REVIEW

of a thesis for awarding the educational and scientific degree "doctor" in the higher education area 6. Agricultural sciences and veterinary medicine, professional field 6.3 Animal husbandry, scientific major "Breeding of farm animals, biology and biotechnology of reproduction"

Author of the dissertation: Georges Hanna al Hanna, MSc

Title of the thesis: "Impact of different herbs on body performance and meat quality in Awassi male lambs"

Member of the scientific jury: Prof. Teodora Ludmilova Popova, PhD, Engr., Institute of Animal Science - Kostinbrod, Agricultural Academy, appointed by order No. ZPS-169/01.04.2024 of the Rector of University of Forestry, Sofia

I. Brief biographical data of the PhD student

PhD candidate Georges Hanna al Hanna was born on 27.10.1986 in Lebanon. He graduated secondary education in 2003 and in the period 2004-2009 graduated higher education as MSc in Animal Science from the Faculty of Agriculture and Veterinary Medicine at the University of Lebanon and INRA, Toulouse, France. In 2006 he started working at Blufield Co., where he successively held positions as a sales consultant (2006-2009), seed unit development for the Middle East and North Africa region (2009-2012), business line manager (2012 -2016), business development manager (2016 to date). In 2018, Georges Hanna al Hanna was enrolled in a part-time doctoral program at the Department of "Animal Breeding Sciences" at the Faculty of Veterinary Medicine of the Forestry University, Sofia, with order No. 572/09.10.2018 in the scientific major "Breeding of farm animals, biology and biotechnology of reproduction", in professional field 6.3. Animal husbandry. He was dismissed with the right of defense in 2022 (Order No. ZSD-479/24.10.2022). PhD candidate al Hanna is fluent in written and spoken English and French.

II. General characteristics of the PhD thesis and the abstract

The PhD thesis, submitted for review is written on 124 pages. It is structured in the traditional form for this type of scientific works, as follows: Introduction - 3 pages, Literature review - 34 pages, Aim and tasks - 1 page, Materials and methods - 9 pages, Results and

discussion - 41 pages, Contributions - 1 page, Conclusions and recommendations - 2 pages, References - 22 pages, others, incl. title page, acknowledgments, abstract, table of contents, list of figures and tables, list of abbreviations used, list of publications and appendix - 11 pages. The work is illustrated with 13 tables (including 1 in the appendix) and 35 figures.

The abstract is written in English on 36 pages, including 11 tables and 30 figures. It clearly presents the aim and tasks on dissertation work, the results obtained, the derived conclusions, contributions and recommendations for practice.

III. State of the art of the problem

The ban on the use of antibiotics in many countries in order to satisfy the consumers' demands for healthy and safe meat, leads to increasing researchers interest in finding strategies to maintain animal health and production. Suitable alternative are probiotics, but quite recently plant and plant extracts, mainly herbs and spices, have been gaining much attention. Numerous studies demonstrate their high potential to positively affect the performance in animals, including ruminants. Changes in growth performance often affect various meat quality traits and in this context more recent research show that using herbs as dietary supplements exhibit potential as a natural way to improve meat quality, acting as an antioxidants. The PhD thesis makes a thorough assessment of the influence of different plant supplements included in the ration on the performance and meat quality of male Awassi lambs. It entirely fits into the new and important line of research dedicated to the development of feeding strategies that ensure both the maintenance of good animal health status and the ability to ensure high quality of the products for the consumers.

Considering the studied problems, the goals, the tasks for their accomplishment, set by the doctoral student, the large volume of experimental work, the modern methods of analysis and statistical processing applied, the conclusions and the formulated contributions, I believe that the dissertation work of Georges Hanna al Hanna is very timely and relevant and goes significantly beyond the state of the art.

IV. Awareness on the literature and theoretical preparation of the candidate

The state of the problem has been assessed through an exhaustive literature review. The candidate outlines the effects of antibiotics in ruminant nutrition, focusing on the alternatives that have been implemented to limit the use of antibiotics. These include organic acids, phytogens, prebiotics and growth promoters. Special attention is paid to extracts derived from aromatic plants and their mode of action. As accentuated by the PhD student, these plants have been widely studied and demonstrate good potential to positively impact ruminant performance

through their antioxidant and antimicrobial effects. A significant part of the literature review is devoted to the use of herbs and spices in ruminant nutrition. The candidate focuses on the effect of sage and chamomile on *in vitro* rumen fermentation, milk composition parameters, nutrient utilization, volatile fatty acid production, methane emissions, productivity and some meat quality parameters. 252 references were cited in the thesis, all in Latin.

The PhD student Georges Hanna demonstrates very good awareness and handling of literature sources, not only in reviewing the literature but also in discussing the results obtained. I believe that with the development of the dissertation work, the doctoral student has acquired the necessary theoretical preparation for conducting experimental work, for applying modern methods of analysis using contemporary equipment, skillful presentation and interpretation of the obtained results, formulation of the conclusions.

