ISSN 1313 - 8820
Volume 1, Number 4
December 2009

AGRICULTURAL SCIENCE AND TECHNOLOGY

2009

An International Journal Published by Faculty of Agriculture,
Trakia University, Stara Zagora, Bulgaria

Scope and policy of the journal
Agricultural Science and Technology /AST/ – an International Scientific Journal of Agricultural and Technology Sciences is published in English in one volume of 4 issues per year, as a printed journal and in electronic form. The policy of the journal is to publish original papers, reviews and short communications covering the aspects of agriculture related with life sciences and modern technologies. It will offer opportunities to address the global needs relating to food and environment, health, exploit the technology to provide innovative products and sustainable development. Papers will be considered in aspects of both fundamental and applied science in the areas of Genetics and Breeding, Nutrition and Physiology, Production Systems, Agriculture and Environment and Product Quality and Safety. Other categories closely related to the above topics could be considered by the editors. The detailed information of the journal is available at the website. Proceedings of scientific meetings and conference reports will be considered for special issues.

Submission of Manuscripts
All manuscript written in English should be submitted as MS-Word file attachments via e-mail to ascitech@uni-sz.bg. Manuscripts must be prepared strictly in accordance with the detailed instructions for authors at the website
http://www.uni-sz.bg/ascitech/index.html
and the instructions on the last page of the journal. For each manuscript the signatures of all authors are needed confirming their consent to publish it and to nominate on author for correspondence. They have to be presented by a submission letter signed by all authors. The form of the submission letter is available upon from request from the Technical Assistance or could be downloaded from the website of the journal. All manuscripts are subject to editorial review and the editors reserve the right to improve style and return the paper for rewriting to the authors, if necessary. The editorial board reserves rights to reject manuscripts based on priorities and space availability in the journal.

Subscriptions
Agricultural Science and Technology is published four times a year. The subscription price for institutions is 80 € and for personal subscription 30 € which include electronic access and delivery. Subscription run for full calendar year. Orders, which must be accompanied by payment may be sent direct to the publisher:

Trakia University
Faculty of Agriculture, Bank account:
UniCredit Bulbank,
Sofia BIC: UNCRBGSF

IBAN: BG29UNCR76303100117681
With UniCredit Bulbank Stara Zagora

Internet Access
This journal is included in the Trakia University Journals online Service which can be found at www.uni-sz.bg.

Address of Editorial office:
Agricultural Science and Technology
Faculty of Agriculture, Trakia University
Student's campus, 6000 Stara Zagora
Bulgaria
Telephone.: +359 42 699330
+359 42 699446
http://www.uni-sz.bg/ascitech/index.html

Technical Assistance:
Nely Tzvetanova
Telephone.: +359 42 699446
E-mail: ascitech@uni-sz.bg

ISSN 1313 - 8820

Volume 1, Number 4
December 2009

AGRICULTURAL SCIENCE AND TECHNOLOGY

2009

An International Journal Published by Faculty of Agriculture,
Trakia University, Stara Zagora, Bulgaria

HIGH TECHNOLOGICAL & COST EFFECTIVE SOLUTIONS FOR FOOD INDUSTRY

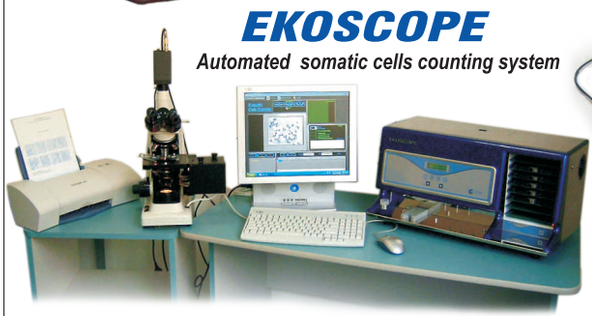
BULTEH 2000

EKOMILK®

Ultrasonic milk analyzers

EKOSCOPE

Automated somatic cells counting system



PH METER

Device for measuring pH

BULTEH 2000

EKOMILK SCAN

Somatic Cells analyzer

BULTEH 2000 Ltd.
Industrial Area,
VEREA PLAST building
Stara Zagora, BULGARIA
Tel./Fax:(+359 42) 626019
Tel. :(+359 42) 620896
e-mail: bulteh@sz.inetg.bg

