REVIEW

Considering the competition for the academic position "Professor"
in the area of higher education 4. Natural sciences, mathematics and informatics, professional field 4.3. Biological Sciences, scientific specialty "Biophysics" announced in the State gazette issue 108 dated December 22, 2020, for the needs of the Institute of biophysics and biomedical engineering, Bulgarian Academy of Sciences, department of "Photoexcitable membranes".

with candidate in the competition **Assoc. Prof. Dr. Anelia Georgieva Dobrikova**

by Prof. DSc Stefka Germanova Taneva, Institute of biophysics and biomedical engineering, Bulgarian Academy of Sciences

General presentation of the materials received for review

Assoc. Prof. Dr. Anelia Dobrikova is the only candidate for the competition. The materials submitted by Dr. Dobrikova from the department of "Photoexcitable membranes", Institute of biophysics and biomedical engineering, Bulgarian Academy of Sciences, are in accordance with the Regulations for Scientific Development of the Academic Staff of the IBPhBME-BAS and the criteria for occupying the academic position of professor. All scientific publications are in the field of the announced competition and have not been presented in previous for the candidate competitions for obtaining the educational and scientific degree "Doctor" and for the academic position "Assoc. Professor".

According to the information provided by the applicant, the total number of points on scientometric indicators is 1185 points (indicator A - 50, indicator B - 140, indicator G – 385, indicator D - 380 and indicator E - 230), while 600 points according to the minimum national requirement and 640 as stated in the regulations of ZAS - IBPhBME-BAS for occupying the academic position of "Professor".

Education and career development

Assoc. Prof. Dobrikova graduated in Faculty of Biology at Sofia University "St. Kliment Ohridski" in 1991 and has a Master's Degree in Biotechnology, speciality "Biophysical chemistry".

Her scientific career began in 1991 as a biotechnologist in the department of "Photoexcitable membranes" at the Institute of biophysics – BAS. From 2000 to 2001 she worked as a research associate II degree, and from 2001 to 2010 as a research associate I degree. She received her doctorate degree in biophysics in 1999 after defending a thesis on "Surface electric properties of thylakoid membrane fragments" and in 2010 was habilitated as an Assoc. Professor in IBPhBMI-BAS.

Scientific indicators

Assoc. Prof. Dobrikova has published 50 publications (total **IF 88.4**), **22** of publications fall in journals with rank **Q1**, **15** with **Q2** and **2** with **Q3**.

It can be noted that Dr. Dobrikova has published in prestigious journals such as *Int. J. Mol. Sci., Materials, Ecotoxicol. Environ. Saf., Sensors & Actuators:* B, *Plant Physiol. Biochem., Nitric Oxide* etc.

The scientific papers have been cited 276 times (indicated by the candidate), according to WEB of Sci (27.04.2021) they are cited **306** times; **h-index 10** (Scopus).

In the competition Assoc. Prof. Dobrikova participated with a total of **25** scientific papers - **22 articles** (of which **21** are with **IF** (total IF of publications - **57.36**) and 1 with SJR) and **3 chapters of books** published in the period 2011 - 2021 after her habilitation as an associate professor.
6 of the publications are included in the habilitation work (Indicator B), 4 of them are with rank Q1 and 2 with Q2.

The publications outside the habilitation work (Indicator G) are 16 (10 with Q1, 3 with Q2 and 2 with Q3, 1 with SJR), and 3 book chapters.

Dr. Anelia Dobrikova has participated in 12 research projects (4 funded by FNI, 1 by MOE, 2 bilateral projects funded by FNI, 5 Academy Exchange Projects of Bulgarian Academy of Sciences) and has coordinated 3 of them.
She is a member of the scientific organizations: Union of Scientists in Bulgaria and Federation of European Societies of Plant Biology.

Major Scientific Contributions

The presented scientific papers are interdisciplinary and aimed at elucidating the and the role of the light-harvesting complex of PSII (LHCII), its structural organization, and the lipid composition of the thylakoid membranes for the tolerance of plants to stress factors.

A set of biophysical techniques were explored for measuring: the chlorophyll fluorescence (PAM and 77K) of isolated thylakoid membranes and whole leaves; redox kinetics of P700 on leaves; oxygen evolution; the kinetic parameters of the oxygen yields, showing the changes in the catalytic Mn cluster; the membrane fluidity; image analysis of chlorophyll fluorescence and mass spectrometry with inductively coupled plasma and laser ablation; and biochemical methods for determining the content of leaf pigments; total phenols; markers of oxidative stress etc.

The results of the experimental findings in the presented publications can be summarized in the following areas:
- Relationship structural organization - function of the photosynthetic apparatus of higher plants and cyanobacteria;
- Role of the organization of light-harvesting complexes for the resistance of the photosynthetic apparatus of higher plants and cyanobacteria to abiotic stress factors.

The habilitation work summarizes research on the defense mechanisms of the photosynthetic apparatus to stress factors and of the aromatic plant *Salvia sclarea*

L. to high toxic concentrations of heavy metals; the role of DELLA proteins (in wheat mutant (*Rht-B1c*)) and salicylic acid (SA) (in rice plants) on the photosynthetic apparatus in Cd stress.

