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з біоорганічної хімії та нафтохімії  
Інституту біоорганічної хімії та нафтохімії  
НАН України**

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**ТЕЗИ**

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**(Kyiv, March 31 – April 1, 2016)**

**THESES**

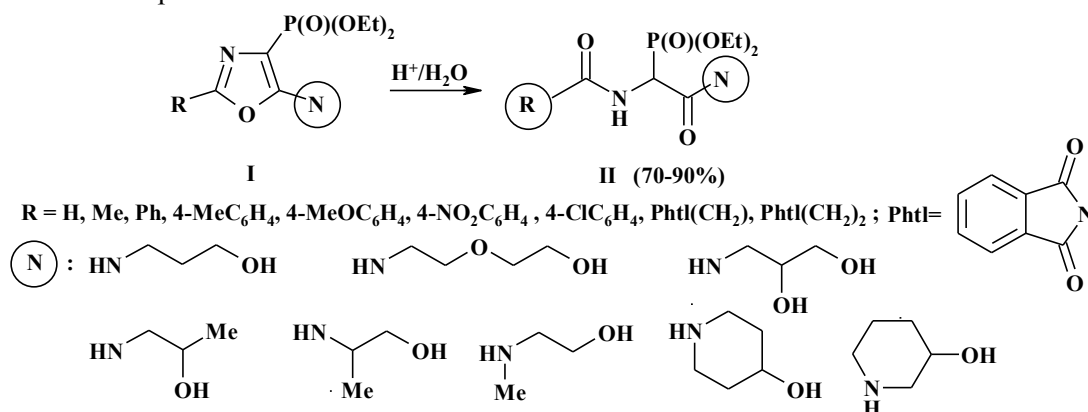
## Synthesis and properties of new Phosphonopeptidemimetics

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It is known that substances of peptide nature exhibit various biological effects and play an important role in vital functions. These compounds include phosphorylated peptidomimetics, which spur considerable interest as enzyme inhibitors, antibacterial and antiviral drugs, herbicides, are widely used in many fields of medicine and agricultural chemistry, and are important intermediates for synthesis of biologically active compounds. Therefore, an urgent task of modern organic chemistry is to develop preparative methods of synthesis of such compounds.

In this paper, we propose a convenient approach to the synthesis of phosphorylated peptidomimetics containing alkanol substituents. For this purpose, we used diethyl esters of 1,3-oxazole-4-ylphosphonic acids (I) with various pharmacophore aminoalkanol substituents in position 5.



When (I) are treated with aqueous solution of acetic or trifluoroacetic acid, disclosure of the 1,3-oxazole cycle occurs to form new phosphorylated peptidomimetics (II). These compounds are thick, colorless oils, which are readily soluble in water. Their structures were confirmed by <sup>1</sup>H, <sup>13</sup>C, <sup>31</sup>P NMR and IR spectroscopy as well as mass spectrometry.

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## Anthropogenic ash residues transformation into marketable products

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Silicon carbide (SiC) is a promising ceramic for various industrial applications including catalyst supports, composite reinforcement, electronic devices, optic devices and so forth, owing to its excellent thermal stability, high mechanical strength and hardness, chemical inertness, wide band gap and unique optical properties. There exist many methods of producing SiC powder, which are chemical vapor deposition of silane compounds, direct carbonization of silicon and carbothermal reduction of SiO<sub>2</sub>. Rice husk is a major agricultural waste, the major constituents of which are cellulose, lignin and ash. Amorphous silica is the key component of rice husk ash. The purpose of this study is to prepare SiC by utilizing rice husk ash from biomass cogeneration plant as the raw material.

The phase composition and microstructure of samples were characterized by X-ray diffraction using an X-ray diffractometer (XRD, Rigaku, MiniFlex600), Infrared spectra was recorded on an IR spectrophotometer (Vertex 70/80 FT-IR Bruker Spectrometer), scanning electron microscopy (SEM, Zeiss, EVO MA-10). The XRD patterns of the as-received products were analyzed and formation of β-SiC was detected. The diffraction peaks at 2θ = 35.6, 41.4, 60.0° can be indexed as (111), (200), (220) reflections of β-SiC structure. The stronger (111) diffraction peak indicates the dominant growth direction of the β-SiC. SiC monocystal's cubic structure was determined by SEM images.

## Degradation of ethyl and butyl fatty acids esters obtained from rapeseed and linseed oils during protracted storage and ways of its prevention

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Biodiesel can be considered as fully biorenewable fuel when bioalcohols (ethanol (E) and *n*-butanol (B) are used for transesterification. This paper deals with antioxidation stability of fuel systems, obtained from rapeseed oil (EER and BER) as most resistant to oxidation and from linseed oil (EEL and BEL) as least resistant to oxidation.