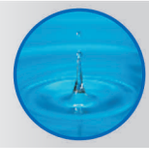
ISO 9001:2000

ALKOTEST

Ultrasonic alcohol analyzer

electronic EBULLIOMETER

Ethyl alcohol analyzer in wine



www.bulteh.com

AGRICULTURAL SCIENCE AND TECHNOLOGY, VOL. 1, No 4, pp 133 - 136, 2009

Nutrition and Physiology

Investigations on the content of lead and cadmium in compound feed additives

D. Alexieva[1]*, S. Chobanova[2]

[1]Department of Nonruminant Livestock Husbandry, [2]Department of Animal Nutrition, Faculty of Agriculture, Trakia University, 6000 Stara Zagora, Bulgaria

(Manuscript received 6 April 2010; accepted for publication 21 April 2010)

Abstract. *The lead and cadmium content of samples from the most commonly utilized feed additives (limestone, dicalcium phosphate, sodium chloride, zinc, vitamin and trace element premixes) was analyzed by means of atomic absorption spectrophotometry. It was found out that up to 30% of the allowed limit for lead content and up to 100% of the allowed limit of cadmium content in compound feed for layer hens could be attributed to limestone, therefore emphasizing the importance of monitoring lead content of this ingredient. Additives such as dicalcium phosphate, trace element mixes, vitamin premixes and particularly sodium chloride, could also contribute to the higher lead and cadmium content in compound feed. As these ingredients are included at quite low levels, the risks for increasing lead and cadmium content of compound poultry feed through them is assessed as insignificant.*

Keywords: lead, cadmium, compound feed ingredients

Introduction

Living beings are exposed to considerable risk of long-term and chronic effects of heavy metals, which move along the trophic chain "soil→plant→animal→man". Numerous studies performed during the last two decades have demonstrated the relationship between blood lead concentrations at birth (in umbilical cord blood) and during the first years of life of children and their intellectual achievements in preschool and early school years. Most of current toxicity studies related to intellectual development of children presume that the observed deficiency could result from exposure to heavy metal levels, previously considered as safe (Lanphear et al., 2000; Gardella, 2001; Canfield et al., 2003; Lidsky et al., 2003; Selevan et al., 2003).

Cadmium is a heavy metal that penetrates in the environment from natural (volcanic emissions, rock erosion) as well as from industrial and agricultural sources (WHO-IPCS, 1992; McBride, 1998; Nordic Council, 2003). It is found out in the air, the soil and the water and could accumulate in plants and animals. In nature, it most often occurs together with zinc. That is why the commonest source of cadmium pollution of air is the zinc production. After its entry into the human body, cadmium accumulates in the liver and from there, is slowly transferred in kidneys, where attains peak concentrations. Cadmium has various toxic effects, including nephrotoxicity, osteoporosis, carcinogenicity and genotoxicity, teratogenic, endocrine and reproductive effects (Goering et al., 1993; Ju and Nordberg, 1998; Brz?ska and Moniuszko-Jakoniuk, 1998; Gupka and Gupka, 1998). The systemic elimination of cadmium is very slow. It takes approximately ten years for half of the content accumulated in the liver and kidney to be removed. Cadmium provokes demineralization of bones and is classified by the International Agency for Research on Cancer as a human carcinogen. Cadmium is known also to increase blood pressure.

The Joint FAO/WHO Expert Committee on Food Additives (JECFA) have specified a provisional tolerable weekly intake (PTWI) of 7 µg/kg b.w. (WHO, 2001), that has been recently confirmed (WHO, 2003) and that is based on a system of early biomarker evaluation of kidney injury after low level of cadmium intake. This PTWI value corresponds to 60 µg cadmium for a man weighing 60 kg. The new data provide a sufficient basis for revising the PTWI. The Scientific Panel on Contaminants in the Food Chain (CONTAM) established a tolerable weekly intake for cadmium of 2,5 µg/kg b.w. (EFSA, 2009). The average nutritive exposure to cadmium for adult in Europe is estimated to be near that level. Some groups of the population, as vegetarians, children, smokers and people living in highly polluted regions, could have a higher exposure up to two times PTWI. Cadmium is toxic for all animal species. In Directive 2005/87/EC, the maximum allowed cadmium content in compound poultry feed is set to 0.5 mg/kg.

