

# REVIEW

of the official reviewer for dissertation work of

Baidildayeva Assel Kuanyshevna on the theme «Research of microencapsulation technology of leather for footwear of people with pathological deviations of the feet» presented for the degree of Doctor of Philosophy (PhD) in the educational program «SD07211 - Leather Goods Industry».

| No | Criteria                                                                                                                               | Eligibility (one of the options must be checked)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Justification of the position of the official reviewer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
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| 1. | The topic of the thesis (as of the date of its approval) corresponds to the directions of development of science and/or state programs | <p>1.1 Compliance with priority areas of science development or government programs:</p> <p>1) The thesis was completed within the framework of a project or target program financed from the state budget (indicate the name and number of the project or program)</p> <p>2) The thesis was completed within the framework of another state program (indicate the name of the program)</p> <p>3) The dissertation corresponds to the priority direction of the development of science, approved by the Higher Scientific and Technical Commission under the Government of the Republic of Kazakhstan (indicate the direction)</p> | The dissertation work complies with one of the ten priority areas of science and technology for 2021–2023, as approved by the Higher Scientific and Technical Commission under the Government of the Republic of Kazakhstan. It is “Geology, extraction and processing of mineral and hydrocarbon raw materials, new materials, technologies, safe products and structures”                                                                                                                                                                                            |
| 2. | Importance for science                                                                                                                 | The work <u>makes</u> /does not make a significant contribution to science, and its importance is <u>well disclosed</u> /not disclosed                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <p>The dissertation work provides a significant contribution to the development of scientific knowledge in the field of footwear and leather industry through the development of innovative antibacterial materials and technologies. Research was conducted in the laboratories of Ege University and Dokuz Eylul University (Izmir, Türkiye) and M.Kh. Dulaty Taraz University.</p> <p>The developed technology for microencapsulating laurel essential oil and chitosan and then applying it to leather materials provides a long-lasting antibacterial effect.</p> |

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|    |                               |                                                                                                                            | improves the performance properties of footwear, and helps reduce the risk of developing microorganisms that cause odor and skin infections. Therefore, this work is important, promising and in demand for the footwear industry.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 3. | The principle of independence | Self-reliance level:<br>1) <u>High</u> ;<br>2) Medium;<br>3) Low;<br>4) No independence                                    | The dissertation demonstrates a high level of independence in conducting the research. The PhD candidate independently designed and carried out the experimental work, performed data analysis, validated the research hypotheses, and prepared the dissertation. The principal findings of the study have been published in a high-impact peer-reviewed scientific journal, confirming the scientific quality and originality of the research: (Q2 WoS) DOI: 10.1007/s13726-024-01417-3. Based on the scope and quality of the work accomplished, the candidate's level of independence and research competence is assessed as high.                                                                                                                                                                  |
| 4. | The principle of inner unity  | 4.1 Justification of the relevance of the thesis:<br>1) <u>Justified</u> ;<br>2) Partially justified;<br>3) Not justified. | The relevance of this dissertation is beyond doubt and convincingly substantiated by the PhD candidate. The development of a technology for producing antibacterial leather footbeds and linings using environmentally friendly components, such as laurel essential oil and chitosan, is based on microencapsulation technology and aligns with current trends in the creation of functional and environmentally friendly materials. The research aims to improve the hygienic properties of footwear, ensure long-term antimicrobial protection, and expand the range of innovative materials for the footwear industry. The practical value of the developed technology lies in its applicability in the production of footwear for both individuals with foot deviations and the general consumer. |
|    |                               | 4.2 The content of the thesis reflects the topic of the thesis:                                                            | The content of the dissertation work fully reflects the topic.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

