study in Table 2, and parameters of fermentation processes in the digestive system in Table 3.

The biochemical parameters in blood serum of weaned pigs varied within relatively wide ranges of physiological values for pigs, presented by Doubek et al. and Craft et al. [3], [7]. The mean values of biochemical parameters, such as total protein, albumin, glucose, total lipids, did not differ significantly within the groups. Urea as an important indicator of protein nutrition [2] showed marked changes. Reduced levels of dietary CP significantly ($P < 0.01$) increased serum urea nitrogen. Lower blood urea nitrogen indicated higher availability of dietary nitrogen [2], [6]. Evaluation of the fermentation process through determination of VFA in the faeces showed decreasing tendency in individual VFA in

Table 1. Chemical composition of experimental diets

Parameters	Control diet		Experimental diet	
Dry mater [g.kg^{-1}]	888.40	1000	881.20	1000
CP [g.kg^{-1}]	209.40	237.84	176.00	189.72
EE [g.kg^{-1}]	23.30	25.46	24.00	27.24
CF [g.kg^{-1}]	39.03	44.33	37.80	42.89
Ash [g.kg^{-1}]	57.80	65.65	55.40	62.87
NFE [g.kg^{-1}]	550.87	625.58	588.00	667.26
Lys [g.kg^{-1}]	13.30	15.11	11.50	13.05
Tre [g.kg^{-1}]	8.50	9.65	7.50	8.51
Met + Cys [g.kg^{-1}]	6.40	7.27	6.60	7.49
BUF 4 [mEq.kg^{-1}]	69.00	77.70	49.00	55.60

Table 2. Effect of dietary CP on biochemical parameters of piglets

Parameters	Experimental diet				Control diet			
Week	1	2	3	4	1	2	3	4
Total protein [g.kg^{-1}]	56.80 ± 2.50	53.70 ± 3.21	57.30 ± 2.22	54.60 ± 3.10	54.50 ± 2.59	56.20 ± 2.32	57.30 ± 2.85	56.60 ± 2.53
Urea [mmol.l^{-1}]	5.10^{a} ± 0.24	5.90^{a} ± 0.33	6.70^{a} ± 0.28	5.70^{a} ± 0.35	3.70^{b} ± 0.32	3.10^{b} ± 0.24	4.30^{b} ± 0.36	3.50^{b} ± 0.29
Albumin [g.l^{-1}]	35.40 ± 2.28	36.40 ± 2.99	33.60 ± 1.58	33.70 ± 2.80	34.10 ± 2.75	32.40 ± 1.99	32.70 ± 2.56	30.30 ± 2.98
Glucose [mmol.l^{-1}]	5.52 ± 0.41	5.45 ± 0.33	5.31 ± 0.41	5.26 ± 0.69	5.65 ± 0.86	6.18 ± 0.77	6.23 ± 0.92	5.45 ± 0.92
Total lipid [g.l^{-1}]	2.01 ± 0.08	2.58 ± 0.43	2.06 ± 0.35	2.47 ± 0.31	1.39 ± 0.80	1.89 ± 0.49	2.79 ± 0.29	2.68 ± 0.29

^{ab} — Significant differences ($P < 0.01$)

Table 3. Parameters of the fermentation processes in the digestive system of piglets

Parameters	Control diet	Experimental diet
Acetic acid [g.kg^{-1}]	25.37 ± 4.21	23.16 ± 3.13
Propionic acid [g.kg^{-1}]	15.23 ± 2.42	13.97 ± 1.56
Butyric acid [g.kg^{-1}]	8.38 ± 1.01	6.94 ± 0.90
Total VFA [g.kg^{-1}]	49.07	44.07
pH	6.23 ± 0.37	6.740.40
Crude protein [g.kg^{-1}]	252.70 ± 9.80^{a}	201.10 ± 10.30^{b}
NH_3 [mg.kg^{-1}]	428.00 ± 15.10^{a}	361.00 ± 11.80^{b}
Dry matter [g.kg^{-1}]	276.00 ± 4.20	281.00 ± 3.30

^{ab} — Significant differences (P < 0.01)

the group with lover level of CP in the diet but the differences were insignificant. Intake of diet with decreased CP and BUF 4 resulted in significant (P < 0.01) decrease in NH_3 (by 16 %) and CP (by 20 %) in the faeces.

The decrease in the diet CP (20.9 % and 17.6 %) and BUF 4 (69 and 49 mEq, resp.) significantly (P < 0.01) decreased levels of blood urea (3.65 mmol.l^{-1} and 5.85 mmol.l^{-1}, resp.), crude protein (201.1 g.kg^{-1} DM and 252.7 g.kg^{-1}DM, resp.; P < 0.01) and NH_3 (361.0 mg.kg^{-1} DM, 428.0 mg.kg^{-1} DM resp. ; P < 0.01) in faeces.

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THE USE OF SYNTHETIC AMINO ACIDS IN FATTENING PIGS

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ABSTRACT

The aim of the feeding experiment was to verify and extend the knowledge on the use of synthetic amino acids and monitor production parameters in fattening pigs. One hundred animals divided into two groups were included in the experiment. After addition of synthetic amino acids (lysine, threonine, methionine) into the test feed to fulfil requirements of meat hybrid fattening pigs (category 40—80 kg) we observed in the experimental group: higher mean weight at the end of the experimental period (81.57 kg vs. 77.48 kg); higher mean daily gain (1.16 kg vs. 1.02 kg); better feed conversion (2.36 kg.kg^{-1} vs. 2.75 kg.kg^{-1}) and better nitrogen conversion (463.93 g.kg^{-1} vs. 393.88 g.kg^{-1}).

Key words: amino acids; fattening pigs; nutrition

INTRODUCTION

Nutrition of fattening pigs is one of the major factors influencing the intensity of growth. The modern pig genotypes are characterized by genetically determined ability of intensive growth [7]. The pig does not have specific requirements for crude protein, but rather for the individual amino acids. The optimal dietary supply of amino acids to growing pigs has been intensively studied for many years. The amino acids of greatest practical importance are lysine, tryptophan, threonine, and methionine. If these amino acids are not balanced in the diet, the use of other amino acids for protein synthesis is limited [5].

