ISSN 1313 - 8820
Volume 3, Number 2
June, 2011

AGRICULTURAL SCIENCE AND TECHNOLOGY

2011

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 3, Number 2
June 2011

AGRICULTURAL SCIENCE AND TECHNOLOGY

2011

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

AGRICULTURAL SCIENCE AND TECHNOLOGY, VOL. 3, No 2, pp 160 - 164, 2011

Product Quality and Safety

Use of nearinfrared spectroscopy technology with a remote reflectance fibre-optic probe for predicting of trace elements contents in tobacco

L. Dospatliev[1]*, S. Atanassova[2]

[1]Department of Pharmacology, Animal Physiology and Physiological Chemistry, Faculty of Veterinary Medicine, Trakia University, 6000 Stara Zagora, Bulgaria
[2]Department of Biochemistry, Microbiology and Physics, Faculty of Agriculture, Trakia University, 6000 Stara Zagora, Bulgaria

Abstract. *The purpose of this study is to analyze the content of trace element contents in tobacco by nearinfrared spectroscopy (NIRS) technology together with a remote reflectance fibre-optic probe. The method allows immediate analysis of the tobacco without prior sampletreatment or destruction through direct application of the fibre-optic probe on ground samples.The calibration results obtained using samples of tobacco allowed the determination of Pb, Cd, Cu, Fe, Mn and Zn, with a standard error of prediction (SEC (P)) and a correlation coefficient (RSQ) expressed in mg.kg-1 of tobacco of 1.68 and 0.954 for Pb, 1.05 and 0.860 for Cd, 12.69 and 0.902 for Cu, 16.67 and 0.68 for Fe, 59.96 and 0.737 for Mn and of 12.14 and 0.869 for Zn, respectively. The prediction capacity of the model and the robustness of the method were checked in the external validation of sertified referent material of Virginia tobacco(CTA-VTL-2) which do not belong to the calibration group. Based on the results, it can be concluded that NIRS technology is an appropriate method for determining the concentration of Pb, Cd and Mn in tobacco.*

Keywords: nearinfrared spectroscopy, trace element contents (Pb, Cd, Cu, Fe, Mn and Zn), tobacco variable.

Abbreviations: NIRS – nearinfrared spectroscopy, AAS – atomic absorption spectrometer, CTA-VTL-2 – sertified referent material of Virginia tobacco, SEC (P) – standard error of prediction, RSQ – multiple correlation coefficient, PLS – partial least-squares, PCR – principal component regression, SECV – standard error of cross-validation, SNV – standard normal

Introduction

It is known that tobacco is a major industry in many countries , including Bulgaria . The content of toxic components over values is essential for product quality and human health , which requires continuous monitoring . Compared with other crops tobacco accumulates larger quantities of trace elements, even when grown in contaminated soils. Requirements of international markets impose strict controls on their content in tobacco stocks. The great variation in concentrations of these elements in tobacco requires the development of rapid methods for effective control of total and mobile forms in order to prevent pollution of tobacco products. The methods used in routine tests to determine the quantity of different elements in a sample are long, slow and not very cost-effective (Murray and Cowe, 1996; Kume et al., 2001). The use of NIRS allows analytes to be determined with little or no sample preparation. This technique has been used in forages such as alfalfa to determine their quality (Shenk and Westerhaus ,1995), fibre and crude protein contents, digestibility, the changes that occur during silo storage, and after they have been subjected to a drying process (Barton and Windham, 1988). NIRS also has been used to determine the different nitrogen fractions (Valdes et al., 2006; Gonzalez et al., 2007). If NIRS can be used for determining mineral concentrations this is due to the association between minerals and organic functional groups or the organic matrix (Shenk and Westerhaus,1995). The prediction of trace elements by NIRS in agricultural products has been reported even less frequently and has always been used in the context of plants. Only a few reports can be found related to the use of NIRS for macro and trace minerals, specifically in both grasses and hay samples, in natural grasses or in botanical fractions of semi-arid grasslands, to predict trace minerals, Na (0.2–6.8) $g.kg^{-1}$, Cu (5–31) mg.kg-1 and Zn (19–417) $mg.kg^{-1}$, in legumes (Cozzolino and Moron, 2004; Gonzalez et al., 2007), and to determine the mineral content, P (0.24–2.9) and Ca (1.0–20.1) expressed as $g.kg^{-1}$ dry matter, in woody plant species (Petisto et al., 2005). Likewise, NIRS spectroscopy has been used to determine the mineral content in soils of common elements such as Ca, Mg, Fe, Mn and K (Udelhoven et al., 2003), the heavy elements Co, Cu, Ni, Pb, Zn and Mn (Atanassova et al., 2004) or possible contaminants in urban soils (Wu Y et al., 2005; Todorova et al., 2009). In alfalfa the method has been used to determine the mineral and ash contents in different parts of the plant, separating the leaves and stems(Shenk et al., 2001; Azzouz et al., 2003; Halgerson et al., 2004), using measurements carried out in conventional cells. With NIRS technology and a fibre-optic probe, Martín et al.(2002) determined fat, protein and the mineralogical composition and fatty acid contents of Iberian pig carcasses by applying the probe directly onto the meat, determining the mineral composition in commercial feeds with this technology. NIRS has also been used to determine the mineral composition of the cheese(Almenara et al., 2007; Karoui et al., 2007; Lucas et al., 2008).