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|    |                              | 1) <u>Reflects</u> ;<br>2) Partially reflects;<br>3) Does not reflect                                                                                                                                                                                                                                                            | <p>The first part of the dissertation work analyzes information on footwear materials, microencapsulation technology, antibacterial properties, properties of chitosan and laurel oil, data on pathological deviations of the feet, as well as footbeds used for these groups.</p> <p>The second part of the dissertation work describes the objects of research, the materials used and the research methods.</p> <p>In the third part of the dissertation work, an analysis of the obtained results is carried out.</p> |
|    |                              | 4.3. The purpose and objectives correspond to the topic of the thesis:<br>1) <u>correspond</u> ;<br>2) partially correspond;<br>3) do not correspond                                                                                                                                                                             | The purpose and objectives of the research correspond to the topic of the dissertation, as they are in strict accordance with the topic of the dissertation.                                                                                                                                                                                                                                                                                                                                                              |
|    |                              | 4.4 All sections and provisions of the thesis are logically interconnected:<br>1) <u>completely interconnected</u> ;<br>2) the interconnection is partial;<br>3) there is no interconnection                                                                                                                                     | The dissertation is a well-structured and coherent piece of research. All chapters are closely interconnected, follow a logical progression, and collectively contribute to achieving the stated research objectives.                                                                                                                                                                                                                                                                                                     |
|    |                              | 4.5 The new solutions (principles, methods) proposed by the author are reasoned and evaluated in comparison with the known solutions:<br>1) <u>there is a critical analysis</u> ;<br>2) partial analysis;<br>3) the analysis does not represent one's own opinions, but quotes from other authors;<br>4) the analysis is absent. | Drawing upon a critical analysis of existing research and technological developments in the footwear industry in Kazakhstan and internationally, the PhD candidate has proposed and scientifically justified original solutions that underpin the dissertation and demonstrate its scientific novelty and practical significance.                                                                                                                                                                                         |
| 5. | Scientific novelty principle | 5.1 Are the scientific results and provisions new?<br>1) <u>completely new</u> ;<br>2) partially new (25-75% are new);<br>3) not new (less than 25% are new)                                                                                                                                                                     | The scientific results and provisions are new. The scientific novelty of the dissertation lies in the development of an innovative technology for producing chitosan-based microparticles containing laurel essential oil and their application to leather footbeds and footwear                                                                                                                                                                                                                                          |

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|    |                                   |                                                                                                                                                                                                  | lining materials to impart durable antimicrobial properties. The study experimentally demonstrated the controlled release of the active compound, improved physicochemical performance, and effective antimicrobial activity, confirming the potential of the developed materials for both therapeutic and general footwear applications.                                                                                                                                                                                                                                                                                            |
|    |                                   | 5.2 Are the dissertation findings new?<br>1) <u>completely new</u> ;<br>2) partially new (25-75% are new);<br>3) not new (less than 25% are new)                                                 | The scientific novelty lies in developing and experimentally evaluating chitosan-based microparticles containing laurel essential oil for leather footwear treatment, identifying key formulation and processing parameters, and assessing the antimicrobial activity and durability of the treated materials.                                                                                                                                                                                                                                                                                                                       |
|    |                                   | 5.3 Technical, technological, economic or management decisions are new and reasonable:<br>1) <u>completely new</u> ;<br>2) partially new (25-75% are new);<br>3) not new (less than 25% are new) | The technical and technological solutions presented in the dissertation are new and well substantiated. The application of microparticles derived from natural chitosan and laurel essential oil to leather footbeds and footwear lining materials provides durable antibacterial properties. The proposed manufacturing technology significantly improves the hygienic characteristics of footwear, promotes foot health, and has considerable potential for practical implementation in the footwear industry.                                                                                                                     |
| 6. | The validity of the main findings | All main conclusions <u>are</u> /are not based on scientifically significant evidence or well-grounded (for qualitative research and areas of training in the arts and humanities)               | All conclusions presented in the dissertation are scientifically justified and supported by experimental evidence, including an encapsulation efficiency of approximately 90%, a median microparticle size of 12 $\mu\text{m}$ , and confirmed antimicrobial activity of the treated footwear materials. The dissertation represents a research work of considerable scientific and practical significance, with the stated aim and research objectives fully accomplished. The dissertation is logically organised, and all chapters and findings are coherently interconnected, demonstrating the consistency and integrity of the |