For the first time several different mechanisms have been proposed for the photosynthetic tolerance of *Salvia sclarea* L. (clary sage) to the toxic effects of Cd, on one hand greatly increased content of phenolic compounds and anthocyanins, as well as Fe in the leaves, and on the other increased non-photochemical quenching and accelerated cyclic electron transport around PSI.

It has been demonstrated that:
- The uptake and distribution of Cd in plants and their ability to cope with oxidative stress depends on the genotype of the plants (the study was conducted with two varieties of wheat);

- The effect of Cd on the photosynthetic apparatus depends on the amount of nitrogen, therefore nutrition conditions can contribute to the stress tolerance of wheat to heavy metals and might be important to limit metal(loid) uptake from soil in contaminated areas.

- *Salvia sclarea* tolerates significantly high toxic levels of Zn in leaves by increasing the leaf content of Fe, Ca and Mn ions as protection of photosynthetic apparatus and stimulation of the PSI and PSII function;
Accumulation of heavy metals (Cd, Zn, Fe) in both tissues and leaves of the sage plant, confirms the plant potential for phytoremediation or phytoextraction of soils contaminated with metals;

- A protective effect of salicylic acid (SA) associated with a change in the kinetics of oxygen-releasing reactions, leading to protection of the Mn-cluster from damage, as well as to stimulation of cyclic electron transport around PSI has been established. Low concentrations of SA significantly reduce the levels of hydrogen peroxide, lipid peroxidation and proline in Cd stress, indicating that exogenous application of SA through the root medium has a protective effect against Cd toxicity (in rice plants).

- Cd accumulation is associated with an increase in the non-photochemical quenching (NPQ), which in turn leads to a decrease in the quantum yield of unregulated energy loss (Φ_{NO}).
The spatial heterogeneity of PSII in *S. sclarea* leaves with high Cd accumulation and the spatial heterogeneity of the reduced effective quantum yield of PSII electron transport were analyzed using image analysis of chlorophyll fluorescence and mass spectrometry with inductively coupled plasma and laser ablation. The combination of these two techniques could be explored in the future to study the effects of metals on and the mechanisms of tolerance in plants.

- For the first time, the participation of DELLA proteins in the adaptation of wheat plants to stress and increased tolerance of the photosynthetic apparatus of two wheat varieties to Cd toxicity has been established.

Non-habilitation publications (B1-B14)

The presented data are an in-depth research in the same scientific field - the effect of stress factors: light intensity, UV-B radiation, high temperature, salinization, heavy metals, NO, herbicides and brassinosteroids, the effects of various signaling molecules (nitric oxide, 24-epibrasinolide, salicylic acid, DELLA proteins) and

antioxidant molecules on photosynthetic membranes, the role of the light-harvesting complex of PSII (LHCII) for the adaptation of plants to some environmental stressors. The publications give insights into:

- The protective role of high endogenous levels of NO in chloroplasts under oxidative stress and influence of NO on the efficiency of electron transport and the redox state of Mn-cluster on the donor side of PSII as a result of its interaction with photosynthetic apparatus components. It was found that the site of action of NO (derived from sodium nitroprusside as a donor of NO) is the donor side of PSII and that NO stimulates electron transport through PSII.

- The toxic effects of Cd on the photosynthetic apparatus and the accumulation of Cd in the stems and leaves of wheat plants are suppressed by higher amounts of nitrogen. Understanding the mechanisms of different wheat varieties for metal uptake and accumulation is important for identifying low-accumulation metal varieties in order to reduce toxic effects.

- 24-epibrasinolide has been shown to induce structural reorganization of pigment-protein complexes in photosynthetic membranes, possibly related to protective function in plants to stress factors, and the optimal concentrations for exogenous treatment of plants have been determined.

- The oxygen-evolving complex has been shown to be effectively protected against UV-B-induced damage by exogenously added natural antioxidants (ascorbate and the flavonoids quercetin and naringin) as a result of structural changes in the photosynthetic membranes and Mn-cluster modifications.

- The participation of *Rht-B1c*-encoded DELLA proteins in the protection of wheat plants from salt stress has been established, which makes this allele a suitable candidate for use in the selection of new wheat varieties in order to increase their tolerance to salinity. The increased tolerance of the *Rht-B1c* mutant to Cd stress compared to the wild type (*Rht-B1a*), despite the greater accumulation of Cd in its stems, is an indication of the DELLA proteins' participation in the mechanisms of plant adaptation to Cd stress.

- The role of the structural organization the light-harvesting complex of PSII (amount of LHCII oligomeric forms) and the lipid composition of thylakoid membranes (level of anionic lipids) for the sensitivity of the photosynthetic apparatus to high temperature and high light intensity has been demonstrated for four genotypes of pea.

