Ontology-Based Systemizing of the Science Information Devoted to Waste Utilizing by Methanogenesis

Ye. Shapovalov, V. Shapovalov, O. Stryzhak, A. Salyuk

Abstract—Over the past decades, amount of scientific information has been growing exponentially. It became more complicated to process and systemize this amount of data. The approach to systematization of scientific information on the production of biogas based on the ontological IT platform "T.O.D.O.S." has been developed. It has been proposed to select semantic characteristics of each work for their further introduction into the IT platform "T.O.D.O.S.". An ontological graph with a ranking function for previous scientific research and for a system of selection of microorganisms has been worked out. These systems provide high performance of information management of scientific information.

Keywords—Ontology-based analysis, analysis of scientific data, methanogenesys, microorganism hierarchy, T.O.D.O.S.

I. INTRODUCTION

THE amount of scientific information in the field of biotechnology has been growing and its processing and systematization has become more complicated over the past decades. The number of science articles and patents has grown exponentially since 2000. The number of patents in 2000 was about 70 and then grew to 2235 in 2017 (Fig. 1). The similar situation is observed with science articles. Their number was about 50 and it grew to 3959 in 2017 (Fig. 2) [4]. In addition, there is a fairly large amount of unsystematic data that has to be used in biotechnology research. As far as more and information is being accumulated, its scientific and analytical processing will become increasingly difficult with every year. Therefore, there is a problem with information management of the scientific branch, in particular, with regard to the production of biogas.

The aim of the work is to propose an approach to systematization of information on biogas production for further scientific work.

II. LITERATURE REVIEW

At the moment, the tools that are used do not allow to provide semantic analysis, but just provide user-based relevant information sorting. For example - Google-search, Google scholar, Microsoft Academy, etc. [3], [5], [7].

Salyuk A. I. is with National University of Food Technologies, Kyiv, Ukraine.

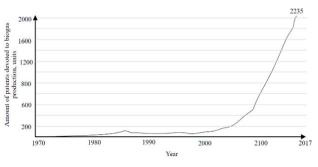


Fig. 1 The number of patents devoted to biogas production [4]

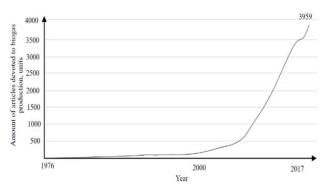


Fig. 2 The number of articles devoted to biogas production [4]

Lack of information management is the main disadvantage of these systems, so development of systems that allows to provide a quick and relevant search of scientific works is actual. One of the ways of solving this problem is the creation of ranging-based databases.

This aim may be solved using "T.O.D.O.S." (Transdisciplinary Ontology Dialog Object-oriented Systems) services. They allow to highlight semantic and numeric characteristics of each scientific work, which can be used as criteria to range scientific works [10], [11]. An example of ranking systems is presented in Figs. 3 and 4.

Still, the problem of information systematization of scientific data in the biotechnology field, using semantic characteristics, has not been realized yet. Thus, there is a scientific task to adapt a ranging platform to systematization of previous research results. It is possible in the case where scientific results may be interpreted using numeric data. However, it is often necessary to use in scientific work theoretic and not numeric information, which can be

Shapovalov Ye. B., Shapovalov V. B., Stryzhak A.Ye are with the National Center of Junior Academy of Science, Kyev, 04119, Ukraine (corresponding author, e-mail: gws0731512025@gmail.com).

interpreted using semantic data. An example of theoretic information used in the field of biotechnology is hierarchy of microorganisms. Nowadays, this information is presented in

Завантажити граф

the text type or in the structure type (Fig. 5). Thus, it takes a lot of time to process it. Operationality of this information can be significantly improved by transforming it to taxonomy [9].

	C		валища (ра (Оттимізси	нжування) ція)									
Врахову	оться властивості Опрацювати												
Dudin	lm's	Bar.	Опт	Способи з	ієнтів								
Вибір	IM'S	Коеф.	(max/min)	Бальна шкала (10)	Лінгвістична шкала	Ранжування							
×.	gis_point	0.143	max 🔻	5 🔻	Середня важливість 🔻	1.							
ø	Область	0.143	max 🔻	5 💌	Середня важливість 🔹	1.*							
×.	Район	0.143	max 🔻	5 •	Середня важливість	1•							
×.	Площа ділянки (га)	0.143	max 🔻	5 •	Середня важливість 💌	1.							
×.	Обсяг відходів (т)	0.143	max 🔻	5 💌	Середня важливість 🔻	1.							
۲	Середньодобовий обсяг відходів (т)	0.143	max 🔻	5 💌	Середня важливість 🔻	1.*							
	Середньодобовий обсяг відходів (м3)	0.143	max 🔻	5 🔻	Середня важливість 🔻	1.							
7/7		Сист	ема переваг										