The objective of this study was to verify and extend the knowledge on the use of synthetic amino acids in nutrition of fattening pigs and to monitor their production parameters.

MATERIALS AND METHODS

One hundred fattening pigs (meat hybrid) were divided in two groups (55 animals in control group and 45 animals in the experimental group). The experiment lasted 33 days, with initial mean body weight (BW) 43.82 ± 5.36 kg of control and 43.37 ± 5.81 kg of experimental animals. The experiment was carried out on Paňovce farm. The experimental diets were supplemented with lysine (Lys), methionine (Met) and threonine (Thr). The amino acids (AAs) were added at the expense of barley. The control group received diet without addition of extra AAs. The pigs were individually weighed, at the beginning and end of the experiment and their feed consumption was observed daily. The content of nutrients and *metabolizable energy* (ME) in the diets was determined according to AOAC [1]. Composition of experimental and control diet is shown in Table 1.

Table 1- Composition of experimental and control diet (%)

	Experimental diet	Control diet
Corn	10.00	10.00
Wheat	37.20	37.20
Barley	32.40	32.80
Soybean meal	10.00	10.00
Rapeseed meal	7.00	7.00
Makropig 3 %	3.00	3.00
Threonine (L) 98 %	0.10	
Lysine (L-Lysine HCl) 78 %	0.25	
Methionine (DL)	0.05	

RESULTS AND DISCUSSION

Nutrition values of complete mixed feed used in the experiment are presented in Table 2. The diets were formulated with very similar content of CP and ME (166.9 g.kg^{-1} vs. 168.7 g.kg^{-1} or 12.70 MJ.kg^{-1} vs. 12.76 MJ.kg^{-1}, resp.). For the standard type, 35 to 65 kg pigs, Šimeček et al. [6] stated the following amino acids requirements: 8.2 g Lys.kg^{-1} diet; 4.5 g Met + Cys.kg^{-1} diet and 5.3 g Thr.kg^{-1} diet. In the control not supplemented with synthetic amino acids these requirements were met. For modern crossbred type, Šimeček et al. [6] recommended: 10.2 g Lys.kg^{-1} diet; 5.6 g Met + Cys.kg^{-1} diet and 6.6 g Thr.kg^{-1} diet. In the experimental diet, we increased amino acids content to fulfil these requirements.

The optimum dietary supply of amino acids to growing pigs has been intensively studied for many years. There is a number of factors (genotype, sex, energy intake) affecting the amino acid requirements [4]. The new hybrid pigs have a genetic predisposition for high protein retention and protein synthesis [3]. It is stated that the modern pig can gain a maximum of 200 to 240 grams of protein every day. Pigs with high rate protein deposition (PDR) potentials have higher Lys : ME requirements compared to slower growing pigs. Coupled with the reduced appetite of these new genotypes, it is essential that energy levels be sufficient to minimize the PDR restriction which may be imposed by these lower appetite levels [9]. Current requirement for the optimum Lys : ME ratio in highly-selected pig genotypes ranges from 1 to 0.79 [6]. In this study with modern crossbred pigs (40—80 kg) the total dietary Lys : ME ratio ranged from 1 to 0.81 in the experimental diet and from 1 to 0.65 in the control diet.

The final mean body weight (BW) was higher in the experimental group. The difference was insignificant (P = 0.1392). The feed and nitrogen conversion ratio values were higher in control group (Table 3). Feed conversion ratio is an important economic parameter of production. The growth rate of pigs can be improved by adding synthetic amino acids into diet of highly-selected pig genotypes. Nutrition of pigs is one of the major factors influencing the quality of meat. It has to be, first of all, balanced in such away so as to enable maximum use of the genetic potential of the animal during fattening [2]. Pigs of modern genotypes have a very high genetic potential for daily protein deposition and these relevant data are important basic information for estimation of amino acid requirements.

Table 2. Chemical composition of control and test diets [g.kg^{-1}]

Parameters	Experimental diet		Control diet	
DM [g.kg^{-1}]	890.00	1000.00	887.60	1000.00
ME [MJ.kg^{-1}]	12.70	14.27	12.76	14.38
CF [g.kg^{-1}]	50.80	57.08	46.25	52.11
ADF [g.kg^{-1}]	59.60	66.97	54.45	61.35
NDF [g.kg^{-1}]	160.10	179.89	151.55	170.74
CP [g.kg^{-1}]	166.90	187.53	168.70	190.06
EE [g.kg^{-1}]	20.40	22.92	21.20	23.88
Ash [g.kg^{-1}]	56.20	63.15	55.45	62.47
Lys [g.kg^{-1}]	10.30	11.57	8.34	9.40
Met + cys [g.kg^{-1}]	5.71	6.42	5.23	5.89
Thr [g.kg^{-1}]	6.73	7.56	5.76	6.49

Table 3. Growth parameters, the feed -and nitrogen conversion ratio in fattening pigs

	Experimental	Control
Number of animals	n = 45	n = 55
Body weight, kg — start	43.37	43.82
Body weight, kg — final	81.57	77.48
Daily feed intake	2.73	2.81
Mean daily gain	1.16	1.02
Feed conversion ratio [kg.kg^{-1}]	2.36	2.75
Nitrogen conversion ratio [g.kg^{-1}]	393.88	463.93

CONCLUSIONS

Addition of synthetic amino acids (lysine, threonine, methionine) to the diet for modern crossbred fattening pigs improved the following parameters in the experimental group: body weight at the end of the period was higher by 4.09 kg; mean daily gain was increased by 0.14 kg per day; feed conversion ratio value was improved by 0.39 $kg.kg^{-1}$; e nitrogen conversion ratio was improved.

