REVIEW

of the official reviewer for dissertation work of Amankulova Dinara on the theme: "Development of a method for non-catalytic synthesis of *meta*-aryloxyphenols from 1,3-cyclogexanedione", submitted for the degree of Doctor of Philosophy (PhD) in the Educational Program "8D07105 - Chemical technology of organic substances.

№	Criteria	Eligibility (one of the options must be checked)	Justification of the position of the official reviewer
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	1.1 Compliance with priority areas of science development or government programs:	I believe this work complies. The work aligns with the outline of the target program indicated below.
		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)	The thesis was completed in accord with the program 8D07105 - Chemical technology of organic substances. The chemistry involved advances the chemical technology for the synthesis of organic molecules, specifically resorcinols.
2.	Importance for science	The work makes/does not make a significant contribution to science, and its importance is well disclosed/not disclosed	The work makes a significant contribution to science, and its importance is disclosed. The thesis clearly outlines alternative methodologies and the use of the molecules prepared. The novel aspects of the chemistry is described fully.
3.	The principle of independence	Self-reliance level: 1) High;	The reported contributions support a high level of independence for the researcher in both practical techniques, theory, and communication. In particular, the thesis is very well written and thorough.
4.	The principle of inner unity	4.1 Justification of the relevance of the thesis: 1) Justified;	The relevance of the thesis is well justified. The thesis is aligned with objectives of the state target program

			and advances science in the field of organic chemistry.
		4.2 The content of the thesis reflects the topic of the thesis: 1) Reflects;	The contents of the thesis accurately reflects existing knowledge in the area of resorcinol synthesis. The novel aspects of the thesis are supported with experimental evidence and detail that is in accord with standards in the field. The scientific conclusions are supported and related to the thesis topic clearly and accurately.
		4.3. The purpose and objectives correspond to the topic of the thesis: 1) correspond;	The objectives are clearly laid out in the introduction and are thoughtfully addressed throughout the thesis. The experiments disclosed are well-designed and in alignment with the accurately studying the objective.
		4.4 All sections and provisions of the thesis are logically interconnected: 1) completely interconnected;	Thesis sections are strongly connected through the theoretical framework of the project. This is an overall strength of the thesis document, which is well written and clear.
		4.5 The new solutions (principles, methods) proposed by the author are reasoned and evaluated in comparison with the known solutions: 1) there is a critical analysis;	There is significant critical analysis of the results presented, along with discussion of related literature, theory, and background. The level of experimental detail and analytical support is aligned with standards in the field of organic synthesis.
5.	Scientific novelty principle	5.1 Are the scientific results and provisions new? 2) partially new (25-75% are new);	The primary work is new, and is based on related results previously developed in the laboratory.
		5.2 Are the dissertation findings new? 2) partially new (25-75% are new);	The primary work is new, and is based on related results previously developed in the laboratory.

		5.3 Technical, technological, economic or management decisions are new and reasonable: 2) partially new (25-75% are new);	The primary work is new, and is based on related results previously developed in the laboratory.
6.	The validity of the main findings	All main conclusions are/are not based on scientifically significant evidence or well-grounded (for qualitative research and areas of training in the arts and humanities)	All main conclusions are based on scientifically significant evidence or well-grounded
7.	The main provisions for the defense	It is necessary to answer the following questions for each provision separately: **Provision 1** 7.1 Is the provition proven? 1) proven; 7.2 Is it trivial? 2) no 7.3 Is it new? 1) yes; 7.4 Application level: 2) medium; 7.5 Is it proven in the article? 1) yes; **Provision 2**	1. A novel approach for synthesizing *meta*-(aryloxy)phenols via cyclohexane-1,3-dione has been devised, comprising a four-step synthesis protocol. The method has yielded eight *meta*-(aryloxy)phenols in high quantities, with an average yield of 66% for all eight compounds. 2. The method avoids the need for operations to bypass the *ortho-, para*- directing effect of oxygen, resulting in a simplified and streamlined synthesis process. The required 1,3-functional group relationship is inherent in the readily available cyclohexane-1,3-dione starting material, allowing for easy access to the desired *meta*-(aryloxy)phenols.