Fig. 3 The general view of a classical ranging system

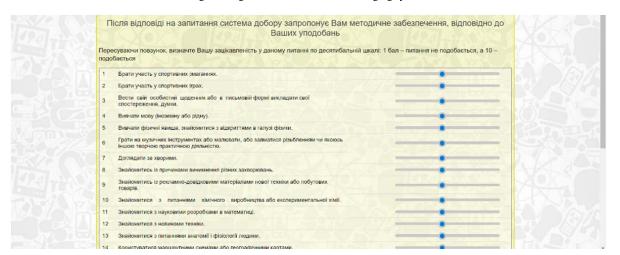


Fig. 4 The general view of a renewed ranging system

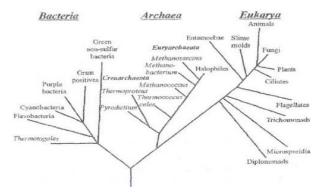


Fig. 5 An example of interpretation of hierarchy of microorganisms

We propose to use filtration instrument of the IT-plafrom "T.O.D.O.S." to improve information management of hierarchy of microorganisms. We have previously realized this idea to systemize the instruments of scientific work [1], [2], [8]. The filtration-based ontology of wastewater clearing technologies is presented in Fig. 6.

The detailed features of instruments of ranging and filtration of the ontology-based data are presented in our previous works [1], [2], [8].

II. MATERIALS AND METHODS

To store information and provide its sharing, google sheets were used, with their further conversion into the .xls and .csv Excel sheets. The obtained documents were used to create the ontology structure (xml) and to fill the ontology graphs with semantic and numeric information for ranking and filtering.

To do this, the sheets were loaded to the part of "T.O.D.O.S." IT-platform editor4. After that, generation of the graph edges with its characteristics was carried out. The obtained ontological graphs were open in the appropriate form

of ranking or filtering.

III. RESULTS

To construct a system of ranking of previous studies, we have identified semantic characteristics of the scientific research devoted to biogas production from chicken manure. These semantic characteristics include temperature (° C), volume of reactor (1), chicken manure content (%), moisture content (%), active sludge content (%), final solids content

ONTOLOGY

(%), biogas and methane production (ml/g VS), methane content (%), year of the research, ammonium nitrogen content (mg / l), final pH, initial pH, minimal and maximum pH of substrate [6].

The characteristics were selected from the studies on dry fermentation of chicken manure and were input to the google sheets (Fig. 7).

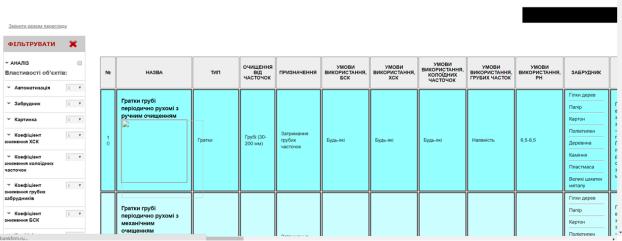


Fig. 6 The filtration-based ontology of wastewater clearing technologies

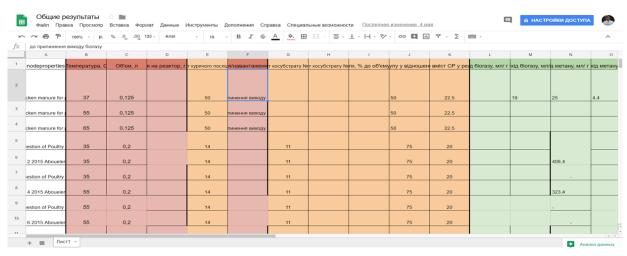


Fig. 7 General view of the google sheet with data on chicken manure dry fermentation

The data were processed by the methods described in detail in our previous works [1], [2], [8]. As a result, it was possible to use ranging of previous research results. The general view of the taxonomy is presented in Fig. 8. The interface for selecting the importance of indicators is presented in Fig. 9, and the interface for ranking the results is presented in Fig. 10.

The interface for selecting the priorities of numerical information for ranking allows to take into account the priority of modern articles, with the correct marking of importance criteria. The considered system allows quick search of the information by necessary criterion.