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UTILIZATION OF EXTRACTS FROM *MATRICARIA RECUTITA*, *MENTHA PIPERITA, ORIGANUM VULGARE AND CORTEX QUERCUS* IN COMBINATION WITH *ENTEROCOCCUS FAECIUM IN* ORDER TO INCREASE THE PRODUCTION AND HEALTH PARAMETERS OF WEANED PIGS

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ABSTRACT

The aim of this study was to evaluate experimentally the influence of mixture of plant extracts composed of oregano essential oil, aqueous extracts from chamomile, peppermint and oak bark, alternatively with probiotic bacteria *Enterococcus faecium*, added into the feed mixtures of weaned pigs, on the production, health parameters and counts of selected bacteria in faeces in two on farm experiments conditions (31—52/32—53 days of age). We observed a favourable effect of additives on the determined parameters in the experimental groups compared to control groups in both experiments. In Exp 1 we observed an increase in body weight by 0.79 kg.pig^{-1} ($P < 0.05$) on day 52, in average daily weight gains (ADWG) by 0.034 kg.day^{-1}.pig^{-1} and feed conversion (FC) by 0.246. In Exp 2 there was an increase in body weight by 0.97 kg.pig^{-1} on day 53, in ADWG by 0.049 kg.day^{-1}.pig^{-1} and in FC by 0.305. The reduction in diarrheal score was determined in both experiments by day 1 or day 6.pig^{-1}. The counts of *Escherichia coli* were reduced by 1.78.10^6 (37 d) in Exp 1, 3.27.10^6 (39 d) and by 1.59.10^7 CFU.g^{-1} (46 d) in Exp 2. The counts of *Lactobacillus* spp. increased by 1.92.10^8 (37 d) and 5.82.10^7 (49 d) in Exp 1 and by 4.99.10^8 (39 d), 1.25.10^8 (46 d) and 2.93.10^7 CFU.g^{-1} (53 d) in Exp 2.

Key words: chamomile; oak bark; oregano; peppermint; plant extracts; weaned pigs

INTRODUCTION

The addition of growth promoting antibiotics to feeds of food producing animals is prohibited in the European Union since 2006. Their advantage was to reduce the economic costs related to incidence of inflammatory changes caused by bacteria in the gastrointestinal tract [1]. For this reason, several approaches to maintain the balance of gastrointestinal microflora were developed.

The aim of this study was to evaluate experimentally the influence of mixture of plant extracts composed of oregano essential oil, aqueous extracts from chamomile, peppermint and oak bark (Exp 1, Exp 2), alternatively with probiotic bacteria *Enterococcus faecium* M-74 (Exp 2), added into feed mixtures of weaned pigs on the production and health state parameters as well as on concentrations of selected enteric bacteria in faeces in two farm experiments.

MATERIALS AND METHODS

Two experiments (31—52 and 32—53 days of age) with weaned pigs (White improved × Landraces) were performed on pig fattening farm of DONA Ltd. (Slovak Republic). The same proportion of males and females with the same average body weight was allocated to the experimental ($n_{ex1} = 50/n_{ex2} = 30$) and control group ($n_{k1} = 50/n_{k2} = 30$). Two feed mixtures (Tekro Ltd., Czech Republic) were used in the experiments: a) Quick Pig 2 (31—38/32—39 day of age); b)

Quick Pig 3 (39—52/40—53 day of age). They contained the following components: barley, heat treated maize, dried whey, soya protein concentrate, wheat feed flour, soy oil, yeasts, NaCl, 3-phytase, plus a) soybean meal, sugar, $CaHPO_{4;}$ b) toasted full fat soya, fishmeal, $CaCO_3$, $CaHPO_4$. The declared content of lysine (L-lysine HCl) was 12 and 12.8 g.kg^{-1}, resp., Oregano (*Origanum vulgare* L., *Lamiaceae*) essential oil 776.07 or 649.76 mg.kg^{-1} (100 % v/v, carvacrol 58 ± 3 %, Calendula Inc., Slovak Republic), and the mixture of aqueous extracts isolated from chamomile (*Matricaria recutita* L., *Asteraceae*,) 5172.10 or 5482.37 mg.kg^{-1} (2.13 g.100 ml^{-1}), peppermint (*Mentha piperita* L., *Lamiaceae*) 2586.05 or 274119 mg.kg^{-1} (1.07 g.100 ml^{-1}) and 3007.25 or 3293.15 mg.kg^{-1} oak bark (*Cortex quercus*, 2.0 g.100 ml^{-1}) were added to feed mixtures in Exp 1 and 2, respectively. The probiotic bacteria *Enterococcus faecium* M-74 (Medipharm Slovakia Ltd.) were added to feed mixtures 77×10^6 CFU.kg^{-1} of Exp 2. All animals were supplied feed and water *ad libitum* and were housed under identical conditions. The measurements and determinations of production parameters and incidence of diarrheal diseases of individual pigs were performed during experiments. The samples of faeces for microbiological investigation were processed by a standard microbiological dilution method [2] with the subsequent inoculation to solid culture media Endo agar (*Escherichia coli*), Slanetz-Bartley agar (*Enterococcus* spp.) and Lactobacillus selective agar (*Lactobacillus* spp.) (Imuna Pharm, Inc., SR). The results were statistically evaluated by one-way analysis of variances and the significance was declared at the level $P < 0.05$ (SAS, Version 8.2, 1999).

RESULTS AND DISCUSSION

The following nutritional parameters were analyzed in both feed mixtures (g.kg^{-1}): dry matter (DM) 931.7/929.0, crude protein (CP) 188.6/208.7, fibre 35.6/ 2.7, ash 60.4/56.0, fat 67.69/77,04, Ca 6.9 6.6, P 5.2/5.12, Na 2.9/2.7, K 1.03/0.82. The results of production parameters from both experiments are presented in Tables 1 and 2.