The monitoring of heavy metal levels in major feed ingredients as a part of food chain control, does not fully guarantee that the produced compound feed will conform to current safety criteria. This is due to the fact that apart the primary ingredients, compound feed contain also numerous microcomponents.

Since August 1, 2003, European Parliament and Council Directive 2002/32/EC from May 7, 2002 on undesirable substances in animal feed has replaced the previous Directive 1999/29/EC from April 22, 1999. One of the main changes is the broadening of the Directive's scope with feed additives.

With regard to heavy metals, it is difficult to evaluate the effects of feed additives on animals' exposure levels, as they are included at various concentrations as per the instructions of the manufacturer. The exposure of animals is a function of lead concentrations in feed and the amount of consumed feed. The evaluation of the risk of lead intake requires the determination of both the possible feed intake for each animal species as well as the typical lead concentration in.

The aim of the study was to establish the level of lead and

* e-mail: d_alex@af.uni-sz.bg

cadmium contamination of principal mineral and vitamin premixes used in feed industry – limestone, dicalcium phosphate, sodium chloride and various vitamin – trace element premixes and the extent of their contribution for the overall contamination of compound feed with this heavy metal.

Material and methods

For the purpose of this study, 27 samples of the most commonly utilized feed additives were collected and analyzed: limestone, dicalcium phosphate, sodium chloride, zinc oxide, vitamin and trace element premixes. The investigation was carried out in 2008 and the beginning of 2009.

The analyses were performed in the Central Research Laboratory of the Trakia University, Stara Zagora. Lead and cadmium concentrations in samples were assayed by means of atomic absorption spectrophotometry(AOAC,1995).The preliminary processing of samples was performed in the laboratory in the Animal Nutrition unit.

Results and discussion

Table 1 presents data about the content of lead and cadmium in vitamin and trace element additives. The maximum allowed content of lead in vitamin premixes as per current regulations (Act 10 from 2009) is up to 200 mg/kg. In the five studied samples from the commonest vitamin premixes used in poultry compound feed, the average lead content was 6.09 mg/kg, with range between 3.34 and 10.67 mg/kg. There was no sample with excess lead concentration above the allowed limit. Having in mind the inclusion level of studied premixes (0.2 to 0.5%), they would supply from 0.007 to 0.022 mg Pb per 1 kg compound feed. For comparison, 100 premix samples analyzed in EC laboratories have demonstrated average lead content of 19.05 mg/kg dry matter with highest levels in premixes for pigs (20.9 mg/kg on the average), whereas for poultry, lead was 9.9 mg/kg dry matter (EFSA, 2004). In 3 samples from trace element mixes, the average detected lead concentration was 19.32 mg/kg dry matter with the maximum allowed limit in such additives being up to 30 mg/kg. The trace element mix as a component of poultry compound feed is included at a level of 0.1-0.15%. Such level would contribute with 0.017 to 0.025 mg Pb per 1 kg compound feed.

As seen from Table 1, the analyzed three samples of zinc supplements, the average lead content was 53.43 mg/kg (min 23.99; max 82.56 mg/kg), that was very much below the maximum allowed content of this element. For zinc oxide, the allowed content of lead is up to 400 mg/kg. Even with non-permitted utilization (in compound feed for nursing piglets, the inclusion of 0.4% ZnO would contribute with 0.096–0.330 mg Pb per kg compound feed.

The 198 samples of mineral supplements, analyzed in the EC showed an average lead concentration of 3.38 mg/kg dry matter and regardless of the individual variations in lead concentration in samples, the maximum level of 30 mg/kg dry matter was established only in two samples of magnesium oxide (EFSA, 2004). In 3 samples $CuSO_4$ an average lead concentration of 4.01 mg/kg was determined, i.e. many times lower than the maximum allowed level of this element in additives, belonging to the groups of trace elements 100 mg/kg. The inclusion of 0.06% $CuSO_4$ in compound feed would add 0.002 mg Pb per one kg.