Systematization of knowledge in the field of biotechnology may also be complicated by the fact that semantic characteristics cannot always be quantified, and therefore the ranking system cannot always solve the issue of information management.

For such systems, it was suggested to allocate semantic characteristics and apply a filtering function. The semantic

characteristics of each microorganism was also proposed and input into the google sheets. All semantic characteristics were added in the collective access mode. The general view of the

Sanzenzo-anne eporte

attachment file for the system for selecting microorganisms is presented in Fig. 11.

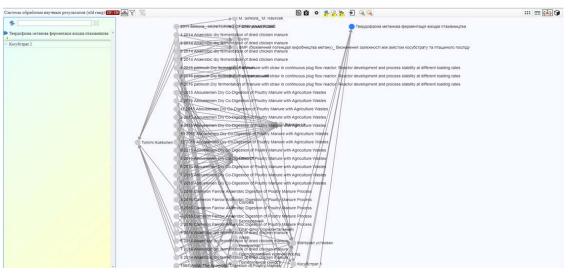


Fig. 8 The general view of the taxonomy

	Система обработ		ных резул имізація)	ьтатов (old rang)	2	_
		Опрацювати				
Bxőip	lp Int's	Ваг. Коеф.	Опт	Способи з	фентів	
вкоф			(max/min)	Бальна шкала (10)	Пназістична цкала	Ранкування
×	Температура, С	0.038	1045 V	5	Серерия вания сть •	1.
	Обси, л	0.038	345 ¥	5 *	Серерни ванинисто ч	
	Bwiet kypekoro nochlay, %	0.038	-	5 .*	Серерет важливесть	
	Виют валом, % до об'юну субстрату	0.038	223. *	5	Ceptors at eren at	1.
	Вијст активного мулу у відношонні до субстрату. %	0.038	[*** *	5 *	Серери ваклисть ч	
×	Kikupawa awiot CP y peartopi, S	0.038	228 4	5.*	Серерия вселия ст.	1.1
	Визід метану, мл' г СОР	0.038		15 •	Середня валинаюта	
×	Виют метану, N	0.038	445.7	5.*	Серария важлия сть	3
	Рк	0.038	(max •	5.+	Середня влагня кла	
	Результат	0.038	145.7	5 .	Середня важливсть •	1.

Fig. 9 The interface for selecting the importance of indicators

												Свинний навоз характеризувався вищою буферністю, тому	
2	2 1985 JANTRANIA HIGH-SOITDS ANALROBIC FERMENTATION OF	0.25	35	15	71			35	42,952		1985		Пері
1	1990 Callaghan Co-digestion of waste organic solida: batch sbudles	0.272	35	1	20		10	15	70		1999		nepi
•	Елементи	Значсния	Теклература, С	05'ен, л	Вніст курячого посліду, %	Виіст вологи, % до об'єну субстроту	Вніст активного мулу у Відношенні до субстрату, %	Кінцевий вніст СР у рескторі, %	Bacia Netaky, Kit/ r COP	BNICT Netoky, %	PK	Результат	Рекля безг

Fig. 10 The interface for ranking the results is presented

The resulting ontological graph provides the possibility to use the filtering, and it is possible to find the discovered microorganism or group of microorganisms. General view of the ontological taxonomy of microorganisms is presented in Fig. 12 and general view of the microorganisms selecting system in Fig. 13.

IV. CONCLUSIONS

Thus, the proposed systems allow to systematize previous research and theoretical information using ontological graphs and provide information management in this field of biogas production. Developed approaches allow us to analyze the results of previous research and theoretical information, as well as to simplify the work with previous information for the scientific research.