The aim of the present work was to obtain NIR calibration

* e-mail: lkd@abv.bg

equations with a remote reflectance fibre-optic probe that would allow instant determination and simultaneous prediction of moisture and total element contents in tobacco samples. Application of the fibre-optic probe directly on the samples affords faster analysis times since sample preparation is minimum or unnecessary.

Material and methods

Samples

To determine the content of elements in tobacco samples made 33 sample tests taken from 4 major tobacco-growing regions in South Bulgaria. Sampling procedures followed Bulgarin 17728-91, including representative samples collection, washing, drying and grounding.

Chemical analyses

Instrumentation. AAS-Specter AA-220(Varian, Australia) atomic absorption spectrometer was used in flame mode. The working wave lengths were as follows: Fe-248.3 nm; Mn-279.5 nm; Cu-324.8 nm; Zn-213.9 nm; Pb-217.0 nm and Cd-328.8 nm.

Reagents and standards. Reagents are qualified "AR" (pa Merck I Fluka). The calibration was perfomed using five or six aqueous standard solutions in 2% v/v HNO3. A commercial multi-element standard solution with concentration 1000 $mg.kg^{-1}$ for AAS were used as a stock solution. The calibration standard solutions had the folding concentrations: 0; 0.2; 0.4; 0.6; 0.8 and 1.0 $mg.kg^{-1}$ (Zn, Cu, Mn and Cd) and 0; 1.0; 2.0; 3.0; 4.0 and 5.0 mg.kg-1 (Fe and Pb) for AAS calibration.

Digestion procedures. Procedure for dry ashing at 525oC in muffle furnace, following Bulgarian standard 17365-94 was used. Samples (0.5 g) were weighed in 50 ml glass beakers, charged on a hot plate with stepwise increasing temperature up to 350°C for 4 hours and finally ashed in a muffle furnace at 525°C for 1 hour. After cooling, ashes were dissolved in 20 ml of 1.5% HNO3.

Statistical evaluation of results. In order to check the accuracy of the method a reference material CTA-VTL-2 was used. To assess the accuracy of assignment in conducting the experiment and the accuracy of the results obtained by different methods, three generally accepted criteria were used, as follows:

1. D = X – XCRM, where X is the measured value and XCRM is the certified value. When D is within the borders of 2σ, where σ is the standard deviation from the certified value, the result is considered to be good; when it is $-3\sigma \leq D \leq 3\sigma$ - satisfactory, and beyond these limits the result is unsatisfactory (ISO/DIS 13528, 2002).