- Modifications of phycobilisomes (PBS) in wild-type cyanobacteria and in four PBS mutant strains correlate with a change in the surface electric charge of thylakoid membranes in strains lacking the PBS-PSII macrocomplex or PSI complex, and the thylakoid membranes in mutant with eliminated PBS has slightly reduced electric dipole moment. These changes in the light-harvesting complex of cyanobacteria correlate with changes in energy transfer between pigment-protein complexes and oxygen release activity.
The change in the morphology and structural organization of the photosynthetic membranes of mutant forms of Synechocystis sp. PCC6803 with altered phycobilisome content correlates with changes in surface electric charge, photosynthetic oxygen release, P700 reduction kinetics and energy transfer between pigment-protein complexes.

- The susceptibility of green microalgae (Chlorella vulgaris and Chlorella kessleri), cyanobacteria (Synechocystis salina) and thylakoid membranes from pea to QB-binding herbicides (atrazine, DCMU, isoproturon and ioxinil) was assessed.
An increase in the PSII centers in the more reduced S0 state was found after treatment with herbicides, which suggests changes in the Mn-cluster of OEC on the donor side of PSII; a strong increase in the number of blocked PSII centers (S_B) and the reversal time of the oxygen-evolving centers (S_i states) in herbicide-treated cells of microalgae and cyanobacteria (atrazine and DCMU have a stronger effect than isoproturon and yoxinil).
A higher sensitivity of the parameters of oxygen release of microalgae and cyanobacteria to herbicides was demonstrated compared to thylakoid membranes from peas.

- The system - thylakoid membranes immobilized in the BSA-GA matrix is characterized by stable oxygen release and quantum efficiency of photosynthesis for a long period of time, and could be applied in the construction of biosensors for detection of herbicides.
The established relationship between herbicide sensitivity and the kinetic parameters of oxygen release in cyanobacteria, green microalgae and thylakoid membranes from higher plants suggests their potential application in the development of biosensors.

Personal contribution of the candidate

Assoc. Prof. Dobrikova is the first author of 11 and corresponding author of 7 of the peer-reviewed publications. I would note that she is the second author of 9 of the publications, which also implies a significant contribution. Dobrikova is the sole author of one of the publications, the others are co-authored with scientists from foreign research centers and Bulgarian scientific institutions. This highlights the significant contribution of the candidate in all published works.

Expert activities

Assoc. Prof. Dobrikova was:

guest editor in 2 Special issues in Plants (MDPI):
https://www.mdpi.com/journal/plants/special_issues/Abiotic_stress_tolerance
https://www.mdpi.com/journal/plants/special_issues/plant_abiotic_stress;

member in the Editorial board of 2 international scientific journals – Acta Sci. Agriculture, Int. J. Plant Biol. & Res.;

member of scientific juries for the award of the scientific and educational degree "doctor";

reviewer of international scientific journals;

scientific adviser of a student from Biological faculty, Sofia University "St. Kliment Ohridski", under a project Student interships – 2013;

superviser of diploma work supported by Erasmus Programme at the Faculty of Chemical Technology and Metallurgy, Sofia.

scientific adviser of one doctoral student who successfully defended PhD Thesis in 2020.

She has been a member of the Scientific Council of the IBPhBME - BAS since 2019 so far.

Personal impressions

I have impressions of Anelia Dobrikova's research work and her strong interest in science since the beginning of her scientific career when as a graduating student she joined our research group in the Institute of Biophysics and made a diploma work for master degree. As a head of the department "Photoexcitable Membranes" until 2007, I can express my positive assessment of her hard and efficient work, responsible attitude, consistency and accuracy as a researcher.
I believe that Anelia has an indisputable qualification and potential for conducting research in the future and that her academic growth will be valuable for the department of Photoexcitable Membranes and IBPhBME.

Prospects for future research

Assoc. Prof. Dobrikova has presented her vision for future research on: (1) the potential of newly synthesized nanoparticles for optimization and protection of photosynthetic activity in pea plants and the protective mechanisms of nitric oxide on the photosynthetic apparatus during salinization; (2) new plant species suitable for phytoremediation of contaminated or saline soils.

CONCLUSION

The scientific production and scientific indicators of Assoc. Prof. Anelia Dobrikova significantly exceed the recommended requirements for occupying the academic position of "Professor" according to the Act for the Development of the Academic Staff in the Republic of Bulgaria (ADASRB), the Regulations for the Application of ADASRB in BAS and the specific requirements of IBPhBME-BAS.

The significant contribution of Assoc. Prof. Dr. Anelia Dobrikova to the development of the scientific field – biophysics of photosynthetic membranes defines her as a highly qualified scientist with distinguished scientific profile that gives a confidence for my positive opinion for the nomination of Dr. Dobrikova for the academic position "Professor" and to recommend to the Scientific Jury to prepare a report-proposal to the Scientific Board of IBPhBME-BAS for election Assoc. Prof. Anelia Georgieva Dobrikova for the academic position "Professor" in professional field 4. Natural sciences, mathematics and informatics, professional field 4.3. Biological Sciences, scientific specialty "Biophysics".

Sofia
28.04.2021 /Prof. DSc Stefka Germanova Taneva/