Reduced diarrhoea scores (i. e. number of days with diarrhoea) were observed in the experimental group by day 1 (Exp 1) and by day 6.pig^{-1} (Exp 2). Several field trials with

Table 1. Weight gains and feed conversion of weaned pigs in experiment 1 (Exp 1)

		Weight [kg.head^{-1}]				Average daily weight gain [kg.day^{-1}]	Feed conversion (feed intake/ weight gain)
	Age [day]	**31**	**38**	**45**	**52**	**31—52**	**31—52**
Control	n = 50	8.09 ± 0.556	8.54 ± 0.744	10.08 ± 1.074	12.23^a ± 1.467	0.197 ± 0.043	1.570
Exp. group	n= 50	8.17 ± 0.546	8.76 ± 0.874	10.25 ± 1.369	13.02^b ± 2.036	0.231 ± 0.071	1.324
Index (c = 100 %)		100.99	102.58	101.69	106.46	117.26	84.336

$^{a, b}$ — $P < 0.05$

Table 2. Weight gain and feed conversion of weaned pigs in the experiment 2 (Exp 2)

		Weight [kg.head^{-1}]				Average daily weight gain [kg.day^{-1}]	Feed conversion (feed intake/ weight gain)
	Age [day]	**32**	**39**	**46**	**53**	**32—53**	**32—53**
Control	n = 30	8.46 ± 0.455	8.60 ± 0.623	10.21 ± 1.252	12.69 ± 1.917	0.201 ± 0.07	1.727
Exp. group	n = 30	8,42 ± 0,435	8.94 ± 0.900	10.85 ± 1.087	13.66 ± 1.369	0.250 ± 0.044	1.422
Index (c = 100 %)		99.55	04.03	106.26	107.63	124.38	82.34

pigs demonstrated that the added plants can influence the occurrence, intensity and duration of the post-weaning diarrhoea on large scale production farms [3].

The number of *E. coli* was reduced in faeces of experimental animals in Exp 1 by $1.78.10^6$ (day 37 of age) and in Exp 2 by $3.27.10^6$ (day 39 of age) and $1.59.10^7$ CFU.g^{-1} (day 46 of age). An increase in the number *Lactobacillus* spp. was observed in the experimental groups by $1.92.10^8$ (day 37 of age) and by $5.82.10^7$ (day 49 of age) in Exp 1, and by $4.99.10^8$ (day 39 of age), $1.25.10^8$ (day 46 of age) and $2.93.10^7$ CFU.g^{-1} (day 53 of age) in Exp 2. A quantitative increase in *Enterococcus* spp. in the experimental groups in comparison to control was observed in Exp 2 by $1.90.10^6$ (day 39 of age), $9.77.10^6$ (day 46 of age) and $5.03.10^6$ CFU.g^{-1} (day 53 of age).

CONCLUSION

The plant extracts isolated from oregano, chamomile, peppermint and oak bark and added alternatively with probiotic bacteria *Enterococcus faecium* M-74 to the feed mixtures of experimental weaned pigs improved growth parameters and feed conversion, reduced diarrheal score, decreased bacterial counts of *E. coli* and enhanced numbers of *Lactobacillus* spp.

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EFFECT OF *LUPINUS ANGUSTIFOLIUS* ON PRODUCTION INDICATORS IN PIG NUTRITION

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ABSTRACT

The control group of pigs was fed feed mixture based on extracted soybean meal in the first (from 22 to 41 kg) and second (from 41 to 119 kg) phase. The experimental group was fed rations containing 10 % (first phase) and 13 % (second phase) of blue lupin. The observed statistical indicators were average daily weight gain, average daily feed consumption and average nutrient conversion. All of the observed indicators were improved in the first phase of the experiment. The treatment group showed increase in nutrient conversion increased by 150 g and average daily weight gain increased by 200 g in comparison with the control group. The observed indicators of this group showed a decrease (additional 350 g of feed mixture were needed for 1 kg weight gain compared to the control group, the average daily weight gain was lower by 130 g) in the second phase of the experiment (during first 31 days). Subsequently a gradual stabilization followed, resulting in a final difference of 160 g in nutrition conversion and 50 g of average daily weight gain in favour of the control group.

Key words: blue lupin; *Lupinus;* nutrition; pig

INTRODUCTION

The effect of lupines in pig nutrition is not always characterized by unequivocally positive results of growth or feed conversion, namely as when differently treated or raw seeds are used. The results of the production effectiveness, which were achieved by verification of cultural lupines (*L. albus, L. angustifolius*) with pigs, can be defined as positive only on the assumption that absent nutrients are compensated [5]. 30 % content of white lupin or blue lupin in the feed mixture causes reduction in feed intake and sometimes reduction in nutrient conversion and depression of growth [4]. The growth depression was not found with pigs fed diet with 41 % content of blue lupin in comparison with diet based on barley and soybean meal [2]. Similar conclusions were reported by Kim et al. [3] when using 35 % of this kind of lupin. Zralý et al. [6], who carried experiment with white lupin varieties Amiga and Butan, arrived at conclusion that these lupines are fully-fledged substitute of soybean meal. Complete feed mixture based on soybean meal was compared with complete feed mixture based on lupin and it was observed that lupin is able to absolutely substitute for soybean meal.

The objective of this study was to assess the possibility of inclusion of *Lupinus angustifolius* in pig nutrition and its effect on production parameters.

MATERIALS AND METHODS

The experimental part of the trial took place under operating conditions. Two groups of pigs with the same weight and age category were used for experimental observation. The same method of crossing was used in both groups [(Czech Improved White × Czech Landrase) × (Pietrain)]. 15 young pigs were in each group, 7 males

and 8 females. Complete feed mixture (1SES) and experimental mixture (1LUP) were used in the first phase of fattening (29 days). Feed mixtures had the same content of nutrients as commercial feed mixture A1. Feed mixture 1LUP contained 10 % *L. angustifolius* at the expense of soybean meal and wheat. The soybean meal was substituted by lupin (13 %) for experimental group in the second phase of fattening (82 days). Feed mixtures for this phase had the same nutrient content as commercial feed mixture CDP. Blue lupin variety Probor was used in experimental feed mixtures.

RESULTS AND DISCUSSION

The possibilities of using blue lupins protein feed were evaluated mainly by means of growth intensity and feed conversion. The composition of complete feed mixtures is presented in Table 1. Table 2 shows production parameters, average growth and feed conversion.

Deterioration of fattening parameters was not found in the first phase of experiment in group fed mixture with 10 % lupin instead of soybean meal and vice versa tendency to the improvement of production indicators was observed. An insignificant decrease in average daily growth and tendency to the higher consumption of feed for 1 kg of growth were detected in the second phase of fattening in experimental group where soybean meal was replaced by blue lupin. This conclusions correspond with the findings of Donovan et al. [1] who reported slowing down of growth when more than 10 % lupin was contained in feed.