The maximum allowed cadmium content in vitamin premixes is 15 mg/kg as per current normative documents (Act No 10/2009). The average cadmium content of the five vitamin premixes, studied by us, was 1.90 mg/kg, ranging within 1.04 and 3.2 mg/kg. There was no sample with cadmium content higher than the maximum allowed one. Taking into consideration the inclusion level of studied premixes, they would contribute with 0.002 to 0.007 mg to 1 kg compound feed. For comparison, 100 premix samples analyzed in EC laboratories have demonstrated average cadmium content of 0.58 mg/kg (range from 0.01 to 2.34 mg/kg) (EFSA, 2004). In the analyzed 3 samples of zinc oxide, the average Cd content was found to be 3.15 mg/kg vs the allowed level of <30 mg/kg dry matter. The highest measured level – 4.05 mg/kg, was not over the allowed limit. The inclusion of 0.4% ZnO, even in cases of unreglamented use (for

Table 1. Content of lead and cadmium in vitamin and trace element premixes, mg/kg

Feed additive	Inclusion level of the feed additive in compound feeds, %	Pb, mg/kg	% of allowed limit	Cd, mg/kg	% of allowed limit
Vitamin premix 1	0.2	3.34	1.67	1.13	3.83
Vitamin premix 2	0.2	10.67	5.33	3.20	21.33
Vitamin premix 3	0.5	4.45	2.23	1.35	9.00
Vitamin premix 4	0.2	3.34	1.67	1.04	6.93
Vitamin premix 5	0.2	8.67	4.34	2.79	18.6
Trace element premix 1	0.1	21.12	70.40	3.02	30.20
Trace element premix 2	0.1	25.20	84.00	2.90	29.00
Trace element premix 3	0.15	11.65	38.83	3.30	33.00
ZnO 1	0-0.4	23.99	6.00	4.05	13.5
ZnO 2	0-0.4	53.75	13.44	1.53	5.1
ZnO 3	0-0.4	82.56	20.64	3.87	12.9
$CuSO_4$ 1	0-0.06	3.34	3.34	0.99	9.90
$CuSO_4$ 2	0-0.06	5.20	5.20	1.10	11.00
$CuSO_4$ 3	0-0.06	3.50	3.50	0.80	8.00

example, in compound feeds for suckling piglets), would add between 0.006 and 0.0162 mg/kg Cd per 1 kg feed. In 3 trace element mix samples, the mean cadmium content was established at 3.07 mg/kg. i.e. many times lower that the maximum allowed content of this element – 10 mg/kg. The share of trace element mix in compound poultry feeds is 0.1–0.15%. Its inclusion in such concentrations therefore would add from 0.003 to 0.005 mg Cd for each kg compound feed.

The analysis of 8 limestone samples from various sources (Table 2) showed an average lead content of 11.34 mg/kg (with variations between 9.34 to 13.66 mg/kg), at the background of allowed lead content in this type of feed additives up to 20 mg/kg. Limestone is included in poultry compound feed at a level between 0.5% and 11% (in compound feed for layer hens). It would contribute to the lead content in 1 kg compound feed with 0.047 to 0.068 mg/kg at a low limestone inclusion level (0.5%) and with 1.027 to 1.503 mg/kg at a highest possible inclusion level (11%).

The analyzed dicalcium phosphate samples from the two main sources of this additive in our country revealed an average lead concentration of 9.6 mg/kg. The allowed lead content in phosphates is 15 mg/kg. Dicalcium phosphate is included as ingredient of traditional poultry compound feed at 0.4 to 1.5%. Thus, it would contribute for additional 0.025–0.092 mg Pb per kg compound feed in the most favourable and for 0.052–0.196 mg Pb in the worst instance.

In 3 samples sodium chloride, the average determined lead concentration was 12.69 mg/kg dry matter with maximum allowed limit of lead in this type of additives up to 10 mg/kg. In two out of the three analyzed samples, lead content was higher than the upper allowed limit of 10 mg/kg dry matter. The inclusion of 0.3-0.5% sodium chloride in compound feed would add 0.017–0.028 mg Pb per kg feed in the most favourable case and 0.060–0.100 mg Pb in the worst case.