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| 7. | The main provisions for the defense | <p>It is necessary to answer the following questions for each provision separately:</p> <p><b>Provision 1</b></p> <p>7.1 Is the provision proven?</p> <p>1) <u>proven</u>;</p> <p>2) rather proven;</p> <p>3) rather not proven;</p> <p>4) not proven;</p> <p>5) in its current wording, it is impossible to verify whether the statement has been proven.</p> <p>7.2 Is it trivial?</p> <p>1) <u>yes</u>;</p> <p>2) <u>no</u>;</p> <p>3) in its current wording, it is impossible to verify whether the statement is trivial.</p> <p>7.3 Is it new?</p> <p>1) <u>yes</u>;</p> <p>2) <u>no</u>;</p> <p>3) in its current wording, it is impossible to verify the novelty of the statement.</p> <p>7.4 Application level:</p> <p>1) narrow;</p> <p>2) medium;</p> <p>3) <u>wide</u>;</p> <p>4) in its current wording, it is impossible to determine the scope of application of the statement.</p> <p>7.5 Is it proven in the article?</p> <p>1) <u>yes</u>;</p> <p>2) <u>no</u>;</p> | <p><b>Provision 1</b></p> <p>7.1. Spray drying is an established technique for producing microparticles from liquid formulations. In this dissertation, the successful production of chitosan-based microparticles containing laurel essential oil was experimentally confirmed by SEM images presented in Figures 3.1-3.3, which demonstrate their morphology.</p> <p>7.2 The provision is not a simple repetition of the established spray-drying principle, as it involves adapting the technique to a specific chitosan-laurel essential oil formulation and establishing suitable processing conditions for obtaining microparticles intended for leather footwear treatment.</p> <p>7.3 According to the literature and patent review conducted, this specific technological approach was not identified in the sources examined, including those relevant to Kazakhstan.</p> <p>7.4 The developed technology can be applied in the footwear and leather industries to produce functional microparticles for treating leather footbeds and lining materials.</p> <p>7.5 - Baidildayeva A., Türkoğlu G.C., Ökeer M., Eraç B., Karavana H.A. Microencapsulation of Laurel Essential Oil with Chitosan for Enhanced Durability and Antimicrobial Properties of Leather Footbeds. // Iranian polymer journal. - 2024. DOI: 10.1007/s13726-024-01417-3</p> <p>- Baidildayeva A., Türkoğlu G.C., Ökeer M., Eraç B., Karavana H.A. Textile-based footwear linings functionalized with laurel oil microparticles:</p> |