The evaluation of the entire experiment (both phases of fattening) showed favourable values of average daily growth in both groups: 0.88 kg in control group (K SES) and 0.87 in experimental group (P LUP). The feed conversion was 2.79 kg in control group (P SES) and 2.87 in experimental group (K SES) throughout the trial period.

Table 1.The composition of ingredients in the experiment [%] — Phase I and Phase II

Components	Phase I		Phase II	
	1_{SES}	1_{LUP}	2_{SES}	2_{LUP}
Hordeum vulgare	33.0	33.0	44.0	44.0
Triticum aestivum	45.0	41.5	45.0	40.0
Lupinus angustifolius	—	10.0	–	13.0
Soybean meal	19.0	12.5	8.0	–
Profimix A1	3.0	3.0	3.0	3.0
Total	100.0	100.0	100.0	100.0

Table 2. Production parameters, average growth, feed conversion

Indicator	Phase I K 1_{SES}	Phase I P 1_{LUP}	Phase II K 2_{SES}	Phase II P 2_{LUP}	Phase I + Phase II	
					$K_{SEŠ}$	P_{LUP}
Initial weight [kg]	21.5	22.06	41.47	45.00	21.5	22.06
Final weight [kg]	41.47	45.00	119.60	118.80	119.6	118.8
Average growth [kg]	0.69	0.79	0.95	0.90	0.88	0.87
Average feed consumption [kg]	1.78	1.93	2.71	2.70	2.46	2.50
Feed conversion [kg]	2.59	2.44	2.84	3.00	2.79	2.87
Number of pigs [kg]	15	15	15	15	15	15

CONCLUSIONS

The blue lupin has potential for use as a substitute of soybean meal. The utilization of blue lupin will be more significant for enterprises which engage not only in pig breeding but also in arable farming. An improvement in economy indicators follows also from plant growing way.

ACKNOWLEDGEMENT

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EFFECT OF NATURAL HUMIC SUBSTANCES ON PERFORMANCE AND SELECTED BIOCHEMICAL VARIABLES IN YOUNG PHEASANTS

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ABSTRACT

The effect of natural humic substances (oxyhumolit) in concentration 5 g per kg in commercial diets, based on plant protein sources, on body weight, weight gain, feed conversion ratio (FCR), and European efficiency index (EEI) as well as selected variables of intermediary metabolism was studied under farm conditions in 1 500 pheasant chicks (*Phasianus colchicus*) in the first phase of growing (weeks 1—4). Supplementation of diet with oxyhumolit increased body weight ($P < 0.01$) and EEI ($P < 0.001$), improved FCR ($P < 0.05$) and decreased mortality (1.34 %) in comparison to control group (1.86 %). Decreased glucose ($P < 0.01$) and increased total lipids ($P < 0.05$), calcium and phosphorus ($P < 0.001$) concentrations were observed in blood serum of chicks fed diets supplemented with humic substances.

Key words: oxyhumolit; performance; pheasant chicks; serum biochemistry

INTRODUCTION

Pheasants are the favourite game for a large number of hunters, not only for their meat characterized by low fat content and high essential fatty acids and amino acids content but because of hunting characteristic too [1]. Their rearing on farms and following release into free nature is one way how to increase their population [4]. Feeding is at the beginning very intensive and is based mainly on concentrate mixtures. Later also feedstuffs such as green forage and grains are introduced in order to mimic natural feeding conditions [8]. Oxyhumolit (natural humic substances) is formed in nature by chemical and biological decomposition of organic matter and synthetic activity of micro-organisms [11]. Stimulation of growth and production performance has been observed after application of humates in feeds or drinking water [7], [10], [12]. Feeding humates during the growing period had the most beneficial effect in terms of growth and feed conversion on broiler performance [5], [10], [12].

The aim of this study is to investigate the effect of oxyhumolit in feed mixtures on production variables and selected variables of intermediary metabolism in pheasant chicks under farm conditions.

MATERIAL AND METHODS

The experiment was carried out on 1500 one-day-old pheasant chicks (*Phasianus colchicus* L.) hatched and reared in the Specialised establishment for rearing and diseases of game, fish and bees of UVMP in Rozhanovce. Pheasant chicks (800 control, 700 experimental) were fed in the1st phase of rearing (days 0—28) complete mixture based on plant protein sources ad libitum. In experimental group (HS) this mixture was supplemented with humic substances (oxyhumolit 5 $g.kg^{-1}$). Weight of pheasant chicks ($n = 50$) and feed consumption were observed weekly, mortality was recorded throughout the period. Feed conversion ratio (FCR) was calculated. Nutrient content of feeds was determined by AOAC (2).

The following equation was used for the evaluation of results using European Efficiency Index (EEI):

EEI = (liveability × live weight in kg/length of growing period in days × FCR) × 100

Blood samples were collected from 12 birds on 28th day of trial and samples of blood serum were analysed for total protein, glucose, total lipids, cholesterol, triglycerides, alkaline phosphatase, amino transferase, Ca and P, using a biochemical analyser "Ellipse" (photometric determinations with diagnostic kits). All the data were statistically analysed by *t*-test.

RESULTS AND DISCUSSION

Mean body weight of pheasant chicks and feed conversion ratio is showed in Fig. 1 and 2. The pheasants fed diet supplemented with HS reached body weight by about 7.9 % higher (219.0 ± 3.35 g) in comparison with control chicks (202.9 ± 3.35 g; $P < 0.01$). Improvement in FCR (1.84 ± 0.028 kg feed.kg gain^{-1}; $P < 0.05$) as well mortality lower by about 28 % (1.34 %) were observed in chicks from HS group when compared with control pheasants (2.09 ± 0.079 kg feed.kg gain^{-1}; 1.86 %). Higher weight gain, lower mortality and improved FCR positively influenced EEI of pheasant chicks in HS group (37.08 ± 0.28) which was significantly higher in comparison to control group (32.05 ± 0.55; $P < 0.001$).