Having into consideration these high lead concentrations, the specified salt sources should not be included at all, provided that the new regulation prohibiting the dilution of contaminated feed materials is observed (Directive 2002/32/EC from May 7, 2002) on undersirable substances in animal feed.

The analysis of 8 limestone samples originating from various regions in the country showed average cadmium content of 3.89 mg/kg (with variations between 3.15 and 4.59 mg/kg). All assayed samples showed almost twice higher cadmium level as compared to the limit of 2 mg/kg for this type of additives. The calculations demonstrate that the inclusion of limestone in poultry feed, especially in those for layer hens, will add a significant amount of cadmium. With the addition of 0.5% limestone in compound feed, the supplementation of Cd with this additive could attain 0.023 mg/kg. Considerably more Cd – 0.505 mg/kg would be added to compound feed, if the share of limestone is higher (for instance 11%) (as in compound feed for layers). It becomes clear that only this ingredient would bring cadmium content over the maximum allowed level of 0.5 mg/kg in poultry compound feed.

Table 2. Content of lead and cadmium in limestone, dicalcium phosphate and sodium chloride, mg/kg

Feed additive	Inclusion level of the feed additive in compound feeds, %	Pb, mg/kg	% of allowed limit	Cd, mg/kg	% of allowed limit
Limestone 1	0.5-11	13.66	68.30	4.26	213.00
Limestone 2	0.5-11	12.0	60.00	4.41	220.50
Limestone 3	0.5-11	10.65	53.25	4.59	229.50
Limestone 4	0.5-11	9.34	46.70	3.64	182.00
Limestone 5	0.5-11	9.99	49.95	3.88	194.00
Limestone 6	0.5-11	13.06	65.30	3.33	166.50
Limestone 7	0.5-11	11.99	59.95	3.15	157.5
Limestone 8 (imported)	0.5-11	10.0	50.00	3.83	191.5
Dicalcium phosphate 1	0.4-1.5	6.13	40.86	5.72	76.26
Dicalcium phosphate 2	0.4-1.5	13.06	87.07	0.90	12.00
Sodium chloride 1	0.3-0.5	5.57	55.70	3.87	193.50
Sodium chloride 2	0.3-0.5	20.00	200.00	5.23	261.50
Sodium chloride 3	0.3-0.5	12.50	125.00	4.05	202.50

The investigated dicalcium phosphate samples from the two national sources exhibited an average value of 3.31 mg Cd/kg. A compared to the allowed content of cadmium in phosphates – up to 7.5 mg/kg (0.75% per 1% phosphorus and 7.5 mg/kg at most), the Cd content of both assayed samples of dicalcium phosphate was far below the allowed limit for this element. The inclusion level of dicalcium phosphate in traditional compound poultry feeds is between 0.4 to 1.5%. So, it would add another 0.004–0.023 mg Cd in the best or 0.014–0.086 mg Cd in the worst case.

The three analyzed salt samples contained on the average 4.38 mg/kg cadmium, i.e. higher than the maximum allowed limit of 2 mg/kg. Having in mind the low inclusion level of this ingredient in poultry feed (up to 0.5%), this component would add maximum 0.023 mg Cd per 1 kg compound feed. This is a very low proportion (4.6%) of the maximum allowed Cd content of 0.5 mg/kg in compound feed.

Conclusion

Up to 30% of the allowed limit of lead and up to 100% of the

allowed limit for cadmium content in compound feed for layer hens could be due to limestone therefore emphasizing the importance of monitoring the lead and cadmium content of this feed additive.

Feed additives such as dicalcium phosphate, trace element premixes, vitamin premixes and particularly sodium chloride, could also contribute to the higher lead and cadmium content in compound feed. As these ingredients are included at quite low levels, the risks for increasing lead and cadmium content of compound poultry feed through them is assessed as insignificant.

References

Act № 10, 2009. For maximum allowed concentrations of undesirable substances and products in feed, Official Gazette, 29.

AOAC, 1995. Official Methods of Analysis. 15th ed. Association of Official Analytical Chemists, Washington, DC.

Brzyska MM and Moniuszko-Jakoniuk J, 1998. The influence of calcium content in diet on cumulation and toxicity of cadmium in the organism. Archives of Toxicology, 72, 63-73.