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|  | <p>3) in its current wording, it is impossible to verify whether the statement has been proven in the article.</p> <p><b>Provision 2</b></p> <p>7.1 Is the provision proven?</p> <p>1) <u>proven</u>;</p> <p>2) rather proven;</p> <p>3) rather not proven;</p> <p>4) not proven;</p> <p>5) in its current wording, it is impossible to verify whether the statement has been proven.</p> <p>7.2 Is it trivial?</p> <p>1) <u>yes</u>;</p> <p>2) <u>no</u>;</p> <p>3) in its current wording, it is impossible to verify whether the statement is trivial.</p> <p>7.3 Is it new?</p> <p>1) <u>yes</u>;</p> <p>2) <u>no</u>;</p> <p>3) in its current wording, it is impossible to verify the novelty of the statement.</p> <p>7.4 Application level:</p> <p>1) narrow;</p> <p>2) medium;</p> <p>3) <u>wide</u>;</p> <p>4) in its current wording, it is impossible to determine the scope of application of the statement.</p> <p>7.5 Is it proven in the article?</p> <p>1) <u>yes</u>;</p> <p>2) <u>no</u>;</p> <p>3) in its current wording, it is impossible to verify whether the statement has been proven in the article.</p> | <p>antimicrobial protection. // 10th International Conference «Advanced materials and systems (ICAMS 2024)». Bucharest, 2024.<br/> <a href="https://doi.org/10.2478/9788367405805-003">https://doi.org/10.2478/9788367405805-003</a></p> <p><b>Provision 2</b></p> <p>7.1. The provision is supported by experimental results. Seven formulations, including a blank sample and samples L<sub>1</sub>-L<sub>6</sub>, were prepared using different compositional ratios, as described in Table 2.4. The formulations were produced under controlled spray-drying conditions at 160-170 °C and feed rates of 4-10 mL/min. Their yield, morphology, particle size distribution, and physicochemical characteristics were subsequently evaluated and compared.</p> <p>7.2 The provision is not a simple repetition of known principles because it experimentally examines the effects of several formulation and processing parameters on a specific chitosan-laurel essential oil system.</p> <p>7.3 The scientific contribution lies in establishing the effects of formulation composition and spray-drying conditions on the yield and characteristics of chitosan-based microparticles containing laurel essential oil. The study also demonstrated that processing time depends on the feed rate: increasing the pump flow rate from 3 to 5 mL/min reduced the estimated processing time for 250 mL of solution from approximately 83 to 50 minutes.</p> <p>7.4 The results can be applied in the leather and footwear industries to select formulation compositions and spray-drying conditions for producing microparticles.</p> <p>7.5 - Baidildayeva A., Türkoğlu G.C., Ökeer M., Eraç B., Karavana H.A. Microencapsulation of Laurel Essential Oil with Chitosan for Enhanced Durability and Antimicrobial Properties of Leather Footbeds. // Iranian polymer journal. - 2024, DOI: 10.1007/s13726-024-</p> |
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|  | <p><b>Provision 3</b></p> <p>7.1 Is the provision proven?</p> <p>1) <u>proven</u>;</p> <p>2) rather proven;</p> <p>3) rather not proven;</p> <p>4) not proven;</p> <p>5) in its current wording, it is impossible to verify whether the statement has been proven.</p> <p>7.2 Is it trivial?</p> <p>1) yes;</p> <p>2) <u>no</u>;</p> <p>3) in its current wording, it is impossible to verify whether the statement is trivial.</p> <p>7.3 Is it new?</p> <p>1) <u>yes</u>;</p> <p>2) no;</p> <p>3) in its current wording, it is impossible to verify the novelty of the statement.</p> <p>7.4 Application level:</p> <p>1) narrow;</p> <p>2) medium;</p> <p>3) <u>wide</u>;</p> <p>4) in its current wording, it is impossible to determine the scope of application of the statement.</p> <p>7.5 Is it proven in the article?</p> <p>1) <u>yes</u>;</p> <p>2) no;</p> <p>3) in its current wording, it is impossible to verify whether the statement has been proven in the article.</p> <p><b>Provision 4</b></p> <p>7.1 Is the provision proven?</p> <p>1) <u>proven</u>;</p> | <p>01417-3</p> <p>- Baidildayeva A., Türkoğlu G.C., Ökeer M., Eraç B., Karavana H.A. Textile-based footwear linings functionalized with laurel oil microparticles: antimicrobial protection. // 10th International Conference «Advanced materials and systems (ICAMS 2024)». Bucharest. - 2024. <a href="https://doi.org/10.2478/9788367405805-003">https://doi.org/10.2478/9788367405805-003</a></p> <p><b>Provision 3</b></p> <p>7.1. Microparticles were applied to leather footbeds and lining materials using spraying and dip-coating, as described in Table 2.8. The treated samples were examined by SEM, and their antimicrobial properties were evaluated through microbiological testing.</p> <p>7.2 The provision goes beyond the general knowledge that spraying and dip-coating are established finishing techniques. It compares their suitability for applying chitosan-based microparticles containing laurel essential oil to leather footwear components, considering microparticle distribution and the functional performance of the treated materials.</p> <p>7.3 The scientific contribution lies in experimentally demonstrating that spraying is more suitable than dip-coating for applying the developed microparticles to leather footbeds. SEM images confirmed microparticle deposition and distribution on the leather surface while showing no visible structural damage after treatment.</p> <p>7.4 The results can be applied in the leather and footwear industries when selecting a finishing method.</p> <p>7.5 Baidildayeva A., Karavana H.A., Jiyembetova L., Jumabekova G., Abzakhbekuly B. Loading efficiency and in vitro release studies of microparticles treated on leather and footwear linings. // Mechanics and technology, Taraz. - 2025. - Vol.3. <a href="https://doi.org/10.55956/FVMJ3854">https://doi.org/10.55956/FVMJ3854</a></p> |
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|    |                                                                                 | <p>2) rather proven;<br/> 3) rather not proven;<br/> 4) not proven;<br/> 5) in its current wording, it is impossible to verify whether the statement has been proven.</p> <p>7.2 Is it trivial?<br/> 1) yes;<br/> 2) <u>no</u>;<br/> 3) in its current wording, it is impossible to verify whether the statement is trivial.</p> <p>7.3 Is it new?<br/> 1) <u>yes</u>;<br/> 2) no;<br/> 3) in its current wording, it is impossible to verify the novelty of the statement.</p> <p>7.4 Application level:<br/> 1) narrow;<br/> 2) medium;<br/> 3) <u>wide</u>;<br/> 4) in its current wording, it is impossible to determine the scope of application of the statement.</p> <p>7.5 Is it proven in the article?<br/> 1) <u>yes</u>;<br/> 2) no;<br/> 3) in its current wording, it is impossible to verify whether the statement has been proven in the article.</p> | <p><b>Provision 4</b></p> <p>7.1. The provision is supported by experimental results presented in Table 3.18. All seven leather treatment variants exhibited antimicrobial activity against the tested microorganisms. The antifungal effect against <i>Candida albicans</i> was more pronounced than the activity against the tested bacterial strains.</p> <p>7.2 It addresses the practical challenge of maintaining antimicrobial activity after the treated leather is exposed to mechanical stress, including repeated flexing and dry or wet rubbing.</p> <p>7.3 The results showed that the treated samples inhibited microbial growth in the contact areas, with inhibition zones of approximately 12 mm reported in the study. This provides experimental evidence of the potential of the developed treatment to retain antimicrobial functionality following mechanical testing.</p> <p>7.4 The results can be applied in the leather and footwear industries to develop antimicrobial leather footbeds and lining materials.</p> <p>7.5 Baidildayeva A., Türkoğlu G.C., Jiyembetova L., Jumabekova G., Abzakebekuly B. Study of the antimicrobial properties of footwear materials of people with pathological deviations of the feet. // Mechanics and technology. Taraz. - 2025. - Vol.1. <a href="https://doi.org/10.55956/OTRW6921">https://doi.org/10.55956/OTRW6921</a></p> |
| 8. | The principle of reliability<br>Reliability of sources and information provided | <p>8.1 Choice of methodology - is justified or the methodology is described in sufficient detail<br/> 1) <u>yes</u>;<br/> 2) no</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <p>The choice of research methodology is comprehensive and convincingly justified. The dissertation is founded on well-established and internationally recognised scientific approaches and research methods, which provide a robust methodological basis for achieving the research objectives and ensure the validity and reliability of the</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

