

## OPINION

on dissertation for obtaining the educational and scientific degree "Doctor" in: field of higher education 5. "Technical Sciences", professional field 5.13 "General Engineering", scientific specialty "Woodworking and furniture industry technology, mechanization and automation"

**Author of dissertation:** Yasmina Georges Khalaf, part-time doctoral student at the Department "Mechanical Wood Technology" at the University of Forestry (UF), Sofia, Bulgaria

**Dissertation topic:** Utilization of Lignocellulosic Agricultural Residues for Obtaining Multifunctional Composite Materials

**Reviewer:** Nencho Stanev Deliiski, DrS., professor in field of higher education 5. "Technical sciences", professional field 5.1 "Mechanical Engineering", scientific specialty "Woodworking and furniture industry technology, mechanization and automation", appointed as a member of the scientific jury by Order No. RD-405/20.06.2025 of the Rector of the UF

### 1. Relevance of the problem

The extensive in-depth research conducted in the dissertation on the development and study of the properties of multifunctional ecological composite materials, built entirely from biological agricultural residues, is characterized by a high degree of relevance and novelty in scientific and applied aspect and is of significant interest for practice.

### 2. Degree of knowledge of the state of the problem and creative interpretation of the literature review

The literature review is presented in a systematic and conceptual manner, mainly on 50 pages of the first chapter of the dissertation, but individual sources that are essential for the research conducted are also cited in the following chapters of the dissertation.

A total of 285 literary sources are cited, all in Latin, including 2 standards and 2 Internet sources. The volume and nature of the review of what has already been done in the research area is an important indicator of the level of achievement of the doctoral student of the educational goal of the dissertation. The narrow scientific area treated has broad interdisciplinary connections, with the acquisition of which she has done very well.

The in-depth literature review made by the doctoral student ends with organically arising summaries and conclusions, indicating 10 already studied and solved problems and another 7 still unsolved problems in the research area, the latter being used as a basis for a reasoned formulation of the goal and objectives of the dissertation.

### 3. Aim, objectives, hypotheses and research methods. Relevance of the chosen research methodology to the stated aim and objectives of the dissertation

The purpose of the study, as well as the tasks envisaged for its implementation, are correctly defined and essentially summarize the research carried out, which are described in the next 2 chapters of the dissertation.

The research methodology arises from and largely corresponds to the set goal and the specifics of each of the 3 volume tasks formulated for solution in the dissertation.

It contains a reasoned choice of the type and methods for pre-processing of biological agricultural residues to be used for the development of multifunctional composite materials.

The technological parameters and indicators for the production and subsequent research of such materials with different types and numbers of their ingredients, with different densities and areas of application, some of which are intended to have improved moisture and fire resistance, have also been selected.

#### **4. Visualization and presentation of the obtained results**

The results obtained in the dissertation, which is 206 pages long, are very well illustrated with 67 figures (a significant part of which contain several components or images), 16 tables and 15 equations.

This level of visualization and especially the predominance of multi-colored figures in the text facilitate the comprehension of the analyses and interpretations of the results obtained in the dissertation.

#### **5. Discussion of the results and the literature used**

The achieved results testify to a very good implementation and solution of each of the 3 formulated tasks, and thus – to achieving the goal set in the dissertation.

The 285 literary sources used in total, in their overwhelming part, reflect the contemporary level of the problems treated in the dissertation. Of these, 10% were published before 2001, 29% – between 2000 and 2011, 50% in the period from 2011 to 2020, and the remaining 11% – in the last 5 years. It should be noted that 7 of the sources used were published by lecturers in the department where the doctoral studies have been conducted.

#### **6. Contributions of the dissertation**

Based on the summaries and conclusions made in the dissertation, the achievement of a number of scientific and applied contributions is argued, among which, in our opinion, there is 1 scientific contribution that is not distinguished as such, namely:

**A scientific contribution** is the establishment of basic parameters and ingredients of innovative technologies for the production of ecological composite materials entirely from biological agricultural residues with or without use of a biological adhesive in them.

The most important scientific and applied contributions claimed in the dissertation, in our opinion, are the following:

##### **Scientific-applied contributions**

1. Using particles of the reed-like grass miscanthus (*Miscanthus x giganteus*), olive waste (compost), a substrate of spent mushrooms and textile waste in different proportions with a biologically based adhesive chitosan, ecological composite boards with a density between 685 and 907 kg·m<sup>-3</sup> and a thickness of 10 mm were produced, and their properties were studied.

2. It was found that the composite boards of miscanthus particles and defatted olive compost produced with a chitosan adhesive, as well as the boards produced with spent mushroom substrate and defatted olive compost, have a bending strength that meets the requirements of the European standard EN 312 and are suitable for various applications in dry operating conditions.