Canfield RL, Henderson CR, Cory-Slechta DA, Cox C, Jusko TA and Lanphear BP, 2003. Intellectual impairment in children with blood lead concentrations below 10 microgram per decilitre. New England Journal of Medicine, 348, 1517 - 1526.

Directive 2002/32/EC of Parliament and the Council of 7 May 2002 on undesirable substances of animal feed.

Directive 2005/87/EC of the European Parliament and the Council of 5 December 2005 on undesirable substances in animal feed as regards lead, fluorine and cadmium.

EFSA, 2004. Opinion of the Scientific Panel on Contaminants in the Food Chain on a request from the Commission related to lead as undesirable substance in animal feed. The EFSA Journal, 71, 1-20

EFSA, 2009. Cadmium in Food. Scientific Opinion of the panel on Contaminant in the Food Chain. The EFSA Journal, 980, 1-139.

Gardella C, 2001. Lead exposure in pregnancy: a review of the literature and argument for routine prenatal screening (review). Obstetrical and Gynecological Survey, 56, 231 – 238.

Goering PL, Fisher BR and Kish CL, 1993. Stress protein synthesis induced in rat liver by cadmium precedes hepatotoxicity. Toxicology and Applied Pharmacology, 122,139-48.

Gupka UC and Gupka SC, 1998. Trace element toxicity relationships to crop production and livestock and human health: implications for management. Communications in Soil Science and Plant Analysis, 29, 1491-1522.

Ju JT and Nordberg M, 1998. Toxicokinetics and biochemistry of cadmium with special emphasis on role of metallothionein. Neurotoxicology, 19, 529-535.

Lanphear BP, Dietrich K, Auinger P and Cox C, 2000. Cognitive deficits associated with blood lead concentrations < 10mirog/dL in US children and adolescents. Public Health Reports, 115, 521-529.

Lidsky TI and Schneider JS, 2003. Lead neurotoxicity in children: basic mechanisms and clinical correlates. Brain, 126, 5 – 19.

Selevan SG, Rice DC, Hogan KA, Euling SY, Phahles-Hutchens A and Bethel J, 2003. Blood lead concentration and delayed puberty in girls. New England Journal of Medicine, 348, 1527-1536.

McBride MB, 1998. Growing Fot. Crops on sludge-amended soils: problems with the U.S. Environmental Protection Agency method of estimating toxic metal transfer. Environonmental Toxicology and Chemistry, 17, 2274-2281.

Nordic Council, 2003. Nordic council of ministers 2003. Cadmium review.

WHO-IPCS, 1992. Cadmium, Environmental Health Criteria 134. World Health Organization, Geneva, Switzerland.

WHO, 2001. Cadmium. In: Safety evaluation of certain food additives and contaminants. Joint FAO/WHO expert Committee on Food Additives, Food Additives Series,46.World Health Organization, Geneva, Switzerland.

WHO, 2003. Cadmium. In: Safety evaluation of certain food additives and contaminants. 61st Meeting of Joint FAO/WHO expert Committee on Food Additives, WHO, Geneva, Switzerland.

Instruction for authors

Preparation of papers

Papers shall be submitted at the editorial office typed on standard typing pages (A4, 30 lines per page, 62 characters per line). The editors recommend up to 15 pages for full research paper (including abstract references, tables, figures and other appendices)

The manuscript should be structured as follows: Title, Names of authors and affiliation address, Abstract, List of keywords, Introduction, Material and methods, Results, Discussion, Conclusion, Acknowledgements (if any), References, Tables, Figures.

The title needs to be as concise and informative about the nature of research. It should be written with small letter /bold, 14/ without any abbreviations.

Names and affiliation of authors

The names of the authors should be presented from the initials of first names followed by the family names. The complete address and name of the institution should be stated next. The affiliation of authors are designated by different signs. For the author who is going to be corresponding by the editorial board and readers, an E-mail address and telephone number should be presented as footnote on the first page. Corresponding author is indicated with *.

Abstract should be not more than 350 words. It should be clearly stated what new findings have been made in the course of research. Abbreviations and references to authors are inadmissible in the summary. It should be understandable without having read the paper and should be in one paragraph.