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|   |                           |                                                                                                                                                                                                                                                                                        | findings.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|   |                           | 8.2 The results of the thesis were obtained using modern methods of scientific research and methods of processing and interpreting data using computer technologies:<br>1) <u>yes</u> ;<br>2) no                                                                                       | The dissertation work results were achieved through modern scientific research methods and advanced data processing techniques using computer technologies: scanning electron microscopy, particle size distribution, Fourier-transform infrared spectroscopy, ultraviolet visible spectrophotometers, <i>in vitro</i> release testing, color measurement, and loading efficiency.                                                                                                                                                                        |
|   |                           | 8.3 Theoretical conclusions, models, identified relationships and patterns have been proven and confirmed by experimental research (for areas of training in pedagogical sciences, the results have been proven on the basis of a pedagogical experiment):<br>1) <u>yes</u> ;<br>2) no | <i>In vitro</i> studies revealed solvent-dependent release profiles. Microscopy confirmed uniform microparticle distribution without visible structural damage, and microbiological tests demonstrated antimicrobial activity in the treated footwear materials. The main findings of the study have been published in international and Kazakhstan peer-reviewed journals and presented at international scientific conferences, demonstrating their scientific validity and contributing to the dissemination and verification of the research results. |
|   |                           | 8.4 Important statements are <u>confirmed</u> / partially confirmed / not confirmed by references to current and reliable scientific literature                                                                                                                                        | The main statements are well substantiated and supported by relevant and consistent references to authoritative scientific works by Kazakhstan and international researchers.                                                                                                                                                                                                                                                                                                                                                                             |
|   |                           | 8.5 Used literature sources are <u>sufficient</u> /not sufficient for a literature review                                                                                                                                                                                              | A total of 101 literature sources were used in the dissertation. The selected references are sufficient to provide a comprehensive and well-structured literature review and to ensure an adequate analysis of the current state of research in the field.                                                                                                                                                                                                                                                                                                |
| 9 | Practical value principle | 9.1 The thesis has theoretical value:<br>1) <u>yes</u> ;<br>2) no                                                                                                                                                                                                                      | The dissertation has theoretical significance in establishing relationships between formulation composition, microparticle characteristics, and the release                                                                                                                                                                                                                                                                                                                                                                                               |