Positive effect of diet supplementation with oxyhumolit on growth and FCR was observed in 42 days old broiler chickens too but the total feed intake and mortality of these birds were not affected significantly [7], [5]. Significantly improved production variables and decreased mortality just as in our trial were observed in younger chicks (22 days old) fed product containing peat [10]. Higher gain and improved FCR were described in Japanese quails fed humic acids [3]. Decreased glucose ($P < 0.01$) and increased total lipids ($P < 0.05$), calcium and phosphorus ($P < 0.001$) concentrations were observed in pheasant chicks of HS group. Other variables (data not showed) were not affected by oxyhumolit. Similar results in broiler chickens were published by Rath et al. [9] and Kaya and Tuncer [6].

In conclusion, diet supplemented with oxyhumolit (5 g per kg), fed to pheasant chicks in the 1st phase of rearing (28 days) led to a higher body weight, EEI, improved FCR and decreased mortality. Other variables of intermediary metabolism in blood serum except for decreased glucose and increased total lipids, calcium and phosphorus, were not affected by supplementation of diet with humic substances.

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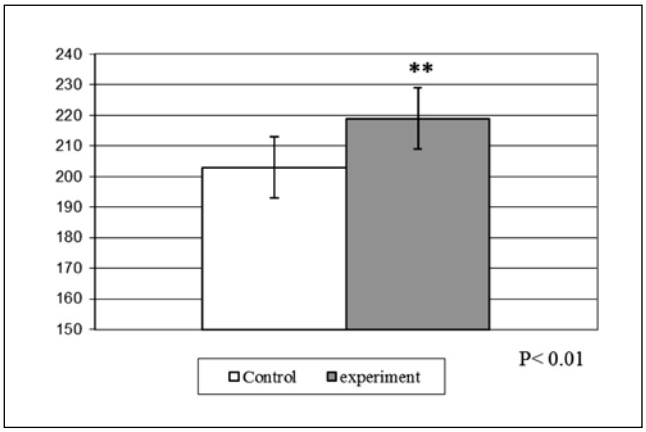

Fig. 1. Average body weight of pheasant chcicken (age 28 days)

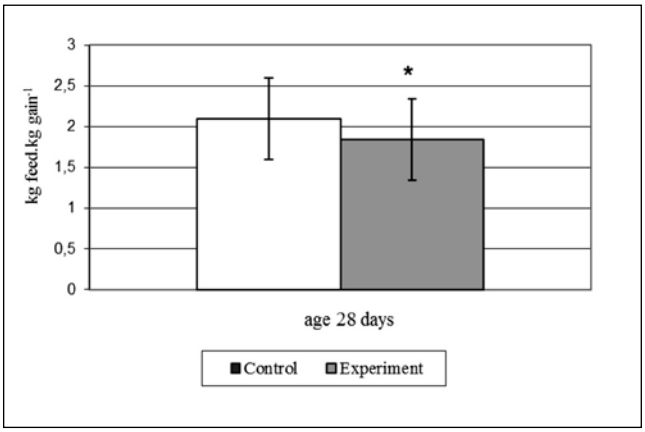

Fig. 2. Feed conversion ratio

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FOLIA VETERINARIA, 58, Supplementum I: 48—50, 2014

THE INFLUENCE OF SELECTED ADDITIVES ON GROWTH PERFORMANCE OF BROILER CHICKS

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ABSTRACT

The objective of this paper was to determine the effect of beta-glucane and its combination with oxyhumolite on growth intensity, flock uniformity, feed, crude protein and energy conversion ratio and performance index in broiler chicks after 35 days of the trial. Live body weight of chicks and flock body weight uniformity were not significantly affected by the addition of test substances in diets, but they significantly improved feed, energy and crude protein conversion ratios compared with the control group ($P < 0.05$ and $P < 0.001$, resp.). The combination of both tested substances added to the diets during the entire trial period significantly increased the performance index compared with the control group ($P < 0.05$).

Key words: chicks; flock uniformity; nutrient utilization; performance index

INTRODUCTION

Beta-glucans are polysaccharides built from β-glucose units. They are the main structural component of cell walls of grain, yeast, fungi, algae, and some bacteria [4]. Humic compounds are organic substances raised during humidification at reduced air access, as final product of plant and animal residues degradation caused mainly by microbial enzymatic activity. Humic compounds occur in soil, peat, brown coil, oxyhumolite and lignite [8]. The use of beta-glucane as well as humic compounds in animal nutrition may positively influence performance, growth and feed conversion [2], [9].

The aim of the study was to observe under experimental conditions the growth intensity, flock body weight uniformity, feed, crude protein, energy conversion and performance index in broiler chicks fed diets enriched with beta-glucane and humic compounds.

MATERIAL AND METHODS

Two hundred one day old unsexed broiler chicks Ross 308 were randomly divided to four groups (one control and three trial groups; n = 50) and placed on deep bedding. The birds were fed complete mixed diet according to growth phases (HYD-01 in 1st and 2nd week; HYD-02 in 3rd to 5th week) *ad libitum*. Beta-glucane purified from oyster mushrooms (*Pleurotus ostreatus*) (NATURES s. r. o., Trnava, SR) was added to the mentioned feed diets in all trial groups (B, BO_1, BO_2) in amount of 0.02 $g.kg^{-1}$ in the 1st phase (1st and 2nd week) and 0.04 $g.kg^{-1}$ in the 2nd phase (3rd to 5th week) of the trial. In addition to beta-glucane, natural humic compounds (oxyhumolite, Dudar area, Hungary) were added to the diets at the expense of wheat to trial groups BO_1 (5 $g.kg^{-1}$ of the diet in the 2nd phase) and BO_2 (3 $g.kg^{-1}$ of the diet in the 1st phase and 5 $g.kg^{-1}$ in the 2nd phase). The diets were analyzed for dry matter, crude protein, ether extract, crude fibre and ash by the AOAC methods [3].Weight of chicks and feed consumption were observed weekly.

Performance index was calculated as follows:
(live body weight/feed conversion) × 100

Body weight uniformity of the flock was calculated as follows:
100 – [(standard deviation/average live body weight) × 100]

Results were statistically evaluated using one way ANOVA (Tukey's multiple comparison test).