2. D % = D/ XCRM .100 – percentage difference. When the values of D % are in the limits $\pm$ 200σ/ XCRM the result is considered to be good, when the value is in the limits $\pm$ 200σ/ XCRM and $\pm$ 300σ / XCRM - satisfactory, and when it is out of the limits $\pm$ 300σ/XCRM the result is unsatisfactory.

3. $Z = X – XCRM / \sigma$. When $Z \leq 2$ the result is considered to be good, when $2 \leq Z \leq 3$- satisfactory, when $Z \geq 3$- unsatisfactory.

In presenting the results in the tables, the good results are marked with 2 stars (**), and the satisfactory with 1 star (*) . For easier evaluation of the effectiveness of the different methods for sample preparation we have used R criterion showing the extent of extraction of the element in percents from the certified value. K criterion showing the differences (%) between the Chemical reference method and the NIRS method.

NIR spectroscopy

A Foss NIRSystem 5000 with a standard 1.5-m 210/7210 bundle fibre-optic probe was used. The probe employs a remote reflectance system and uses a ceramic plate as reference. The window is of quartz with a 5×5cm surface area, measuring reflectance in the IR zone close to 1,100–2,000 nm. The spectra were recorded at intervals of 2 nm, performing 32 scans for both the reference and samples. To minimise sampling error, all the samples were analysed in triplicate. NIR spectra have been measured by using the remote reflectance fibre-optic probe directly on the samples. For easier evaluation of the effectiveness of the NIRS method for sample preparation we have used Rn criterion showing the extent of extraction of the element in percents from the certified value. Xn is the measured value.

Statistical analyses. PLS regression is similar to PCR, but uses both reference data (chemical, physical, etc.) and spectral information to obtain the factors of use for fitting purposes(Martens and Naes, 2001). For cross-validation, the calibration set is partitioned into several groups; each group is then validated using a calibration developed from the other samples. Finally, validation

Table 1. Chemical composition of calibration set (all units in $mg.kg^{-1}$)

Parameter	Minimum	Maximum	Mean	Standard deviation SD
Pb	0.1	22.1	6.157	5.16
Cd	0.4	9.6	2.09	1.95
Cu	9.2	126.8	33.69	28.33
Zn	17.67	97.5	44.91	23.36
Mn	22.7	359.4	103.11	92.45
Fe	38.3	151.1	78.68	23.94

Table 2. Calibration statistical descriptors for the NIR determination trace elements in tobacco

Parameter	Data transform	Partial least-squares PLS	Standard error of cross-validation SECV	Multiple correlation coefficient RSQ	Standard error of prediction SEC
Pb	1D	11	3.53	1.68	0.954
Cd	1D	6	1.44	1.05	0.860
Cu	2D	4	17.68	12.69	0.902
Zn	2D	4	16.55	12.14	0.869
Mn	1D	5	78.43	59.96	0.737
Fe	smooth	8	20.78	16.67	0.680

Table 3. Effectiveness of microwave mineralization in the determination of Pb, Cd, Cu, Fe, Mn and Zn in Virginia Tobacco-CTA-VTA-2 certified reference material

Method - EPA 3051	X, $mg.kg^{-1}$	σx, $mg.kg^{-1}$	D	D, %	Z	R
Pb	848.00	24.0	-235.00	-21.70	-7.12*	78.3
Cd	64.90	1.4	-14.80	-18.57	-5.69	81.4
Cu	16.30	0.9	-1.90	-10.40	-2.10	89.6
Zn	36.50	2.7	- 6.80	- 15.70	-3.24**	84.3
Mn	18.00	0.7	- 4.10	18.60	-3.42	81.4
Fe	1.65	0.1	0.13	8.60	0.76	108.5

Table 4. Differences (%) between the reference method and the NIRS method.