3. Using miscanthus particles, rice husks and textile waste in various combinations with a chitosan adhesive, ultralight insulation boards with a density between 350 and 400 kg·m<sup>-3</sup> and a thickness of 17 mm were produced, and when examining their properties, it



was found that their compressive strength was greater than 0.2 MPa and they meet the requirements of the EN 13171 standard in this indicator.

4. It has been established that miscanthus particles with a length of 7.0 mm and a width of 0.4 mm, after impregnation with water and 210 °C treatment with saturated water vapor for 8 min, significantly change their chemical composition, and their increased lignin content (36.2%) makes them particularly suitable for the production of composite materials without the use of adhesives.

5. Using miscanthus particles, treated as described above in item 4 and subsequently treated with phytic acid and urea solution (and also without such treatment) with or without the participation of olive compost, composite boards without an adhesive were produced and their properties were studied.

6. It has been proven that after 2 h of treatment with a combination of phytic acid (20 weight percent) and urea (10 weight percent) of miscanthus particles treated with 200-degree water vapor, they acquire a high degree of fire resistance.

7. It has been established that the use of phosphorus-grafted miscanthus particles in the produced composite plates improves their fire and humidity resistance.

### **Applied contributions**

1. The chemical composition of the following main lignocellulosic raw materials used for the production of ecological composite board materials has been established: miscanthus, oily olive compost, crushed olive pits and spent mushroom substrate.

2. It has been proven that the use of chitosan as a biological adhesive in the production of composite board materials improves their mechanical properties, making it competitive with other adhesives.

3. It was found that increasing phytic acid levels and cooking duration during the fireproofing process resulted in an increase in phosphorus and nitrogen grafted onto the miscanthus particles.

4. Modern technical and software tools have been mastered and applied for conducting precise experimental studies and for computer processing of the data sets obtained with them.

### **7. Assessment of the extent of the dissertator's personal involvement in the contributions**

I consider the personal participation of the doctoral student to be decisive in achieving the contributions in the dissertation work and in its overall development under the guidance and good professional expertise of her scientific supervisor and her scientific consultant.

### **8. Critical comments and questions**

I consider the contributions in the dissertation to be insufficiently well edited and graded in importance.

### **9. Published articles and citations**

The doctoral student has presented 5 collective publications on essential parts of the dissertation work, including 4 articles in journals and 1 chapter in a book. In all 4 articles she is a lead co-author, and in the book chapter she is a second co-author. The four articles were cited by other authors in a total of 37 of their journal publications, and the book chapter was cited in 9 journal publications and in 1 dissertation.

She has presented reports with materials from her dissertation at 4 international scientific forums: in Lyon and Ales, France, in Kaunas, Lithuania and in Sofia.

**10. Assessment of publications on the dissertation: number, nature of the editions in which they were printed. Reflections in science – use and citation by other authors**

Two of the publications on the dissertation work have been published in the following journals with a high impact factor: *Polimers* c IF = 5.0 and *Construction and Building Materials* c IF = 7.4. One of the articles has been published in the journal *AppliedChem*, which is indexed in Scopus. The fourth article has been published in the journal *Woodworking and Engineering Design*, which, as well as the book with a 70-page chapter co-authored by the doctoral student, are referenced in CABI.

The large number of citations of the publications on the doctoral student's dissertation is impressive – a total of 47. About 90% of the citations are in journals referenced in Web of Science and/or Scopus, the majority of which have an impact factor. This testifies to the great relevance and significance of the topic and the results obtained in the dissertation.

The presented abstract objectively reflects the structure and content of the dissertation.

**CONCLUSION**

The dissertation represents a completed study in fulfillment of the set goal and the objectives arising from it. It shows that the doctoral student possesses in-depth theoretical knowledge in the relevant field and abilities for independent scientific research. Scientifically-applied and applied results sufficient for the educational and scientific degree "doctor" have been obtained, which represent an original contribution to science, some of which have immediate applicability in practice.

In educational terms, the doctoral student has expanded and deepened her existing and has mastered new interdisciplinary knowledge, which was necessary for the development of her dissertation. In a scientific aspect, she has built on what has been done so far in the thematic area of the dissertation, using the experience of other researchers in the field that she has studied.

Based on the various research methods mastered and applied by the doctoral student, the correctly conducted experiments, the generalizations, conclusions and scientific, scientifically applied and applied contributions, I believe that the presented dissertation fully meets the requirements of the Law on the Development of the Academic Staff in the Republic of Bulgaria and the Regulations of the University of Forestry for its application, which is why I evaluate it POSITIVELY.

All of the above gives me reason to confidently recommend to the members of the esteemed Scientific Jury on the procedure to award the doctoral student Yasmina Georges Khalaf the educational and scientific degree "*Doctor*" in professional field 5.13 "General Engineering".

08.07.2025  
Sofia

PREPARED THE  
OPINION:

/Prof. DSc Nencho Deliiski/