		7.1 Is the provition proven? 1) proven; 7.2 Is it trivial? 2) no 7.3 Is it new? 1) yes; 7.4 Application level: 3) wide 7.5 Is it proven in the article? 1) yes; **Provision 3** 7.1 Is the provition proven? 1) proven; 7.2 Is it trivial? 2) no 7.3 Is it new? 1) yes;	3. The synthesis method does not entail the use of heavy metals or ligands, rendering it a more ecologically sound and safer substitute to conventional techniques. *Comments:* All three provisions are supported by experimental evidence that point to their validity and importance to the field. The significance of the results is evidenced by two publications in internationally recognized scientific journals (*Tetrahedron* **2023**, *133*, 133264 and *Molecules* **2023**, *28*, 2657) which describe aspects of this work. Each publication includes detailed analysis of the chemistry and full details of the experimental protocols which are in accord with standards in the field of organic chemistry. Theoretical context is also supplied to further support the use of the proposed methods for various future applications. The chemical transformation is not trivial, given that the specific functionalization of electron rich aromatic systems is a significant challenge. Whereas conventional

		7.4 Application level: 3) wide 7.5 Is it proven in the article? 1) yes;	methods frequently require harsh reaction conditions and often lead to product mixtures, this work is of significant value, and represents an important contribution to the synthesis of this class of organic molecules.
8.	The principle of reliability Reliability of sources and information provided	8.1 Choice of methodology - is justified or the methodology is described in sufficient detail 1) yes;	Yes, rationale for the selected approach and methods are provided. Experimental procedures and analytical data are provided to facilitate future users of this chemistry.
		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: 1) yes;	Yes, the data is supported using standard analytical techniques for chemical synthesis. The data examined is in accord with the conclusions stated in the thesis and published manuscripts.
		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): 1) yes;	Yes, models are supported by experimental evidence. Sufficient detail for experimental procedures is supplied and analytical data is aligned with the conclusions.
		8.4 Important statements are confirmed / partially confirmed / not confirmed by references to current and reliable scientific literature	Statements are suitably confirmed.
		8.5 Used literature sources are sufficient/not sufficient for a literature review	Literature sources are sufficient
9	Practical value principle	9.1 The thesis has theoretical value:	Yes, the thesis has theoretical value. The reactivity of electron rich arenes is

		1) yes;	complex and presents significant synthetic challenges. The work presented in this thesis and the related publications confirm the value of this chemistry and the improved insights into the reactivity of these challenging molecules.
		9.2 The thesis is of practical importance and there is a high probability of applying the results obtained in practice: 1) yes;	This methods disclosed in the thesis and related journal articles is convenient and of use for the synthesis of many related target molecules. Whereas this class of molecules presents many challenges through existing methods, this work has significant potential for future application in the field.
		9.3 Are the practice suggestions new? 2) partially new (25-75% are new);	The work builds upon some existing knowledge in the area, and adds significant new results that advance the area.
10.	The quality of writing and design	Academic writing quality: 1) high;	The language used is clear and the descriptions are comprehensive, supporting a strong command of the subject matter. Complex ideas are well articulated and furnish a full analysis of the related work in the field, while also highlighting the novel aspects of the chemistry reported.

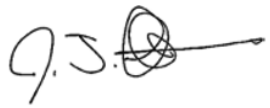
In reviews, official reviewers indicate one of the following solutions:

1) to award the degree of Doctor of Philosophy (PhD) or Doctor of Specialization;

Copies of the reviews of the official reviewers are handed over to the doctoral student no later than 5 (five) working days before the defense of the thesis.

Official Reviewer:

__University of Illinois, Chicago_

_Associate Professor of Chemistry__ _____  __ _____Justin Thomas Mohr__

(place of work, academic title) (signature) (FULL NAME)