Element	X_{CRM}, $mg.kg^{-1}$	X, $mg.kg^{-1}$	X_n, $mg.kg^{-1}$	R	R_n	K
Pb	1083.00	848.0	912.70	78.3	84.3	6.0
Cd	79.70	64.9	88.90	81.4	102.1	20.7
Cu	18.20	16.3	13.50	89.6	43.9	45.7
Zn	43.30	36.5	52.10	84.3	120.3	36.0
Mn	22.10	18.0	21.80	81.4	98.6	10.6
Fe	1.52	1.65	1.57	108.5	103.3	5.2

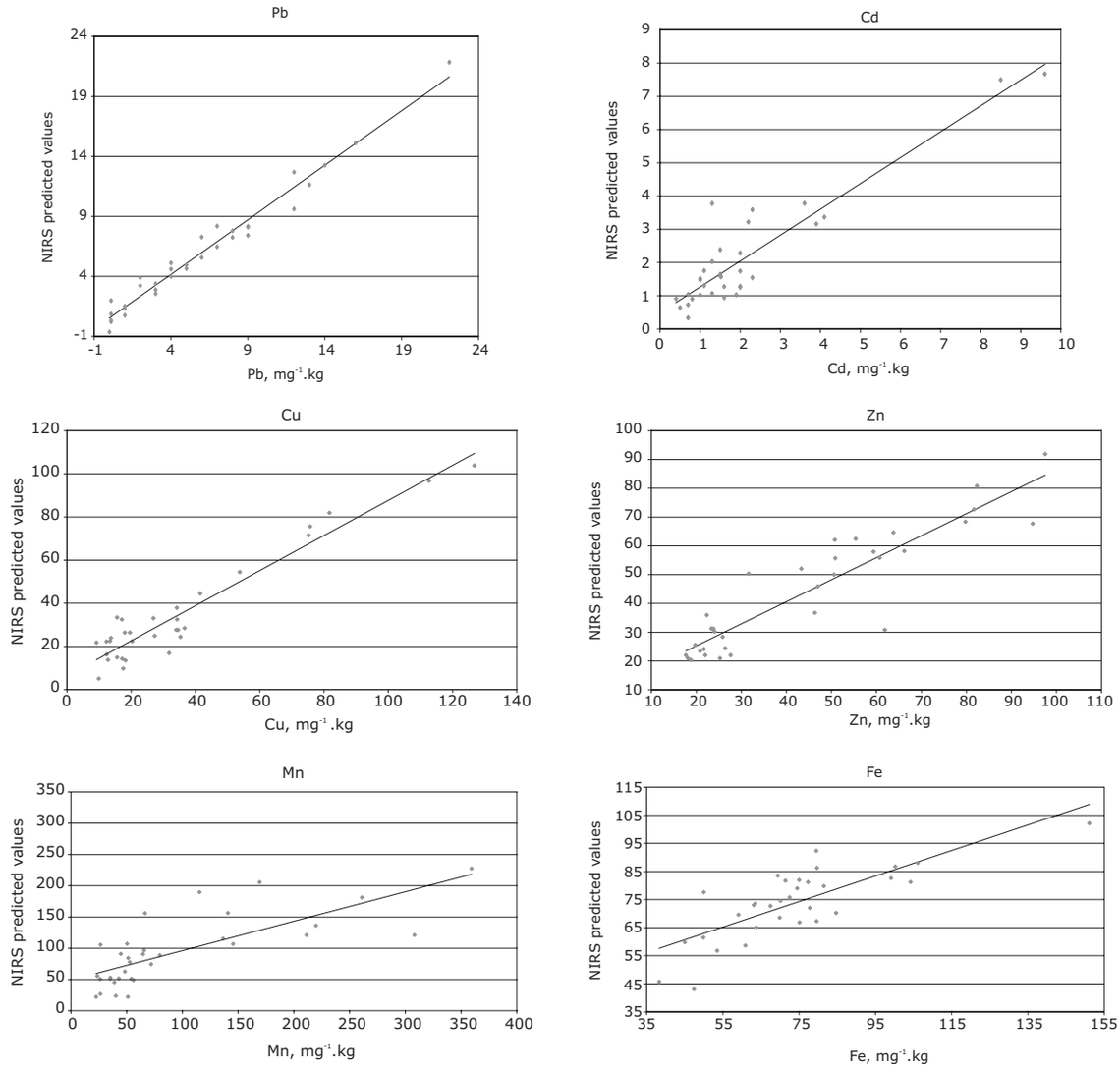

Figure 1. Comparison of reference values with the values predicted by the calibration equations for composition in trace elements (Pb, Cd, Cu, Fe, Mn and Zn) in tobacco.