RESULTS AND DISCUSSION

The body weight of chicks on day 35 day was not significantly influenced by the monitored additives (data not shown). No marked influence on body weight of chicks was found also by Keser et al. [7], who observed the influence of beta-glucane, and Edmonds et al. [5], who observed the influence of humic compounds.

The highest body weight gain during the entire trial period was observed in BO_2 group (Fig. 1). The lowest feed intake was in BO_1 group (Fig. 2). Feed conversion ratio during the trial period was significantly better in all trial groups compared to control ($P_{(B)} < 0.05$; $P_{(BO1,\ BO2)} < 0.001$), and in groups BO_1 and BO_2 in comparison to group B ($P < 0.05$; $P < 0.01$) (Fig. 3). Similar results were observed also by evaluation of crude protein and energy conversion ratio (Fig. 4, 5). Better feed conversion after addition of beta-glucane to the diets of broiler chicks was observed also by An et al. [2] and after addition of humic compounds by Taklimi et al. [9].

The production index was in all trial groups higher than in the control, but significantly only in group BO_2 ($P < 0.05$) (Fig. 6). Significant increase in production index after addition of humic compounds to the diet was observed also in Japanese quail [1].

The uniformity of the flock is one of the most important economical factor in chicken feeding nowadays [6]. Body weight uniformity of the flock in our study was not significantly influenced by feeding diets with the selected additives (data not shown).

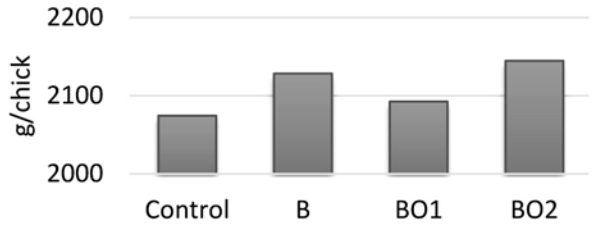

Fig. 1. Body weight gains

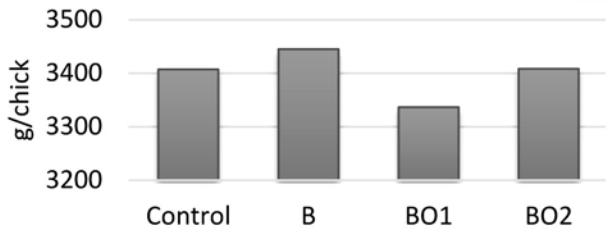

Fig. 2. Feed intake

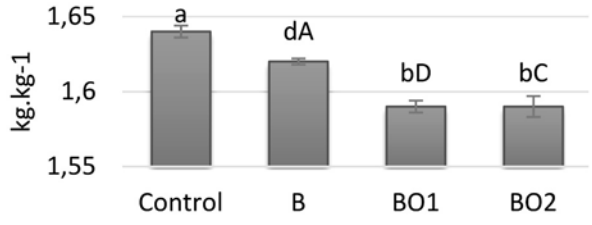

Fig. 3. Feed conversion ratio

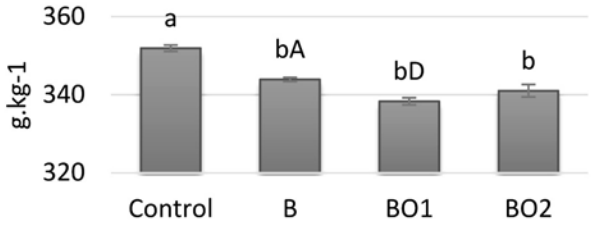

Fig. 4. Crude protein conversion

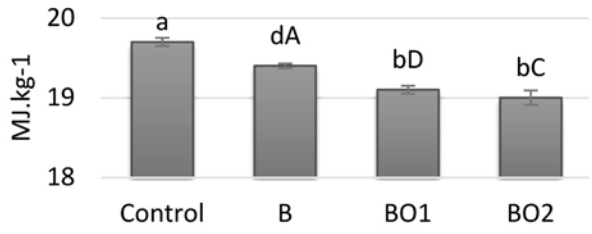

Fig. 5. Energy conversion ratio

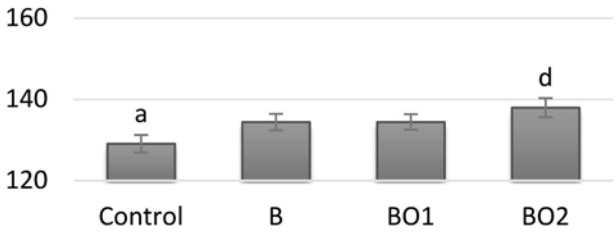

Fig 6. Performance index

$^{ad, AD}$ — $P < 0.05$; ^{AC} — $P < 0.01$; ^{ab} — $P < 0.001$

CONCLUSIONS

Addition of beta-glucane, singly or with humic compounds, to the diets had no significant influence either on body weight of the chicks or body weight uniformity of the flock, but led to a significantly better feed, crude protein and energy conversion ratios (particularly in combination). Combination of both observed feed additives resulted also in significantly higher performance index throughout the trial period.

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EFFECTIVENESS OF 2-HYDROXY-4-METHYLTHIOBUTANOIC ACID COMPARED TO DL-METHIONINE IN BROILER CHICKENS

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ABSTRACT

An experiment with broiler chickens was conducted to compare the relative bioavailability of liquid methionine hydroxy analogue free acid (MHA-FA) with that of DL-methionine (DLM) during fattening to 35 days of age. Ross 308 male chicks were allotted to 9 treatments, each consisting of six replicates of 140 birds/pen. Four graded levels (0.04; 0.08; 0.16; 0.28 %) of MHA-FA or DLM products (weight/weight comparison) were added to a maize-wheat-soyabean meal basal diet deficient in sulphur amino acids. Using a multi-exponential model describing the dose-response relationships, the bioavailability estimates of MHA-FA relative to DLM were 68, 70, 52 and 57 % on a weight-to-weight basis and 77.7, 79.0, 59.3 and 64.6 on equimolar basis for body weight, feed conversion, carcass yield and breast meat yield, respectively. The bioavailability of MHA-FA for carcass yield and breast meat yield was significantly ($P < 0.05$) lower than that of DLM.