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|     |                                   |                                                                                                                                                     | behaviour of laurel essential oil. The research findings have been implemented in the educational process, as confirmed by the relevant implementation act.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|     |                                   | 9.2 The thesis is of practical importance and there is a high probability of applying the results obtained in practice:<br>1) <u>yes</u> ;<br>2) no | The dissertation has significant practical importance. The research findings have been implemented in the production process, as confirmed by the relevant implementation acts.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|     |                                   | 9.3 Are the practice suggestions new?<br>1) <u>completely new</u> ;<br>2) partially new (25-75% are new);<br>3) not new (less than 25% are new)     | The proposals for practical application are novel and have been implemented in the production activities of LLP "TarazKozhObuv" and LLP "Tarazski Kozhevennyi Zavod".                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 10. | The quality of writing and design | Academic writing quality:<br>1) <u>high</u> ;<br>2) average;<br>3) below average;<br>4) low.                                                        | The quality of academic writing and design is high.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 11. | Notes on a thesis                 |                                                                                                                                                     | <p>1. The dissertation contains elements of both British and American English. It is recommended to use a consistent English language style throughout the dissertation to ensure linguistic uniformity and academic consistency.</p> <p>2. Should the statistical data on population health and the activities of healthcare organisations published by the Ministry of Health of the Republic of Kazakhstan be updated with 2026 data?</p> <p>3. In Section 3.9, the same data are presented in both a figure and a table. Is it necessary to duplicate the information in both formats, or could one of them be omitted to avoid unnecessary repetition?</p> <p>The comments and minor shortcomings identified in the dissertation are of a non-critical nature and do not affect the validity of the main theoretical and experimental findings. They do not reduce the scientific significance, practical relevance, or overall value of the dissertation.</p> |

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| 12. | Scientific level of the doctoral student's articles on the topic of research (in case of defense of the dissertation in the form of a series of articles, the official reviewers comment on the scientific level of each article of the doctoral student on the topic of research) | A high level of scientific quality characterises the scientific publications based on the dissertation research. A total of six publications have been published, including an article in a peer-reviewed journal indexed in international bibliographic databases, articles in journals listed by the Science and Higher Education Quality Assurance Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan and articles in international conferences. |
| 13. | Decision of the official reviewer (pursuant to paragraph 28 of the present Model Regulations)                                                                                                                                                                                      | I recommend awarding the degree of Doctor of Philosophy (PhD) to Baidildayeva Assel Kuanyshevna in the educational program «8D07211 - Leather Goods Industry» for her dissertation work titled «Research of microencapsulation technology of leather for footwear of people with pathological deviations of the feet».                                                                                                                                                                   |

**Official Reviewer:**

Professor, Doctor,  
Leather Process Technology Division,  
Central Leather Research Institute,  
Council of Scientific and Industrial Research

  
15/10/2026  
(signature)

VICTOR JOHN SUNDAR

**डॉ. वी. जॉन सुंदर Dr. V. John Sundar**  
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