errors are combined into a SECV(Davies and Williams, 1996). It has been reported that the SECV is the best single estimate of the prediction capability of the equation, and that this statistic is similar to the average SEP from 10 randomly chosen prediction sets.To optimise calibration accuracy, several scattering corrections and mathematical treatments were tested SNV, first derivative and second derivative. Moreover, different mathematical treatments were tested in the development of NIRS calibrations. The statistics used to select the best equations were RSQ and the SECV.

Conclusion

The NIRS technique with a fibre-optic probe is suitable for the determination of composition in tobacco samples. The results, show that NIRS technology is an appropriate method for determining the concentration of Pb, Cd and Mn in tobacco. This method can be used for monitoring tobacco quality. Analytical method discussed,employing a fibre-optic probe with which NIR spectra were measured by applying the fibre-optic probe directly on ground samples, in direct contact with the sample, is rapid and non-contaminating. The prime cost of NIRS analysis is much cheaper than the AAS analysis whilethe results of both methods are similar.

References

Almenara F, Alvarez S, Darias J, Rodriguez E, Diaz C and Fresno M, 2007. Effect of the Ripening in the mineral composition of the cheese made with Majorera goat's milk. Archivos de zootecnia, 56, 667-671.

Atanassova S, Pavlov D, Todorova E and Todorova M, 2004. Near infrared spectroscopy. Proceedings of the 11th Intenational Conference. NIR publications.

Azzouz T, Puigdomenech A, Aragay M and Tauler R, 2003. Comparison between different data pre-treatment methods in the analysis of forage samples using near-infrared diffuse reflectance spectroscopy and partial least-squares multivariate calibration method. Analytica Chimica Acta, 484,121-134.

Barton F and Windham W, 1988. Determination of acid-detergent fibre and crude protein in forages by near-infrared reflectance spectroscopy: Collaborative study. Journal - Association of Official Analytical Chemists, 71, 1162-1167.

Brown J, Shepherd D, Walsh G, Mays D and Reinsch G, 2006. Global soil characterization with VNIR diffuse reflectance spectroscopy. Geoderma, 132, 273–290.

Chen J, Wu Y, Ji J, Gong P, Liao Q, Tian Q and Ma H, 2007. A mechanism study of reflectance spectroscopy for investigating heavy metals in soils. Soil Science Society of America Journal 71, 918–926.

Cozzolino D and Moron A, 2004. Exploring the use of near infrared reflectance spectroscopy to predict trace minerals in legumes. Animal Feed Science and Technology, 111, 161-173.

Dai J, Becquer T, Rouiller H, Reversat G, Bernhard-Reversat F and Lavelle P, 2004. Influence of heavy metals on C and N mineralisation and microbial biomass in Zn-, Pb-, Cu-, and Cd-contaminated soils. Applied Soil Ecology, 99–109.

Davies A and Williams P, 1996. Near infrared spectroscopy: the future waves. The Proceedings of the Seventh International Conference on Near Infrared Spectroscopy. NIR Publications, Chichester, UK.

Halgerson L, Sheaffer C, Martin P, Peterson R and Weston J, 2004. Near infrared reflectance spectroscopy prediction of leaf and mineral concentrations in alfalfa. Agronomy Journal, 96,344.

Garnsworthy C, Wiseman J and Fegeros K, 2000. Prediction of chemical, nutritive and agronomic characteristics of wheat by near infrared spectroscopy. Journal of Agricultural Sciemce, 135,409-417.