Key words: breast meat yield; carcass yield; chicken; DLM; feed conversion; MHA-FA; weight gain

INTRODUCTION

The diets for poultry are commonly supplemented with DL-methionine (DLM) or methionine hydroxy analogue free acid (MHA-FA).

The aim of the present experiment was to determine the biological effectiveness of MHA-FA relative to DLM added to practical-type broiler diets in graded amounts, using growth performance and carcass quality as the criteria of response.

MATERIALS AND METHODS

A total of 7 560 day-old male Ross 308 chicks were randomly assigned to 9 treatments with six replicates and fattened to 35 days of age. On the last day of experiment, five birds of each pen having body weights closest to the pen mean were slaughtered and carcass and breast meat (boneless and without skin) yields were determined. Basal starter, grower and finisher diets were formulated to be deficient in sulphur amino acids (SAA). To the basal diets, DLM or MHA-FA were added at four levels (0.04; 0.08; 0.16; 0.28 %) on a product (weight-to-weight) basis.

The performance data were analyzed as completely randomized block design using analysis of variance procedures. To estimate the biological availability of MHA-FA relative to DLM, a multiexponential model proposed by Littell et al. [4] was used:

$$y = a + b\,(1 - e^{(c_1 x_1 + c_2 x_2)})$$

The relative bioavailabilityvalue (RBV) for liquid MHA-FA was defined as the ratio of steepness coefficients for liquid MHA-FA c_2/steepness coefficient for DLM c_1.

RESULTS AND DISCUSSION

The results of the whole experiment are summarized in Table 1. In general, the weight of broilers gradually increased with increasing levels of both methionine sources, thus demonstrating a clear SAA deficiency of the basal diets. The small difference between DLM 0.16 and DLM 0.28 levels indicated a diminishing returns pattern of the dose-response relationship and suggested that SAA intake was close to the requirement in these groups. Similar results were obtained with feed conversion ratio.

The increase in breast meat yield as a result of SAA supplementation is assumed to be due at least partly to decreased fat deposition. Better amino acid balance or the stimulating effect of methionine on the oxidative catabolism of fatty acids *via* its participation in carnitine synthesis [8] may lead to the redistribution of dietary energy towards higher protein deposition.

The response of chickens to DLM supplementson product basiswas superior to that achieved with MHA-FA, particularly at low levels of supplementation. Fitting experimental data to the exponential model enables to estimate real availability values, representing the whole range of DLM and MHA-FA intake. The RBV of MHA-FA in terms of body weight estimated by this way was 0.68. Based on 10 experiments reported in the literature, Lemme et al. [3] calculated the average MHA-FA bioavailability value of 69 %. A meta-analysis of 46 dose-response experiments by Sauer et al. [6] showed that the RBV of MHA-FA was 81 % on equimolar basis, i. e. 71 % on product basis. The RBV for feed conversion found in the present study (70 %) was slightly higher than that for bodyweight. The literature data are rather variable in this respect, ranging from 51 % (3, 5) up to 73 % [1] and 76 % [2]. The RBV was not significantly different from 0.88 in the present study.

When carcass yield was used as an independent variable in the exponential model, the resulting RBV was estimated to be 0.52. The 95 % confidence interval for c_2/c_1 ratio (27.5—76.8) demonstrated that the biological availability of the active substance of MHA-FA (88 % by weight) was significantly lower than that of DLM. Breast meat yield response to DLM or MHA-FA additions followed a similar pattern. The estimated MHA-FA availability was 56.8 % and was significantly less than 88 %. On product basis, the RBVs of MHA-FA on breast meat yield were reported to be 45 % [1], 48—54 % [5] and 53—64 % [3].

Considering the concentration of active substance in DLM (99 %) and liquid MHA-FA (88 %) and the molecular weight (DLM 149.21 g.mol^{-1}; MHA-FA 150.20 g.mol^{-1}), the relative bioavailability values as well as their confidence intervals estimated on product basis can be recalculated to equimolar basis multiplying the respective values by (0.99 *

Tab. 1. Performance and carcass quality

Treatment		Body weight	Feed conversion ratio	Carcass yield [% LW]	Breast meat yield [% LW]
Basal	–	1633^{a}	1.908^{a}	64.28^{a}	14.88^{a}
DLM supplements [%]	0.04	1964^{b}	1.730$^{b, c}$	66.97^{bc}	17.62$^{b, c}$
	0.08	2164$^{c, d}$	1.641$^{c, d}$	68.31$^{c, d}$	19.29$^{d, e, f}$
	0.16	2220$^{c, d}$	1.612^{d}	68.52$^{c, d}$	19.62$^{d, e, f}$
	0.28	2265^{d}	1.601^{d}	68.62$^{c, d}$	19.87$^{e, f}$
MHA-FA supplements [%]	0.04	1918^{b}	1.749^{b}	65.97^{b}	16.89^{b}
	0.08	2071$^{b, c}$	1.687$^{b, c, d}$	67.32$^{b, c}$	18.25$^{b, c, d}$
	0.16	2146$^{c, d}$	1.648$^{b, c, d}$	68.08$^{c, d}$	18.88$^{c, d, e}$
	0.28	2249$^{c, d}$	1.610^{d}	68.56$^{c, d}$	19.73$^{d, e, f}$
Pooled SEM		**38.6**	**0.0230**	**0.36**	**0.33**
Relative bioavailability of MHA-FA on product basis		**68.4**	**69.5**	**52.2^{1}**	**56.8^{1}**
Relative bioavailability of MHA-FA on equimolar basis		**77.7**	**79.0**	**59.3^{2}**	**64.6^{2}**

DLM- DL — Methionine, purity 99 %; MHA-F — Methionine hydroxy analogue free acid, 88 % of active substance
$^{a, b, c, d, e, f}$ — Means within a column not sharing a common superscript were significantly different ($P < 0.05$)
^{1} — Significantly different from 88 %; ^{2} — Significantly different from 100 %

150.20)/(0.88 * 149.21). In comparison with equimolar levels of DLM, the MHA-FA availability was lower in all cases, the greatest difference being found in carcass and breast meat yields. The sensitivity of both absolute and relative breast meat yield to dietary methionine levels has been demonstrated in many studies [8], [10].

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