Keywords: Up to maximum of 5 keywords should be selected not repeating the title but giving the essence of study.

The introduction must answer the following questions: What is known and what is new on the studied issue? What necessitated the research problem, described in the paper? What is your hypothesis and goal ?

Material and methods: The objects of research, organization of experiments, chemical analyses, statistical and other methods and conditions applied for the experiments should be described in detail. A criterion of sufficient information is to be possible for others to repeat the experiment in order to verify results.

Results are presented in understandable tables and figures, accompanied by the statistical parameters needed for the evaluation. Data from tables and figures should not be repeated in the text. **Tables** should be as simple and as few as possible. Each table should have its own explanatory title and to be typed on a separate page. They should be outside the main body of the text and an indication should be given where it should be inserted.

Figures should be sharp with good contrast and rendition. Graphic materials should be preferred. Photographs to be appropriate for printing. Illustrations are supplied in colour as an exception after special agreement with the editorial board and possible payment of extra costs. The figures are to be each in a single file and their location should be given within the text.

Discussion: The objective of this section is to indicate the scientific significance of the study. By comparing the results and conclusions of other scientists the contribution of the study for expanding or modifying existing knowledge is pointed out clearly and convincingly to the reader.

Conclusion: The most important consequences for the science and practice resulting from the conducted research should be summarized in a few sentences. The conclusions shouldn't be numbered and no new paragraphs be used. Contributions are the core of conclusions.

References:

In the text, references should be cited as follows: single author: Sandberg (2002); two authors: Andersson and Georges (2004); more than two authors: Andersson et al.(2003). When several references are cited simultaneously, they should be ranked by chronological order e.g.: (Sandberg, 2002; Andersson et al., 2003; Andersson and Georges, 2004). References are arranged alphabetically by the name of the first author. If an author is cited more than once, first his individual publications are given ranked by year, then come publications with one co-author, two co-authors, etc. The names of authors, article and journal titles in the Cyrillic or alphabet different from Latin, should be transliterated into Latin and article titles should be translated into English. The original language of articles and books translated into English is indicated in parenthesis after the bibliographic reference (Bulgarian = Bg, Russian = Ru, Serbian = Sr, if in the Cyrillic, Mongolian = Mo, Greek = Gr, Georgian = Geor., Japanese = Ja, Chinese = Ch, Arabic = Ar, etc.)

The following order in the reference list is recommended:

Journal articles: Author(s) surname and initials, year. Title. Full title of the journal, volume, pages. Example:

Simm G, Lewis RM, Grundy B and Dingwall WS, 2002. Responses to selection for lean growth in sheep. Animal Science, 74, 39-50

Books: Author(s) surname and initials, year. Title. Edition, name of publisher, place of publication. Example:

Oldenbroek JK, 1999. Genebanks and the conservation of farm animal genetic resources, Second edition. DLO Institute for Animal Science and Health, Netherlands.

Book chapter or conference proceedings: Author(s) surname and initials, year. Title. In: Title of the book or of the proceedings followed by the editor(s), volume, pages. Name of publisher, place of publication. Example:

Mauff G, Pulverer G, Operkuch W, Hummel K and Hidden C, 1995. C3-variants and diverse phenotypes of unconverted and converted C3. In: Provides of the Biological Fluids (ed. H. Peters), vol. 22, 143-165, Pergamon Press. Oxford, UK.

Todorov N and Mitev J, 1995. Effect of level of feeding during dry period, and body condition score on reproductive performance in dairy cows, IX th International Conference on Production Diseases in Farm Animals, Sept.11 – 14, Berlin, Germany, p. 302 (Abstr.).

Thesis:

Penkov D, 2008. Estimation of metabolic energy and true digestibility of amino acids of some feeds in experiments with muscus duck (Carina moshata, L). Thesis for DSc. Agrarian University, Plovdiv, 314 pp.

The Editorial Board of the Journal is not responsible for incorrect quotes of reference sources and the relevant violations of copyrights.

AGRICULTURAL SCIENCE AND TECHNOLOGY

Volume 1, Number 4
December 2009

CONTENTS

Journal web site:
www.uni-sz.bg/ascitech/index.html

Publisher:
www.alfamarket.biz