Gonzalez M, Gonzalez J and Hernandez M, 2007. Use of NIRS technology with a remote reflectance fibre-optic probe for predicting mineral composition (Ca, K, P, Fe, Mn, Na, Zn), protein and moisture in alfalfa. Analytical and Bioanalytical Chemistry, 387, 2199-2205.

Karoui R, Pillonel L, Schaller E, Bosset O and De Baerdemaeker J, 2007. Prediction of sensory attributes of European Emmental cheese using near-infrared spectroscopy: A feasibility study. Food Chemistry,101, 1121-1129.

Kume S, Toharmat T, Nonaka K, Oshita T, Nakui T and Ternouth J, 2001. Relationships between crude protein and mineral concentrations in alfalfa and value of alfalfa silage as a mineral source for periparturient cows . Animal Feed Science and Technology, 93, 157-168.

Lucas A, Andueza D, Rock E and Martin B, 2008. Prediction of Dry Matter, Fat, pH, Vitamins, Minerals,Carotenoids, Total Antioxidant Capacity, and Color in Fresh and Freeze-Dried Cheeses by Visible-Near-Infrared Reflectance Spectroscopy. Journal of Agricultural and Food Chemistry, 56, 6801-6808.

Malley F, Martin D and Ben-Dor E, 2004. Application in analysis of soils. Near-infrared Spectroscopy in Agriculture. Agronomy, 44, 729–783.

Martens H, Naes T, 2001. Multivariate calibration. Wiley, Chichester.

Martin-Gonzalez I, Gonzalez C, Hernandez J and Alvarez N, 2002. Mineral analysis (Fe, Zn, Ca, Na, K) of fresh Iberian pork loin by near infrared reflectance spectrometry: Determination of Fe, Na and K with a remote fibre-optic reflectance probe. Analytica Chimica Acta, 468, 293-301.

Murray I and Cowe I, 1996. Recent advances in animal nutrition. University of Nottingham Press, UK.

Petisto C, García-Criado B and Vazquez de Aldana BR, 2005. Near infrared reflectance spectroscopy predicting nitrogen, phosphorus and calcium contents in heterogeneous woody plant species. Analytical and Bioanalytical Chemistry, 382, 458.

Rose M, Knaggs M, Owen L and Baxter M, 2001. A review of analytical methods for lead,cadmium, mercury, arsenic and tin determination used in proficiency resting, JAAS, 16, 1101 – 1106.

Shenk J, Workman J and Westerhaus M, 2001. In: Burns DA, Ciurczak E . Handbook of near infrared analysis.Marcel Dekker, NewYork.

Shenk S and Westerhaus M, 1995. Forage quality evaluation and utilitation. ASA, CSSA, SSSA, Madison, WI.

Todorova M, Atanassova S, Santo R, Tsenkova R and lieva R, 2009. Rapid prediction of available P content in soil using near-infrared spectroscopy. Proceedings of the Union of scientists Pousse, EE&AE'2009- International Scientific Conference. Rousse, 204-210.

Udelhoven T, Emmerling C and Jarmer T, 2003. Quantitative analysis of soil chemical properties with diffuse reflectance spectrometry and partial-least-square regression: A feasibility study. Plant and Soil, 251, 319-329.

Valdes C, Andres S, Giraldez J, Garcia R and Calleja A, 2006. Potential use of visible and near infrared reflectance spectroscopy

for the estimation of nitrogen fractions in forages harvested from permanent meadows.Journal of the Science of Food and Agriculture, 86,308-317.
Williams C and Norris K, 2001. Near-infrared technology in the agricultural and food industries. American Association of Cereal Chemists, St Paul, Minnesota.
Wu Y, Chen J, Wu X, Tian O, Ji J and Qin Z, 2005. Possibilities of reflectance spectroscopy for the assessment of contaminant elements in suburban soils. Applied Geochemistry, 20, 1051-1059.

CONTENTS 1 / 2

CONTENTS 2 / 2

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 3, Number 2
June 2011

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

Publisher:
www.alfamarket.biz