The samples of fuels were stored under laboratory conditions with free air access. The esters' loss was 49.0, 35.6, 3.5 and 15.7 % during 90 days and 55.6, 50.7, 21.1 and 26.7 % during 180 days for EEL, BEL, EER and BER respectively. The highest losses in case of EEL can be explained by the fact that this product was additionally purified by vacuum distillation.

Chromatographic analysis of partially oxidized samples showed that low molecular oxidation products had ester nature. The length of its fatty acid carbon chain was 11 atoms; its total amount doesn't exceed 6 % of total esters content.

Application of additive 2,6-ditertbutyl-4-methylphenol (BHT) permitted to gradually decrease the esters' loss. The latter was 1.9 % both during 90 days and during 180 days for EEL and BEL (2000 ppm of BHT) and 0.4 % and 3.5 % during 90 and 180 days respectively for EER and BER (1000 ppm of BHT). By means of extended fatty acid analysis it was found that BHT reduced losses of esters C18:3 20-fold and C18:1 1.1-fold.

Use of BHT is rational for esters with 3 or more unsaturated parts in fatty acid residues.

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## Silicon containing plants residues treatment in microwave irradiation

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The purpose of this research is to create flexible technological scheme of anthropogenic wastes complex processing to yield useful products.

Rice husk (RH) is a byproduct of rice production. The amount of rice husks (RHs) is estimated to be ca. 160 million tons. Applications of rice husk have been very limited. Therefore, RHs are often considered to be a biowaste. RHs could be a suitable option of feedstock for silica-based materials because of their high silica content (15-28 wt %) and vast availability. The utilization of RH has been limited because of their tough and abrasive nature, low nutritive value, and low bulk density. The high content of silica in RH presents opportunities for the preparation of value-added silicon based materials.

We proposed wasteless technology of silicon removal from RH. The inorganic part was extracted by NH<sub>4</sub>F using microwave irradiation for several minutes. After extraction of silicon, ammonium fluoride was used for the new RH. The maximum degree of silicon dioxide extraction was achieved in a few minutes.

The composition of the removed inorganic part was determined by X-ray fluorescence analysis using «EXPERT 3L». The surface morphologies of the samples were inspected via a Zeiss Evo MA 10 SEM. The Si substrate was very clear and smooth, without any observable features. The average size of particles of silicon dioxide was 400 nm.

## Hydrogenation of CO<sub>2</sub> over cobalt membrane catalyst in an electric field

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The research goal is to study the hydrogenation of CO<sub>2</sub> to hydrocarbons over the cobalt catalyst in a reactor of membrane type. The membrane reactor allows simulating the quantitative and qualitative composition of the active centers of the catalyst by increasing the absorption of reactants.

The research has demonstrated that proton centers of catalyst of anode chamber are up to 10 times more active for hydrogenation of CO<sub>2</sub> to CH<sub>4</sub> versus hydride centers of cathode chamber. Formation of C<sub>2</sub>H<sub>6</sub> in the cathode chamber as a result of secondary adsorption of CO<sub>2</sub> molecules on H<sup>-</sup>-CO centers occurs intensely. Its subsequent conversion occurs obviously as a result of attack with newly formed methane. The formation of propane at a lower temperature over the catalyst of the cathode chamber does not occur and therefore, the reaction is secondary. It takes place over the catalyst of anode chamber as a result of conversion of ethane (adsorbed on H<sup>-</sup>-CO centers from the cathode chamber) by the attacked molecules of CO<sub>2</sub> or CH<sub>4</sub>.

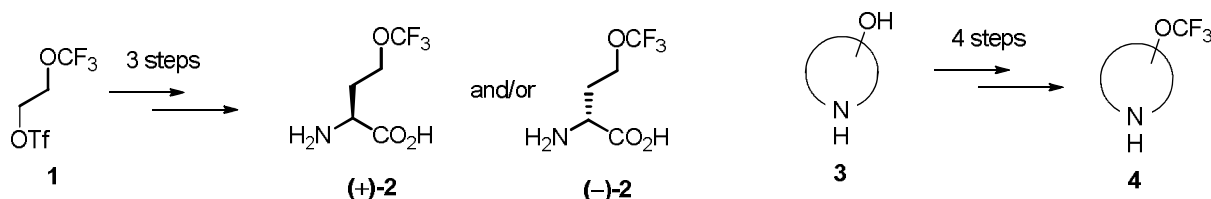
Generation of proton current across the membrane leads to fierce competition on the same active centers: protons are supplied to proton pump and catalytic reactions of hydrogenation and catenation. Proton current causes removal of hydrogen from cobalt catalytic centers and inhibits the hydrogenation reaction. The share of catenation increases owing to significant decrease in rate of methanation in the general process of CO<sub>2</sub>+H<sub>2</sub> conversion.