*	~ ₩ ₽ 100% · p. % .0 .6	0 123 - Arial	- 10	· B I 6	<u>A</u> • .	⊞ 23 · ≣·	± · 1÷ · 🆻	· • • 🖬 🛛	Σ·Υ	III • •	^
fx	Метан										
	A	c	D	L	F	G	-11	1	4	К	
86	Family I, HalobacteriaceasAl,										
10	Family I. LactobacillaceaerAL										
100	Family I. LegumellaceasAL										
01	Family I. Methanobacteriaceaer':								Метан	Виробництво м	
100	Family I. MethanococcaceaeVP								Метан	Виробництво м	
00	Family I. MethanomicroblaceaeVP								Метан	Виробництво м	
04	Family I. Methanopyraosae fam. nov								Метан	Виробництво м	401
00	Family I. MethanosarcinaceaeVP	Псевдопаренке	ми					Органічні кисло	Метан	Метаногенез	1
06	Family I. MethylococcaceaeVP	1. S. S. 10.						Мотан			
07	Family I. MicrococcaceaeAL										
108	Family I. MicromonosporaosaeAL										
09	Family I. MycoplasmataceseAL										
10	Family I. MyxococcaceaeAL										
111	Family I. NeisseriaceaeAL										
12	Family I. PasteureTaceaeVP										
17	Family I. PlanctomycetaceaeVP										
14	Family I. PropionibacteriaceaAL										
115	Family I. PaeudomonadaceaeAL										
18	Family I. PseudonocardiaceaeVP										
17	Family I. RhizobiaceaeAL										
18	Family I. RhodospirillaceaeAL										
19	Family I. RickettsiaceseAL										
20	Family I. RubrobacteraceaeVP										
121	Family I. SphaerobacteraceaeVP										
22	Family I. SphingobacteriaceaeVP										

Fig. 11 The general view of the imputed sheet on hierarchy of microorganism data

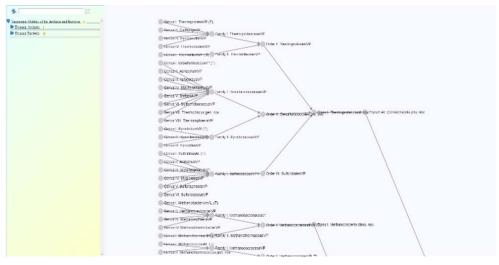


Fig. 12 General view of the ontological taxonomy of microorganisms

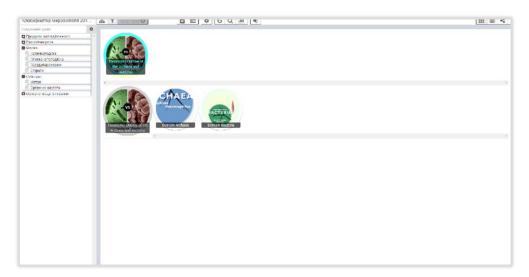


Fig. 13 General view of the microorganisms selecting system

REFERENCES

- Chernetskiy, I. S., Pashcehnko, Y. U., Atamas, A. I., Shapovalov, Ye. B., "Use of information tools for the structuring and visualization of scientific knowledge during a preliminary study", *Scientific notes of Junior Academy of Science*, №17, pp. 20-28, 2016.
 Cherneckiy I. S., Pashchenko Y. U., Shapovalov Ye. B., Shapovalov V.
- [2] Cherneckiy I. S., Pashchenko Y. U., Shapovalov Ye. B., Shapovalov V. B., "The expediency of creating ontological analysis systems for the integration of scientific knowledge", *Modern problems of mathematical modeling, forecasting and optimization*, Kamianec-Podolskiy, 2016, pp. 75-84.
- [3] Google Scholar, web-page, Microsoft, link: https://scholar.google.com/.
- [4] Lens.org, web-page, link: https://www.lens.org, Accessed on: 15/06/2018.
- [5] Microsoft Academic, web-page, Microsoft, link: https://academic.microsoft.com/, Accessed on: 14/05/2018.
- [6] Salyuk A. I., Zhadan S. O., Shapovalov Y. B., Tarasenko R. A., "Influence of water consumption on efficiency on methane fermentation of chicken manure", *International Scientific Journal for Alternative Energy and Ecology (ISJAEE)*, №15, 2015, pp. 53-58.
- [7] Scopus, web-page, link: https://www.scopus.com/home.uri, Accessed on: 10/07/2018.
- [8] Shapovalov V. B., Shapovalov Ye. B., Atamas A. I., Bylyk Zh. I., 2017. "Information ontological tools to provide a research approach in STEAM learning", *Employed Children - the intellectual potential of the* state materials of the Xth International Scientific and Practical Conference, Chernomorsk, 2017, pp. 366-371.
- [9] Shatalkin A. I., "Taxonomy. Grounds, principles and rules", The Partnership of Scientific Publications of KMC, 2012, p. 600.
- [10] Struzhak A. Ye., "Transdiscipline and integration of information resources», *PhD thesis*, Kyiv, Institute of Telecommunications and Global Information Space of the National Academy of Sciences of Ukraine, 2015, p. 45.
- [11] Velichko, V. U., Popova, M. A., Prihodniuk, V. V., Strizhak, O. Y., «TODOS» - IT-platform for the formation of transdisciplinary information environments». Armament and military equipment systems, №49, pp. 10-19, 2017.