V. Methodological approach

The Material and Methods section contains comprehensive description of the experimental design. A correct methodological approach was applied to fulfill the tasks and accomplish the overall aim. Three experiments were conducted with male Awassi lambs, as follows: 1. Experiment with the addition of dried chamomile flowers in amounts of 2%, 4% and 6% to the animals' ration; 2. Experiment with addition of sage -1% and 3 %; 3. Experiment with addition of thyme in quantities of 2%, 4% and 6%. Basic zootechnical parameters of the lambs were measured - live weight and feed intake, used to calculate the weight gain and feed conversion ratio. Analyses were carried out to determine the effect of herbs on the quality characteristics of meat (loin), mainly in terms of its physical and technological parameters - pH, color after cooling and freezing, water-holding capacity, losses during cooking and thawing, structural analysis. Modern analytical methods are applied, guaranteeing reliable results.

The experimental work includes economic analysis of the application of the plant additives.

The obtained results were processed with correct statistical procedures, presented clearly, interpreted skillfully and thoroughly.

VI. Significance and persuasiveness of the obtained results, interpretations and conclusions

The research of the PhD student Georges Hanna al-Hanna is a complete work of high scientific and applied value, which enriches and complements to a significant extent the knowledge about the application of plant supplements in the ration of farm animals and in particular small ruminants. For the first time results on the effect of the addition of chamomile, sage and thyme

in the ration of male Awassi lambs on zootechnical parameters and meat quality are reported. From a practical point of view, valuable recommendations have been made for the development of rations with precisely defined content of phytocomponents to help improve the quality of meat and its healthy value.

VII. Contributions

As a result of the extensive experimental work, significant contributions of a scientific and applied nature have been made. They can be summarized as follows:

The study presents cost-effective methods to improve the productivity of Awassi male lambs by adding widely available low-cost herbs to the ration, thus reducing the cost of meat production in Lebanon.

A strategy is proposed to improve the condition of the sheep farming sector in Lebanon, by addressing the high cost of imported antibiotics, antioxidants and their shortage in the conditions of economic crisis.

The research carried out within the framework of the dissertation shows how natural herbs added to the ration have a growth-promoting effect in lambs of the Awassi breed, which is of extreme importance for improving productive indicators.

A positive effect of the plant additives studied on the quality indicators of the meat was established.

It was found that the addition of different amounts of the investigated plant supplements (2% chamomile, 3% sage and 4% thyme) was an effective method for improving the growth of male Awassi lambs.

VIII. Assessment of scientific publications related to the dissertation work

The results of the dissertation are reflected in three scientific papers. One of them is included in a journal indexed in Scopus (Online Journal of Animal and Feed Research), the other two are published in the proceedings of the prestigious annual scientific forum AGROSYM. In one of the articles, the doctoral student is the single author, and in the others the first, which shows his great personal contribution in the preparation of the scientific works and the presentation of the results.

IX. Critical remarks, questions and recommendations to the candidate

The doctoral student has taken into account a large part of the recommendations made at the preliminary discussions and made the necessary corrections. However, I have a few minor remaks:

1. I recommend that in future work the experiments be organized with a larger number of animals for a better representativeness of the sample;
2. When describing the meat quality analyses, the number of samples used for the measurements of water holding capacity and thawing loss remains unclear.
3. In most of the figures (all bar charts), the standard deviation is not shown.
4. When analyzing meat quality results in which storage is studied, it is appropriate to apply a two-factor ANOVA to determine the effect of the supplement, the duration of storage and their interaction.
5. It would be good in the future when evaluating the quality of the meat to consider analyses of the chemical composition, fatty acid and amino acid profile, in the case of the addition of plant components and analysis of the antioxidant status, lipid and protein oxidation processes. Thus, a more complete picture of the effect of the added plant component on the nutritional and healthy value of the meat will be obtained.
6. It would be good if the conclusions and recommendations for practice were presented separately.

The critical remarks made do not intend to underestimate the merits of the dissertation work.

CONCLUSION

Despite the critical remarks made, I believe that the submitted dissertation meets the requirements of the Law for the Development of the Academic Staff of the republic of Bulgaria, the Rules for its implementation and the Regulations for the implementation of the Law in the University of Forestry. Its development is excellently motivated and organized. The experimental work was carried out competently with the application of modern research methods. Original results were obtained with important significance for science and high potential for application in practice. PhD student Georges Hanna al Hanna demonstrated in-depth knowledge and excellent ability to analyze the results obtained.

Based on the analysis, I give a positive assessment of the thesis and with conviction I recommend Georges Hanna al Hanna to acquire the educational and scientific degree "doctor" in the higher education area 6. Agricultural sciences and veterinary medicine, professional field 6.3 Animal

husbandry, scientific major "Breeding of farm animals, biology and biotechnology of reproduction".

Date: 23.04.2024 **REVIEW SUBMITTED BY:**