## New trifluoromethoxy containing amines and amino acids

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Fluoroorganic compounds are critically important for the modern medicinal chemistry and agrochemistry. While numerous polyfluoroalkyl-containing substances have found their application, compounds bearing OCF<sub>3</sub>-group are less-studied due to absence of simple and selective methods to introduce trifluoromethoxy moiety. Besides, there is a lack of accessible starting materials (building-blocks) containing OCF<sub>3</sub>-group. In the frame of our research work on introduction of new synthetic methods of trifluoromethoxy-group, we have synthesized a hitherto unknown amino acid **2** containing aliphatic OCF<sub>3</sub>-group, starting from accessible alkylating agent **1** [1]. Amino acid **2** was synthesized both as racemate and as individual enantiomers (+)- and (-)-**2** starting from the corresponding derivatives of (+)- and (-)-pinenone [2].



Moreover we synthesized diverse library of trifluoromethoxy-containing cyclic secondary amines of general structure **4** starting from the corresponding "off-the-shelf" available amino alcohols of general structure **3**.

1. J.C. Blazejewski, C. Wakselman. *J. Org. Chem.* **2001**, 1061–1063.
2. K. Laue, G. Haufe. *Eur. J. Org. Chem.* **2000**, 3737–3743.

## Nanoporous carbon materials as the basis of catalytic systems

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New nanocarbon materials (NCM) with prespecified pore structure were prepared for effective catalyst supports using template synthesis and were studied.

New NCM with strengthened carbon frame was obtained by additional saturation of silicate-carbon composite with furfuryl alcohol. It was shown that in that case micropores practically disappeared, mechanical characteristics of the samples increased, and pore surface became smooth. Optimization of NCM porous structure can significantly reduce the cost of materials used for formation of catalytic systems. We obtained an NCM with a specific surface area of about 1200 m<sup>2</sup>/g and a unique value of limiting adsorption capacity relative to benzene vapors of about 2.12 cm<sup>3</sup>/g.

It was shown that nanopores of NCM have 6 nm diameter and branched into the mass-fractal aggregates with a mean diameter of 28 nm. The effective thickness of nickel nanoclusters on the carbon surface is 0.8 nm. It was established that at a certain content of the active metal the character of metal nanoclusters' location on the surface of the NCM radically changed. The primary elements of their structures became dendritic aggregates.

A high activity and its dependence on the nature of pore structure of the catalyst NCM was shown.

## Methane synthesis from CO<sub>2</sub> over graphene–cobalt membrane composite

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Methane production by the hydrogenation of CO<sub>2</sub> is a well developed process with conventional catalysts based on Co, Ni and Ru. The aim of this study was to determine the effects of graphene additive on the catalytic activity of cobalt industrial catalyst as a result of graphene's unique high levels of heat conductivity, mixed electronic and proton conductivity. Graphene was synthesized by three known methods: Hammers' synthesis, mechanical exfoliation of graphite under ultrasound exposure, and oxidation of carbohydrates, like sucrose, in an inert atmosphere.

We added graphene obtained by pyrolysis of sucrose to heterogeneous catalysts containing Co and Ni in the amount of 3 %. It was established that graphene does not lead to any changes in the rates of formation of CO<sub>2</sub> hydrogenation products in a flow reactor at 300 °C under pressure of 1.02 MPa. When the reaction was conducted under similar conditions over the modified catalysts deposited on proton conductive membrane, graphene provoked significant increase in the rate of methane, ethane and propane formation, which reached up to 350 % of the baseline values. Use of graphene-containing membrane catalyst in the hydrogenation of CO<sub>2</sub> at different potentials and intensities of proton current contributes to processes of reduction involving electrons (high yield of methane) and processes of hydrocarbon chain growth involving protons (high yield of C<sub>2</sub>–C<sub>3</sub> alkanes).

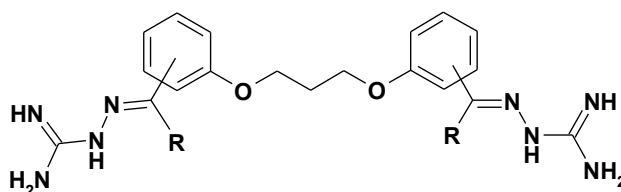
## Effect of *bis*-amidinohydrazone derivatives and environment on the furin catalytic activity

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<sup>2</sup>*Palladin Institute of biochemistry, National Academy of Sciences of Ukraine, Kiev*

Furin is a calcium-dependent serine endoprotease and is present in all examined tissue and cell lines. It represents a significant therapeutic target because this enzyme converts the precursors of many secreted peptide hormones and proteins in their biologically active forms.



R = H, CH<sub>3</sub>

Fig. 1. General formula of *bis*-amidinohydrazones

New isomers of *bis*-amidinohydrazone that had the general formula presented on Fig. 1 were synthesized. The efficiency of furin inhibition depends on position of the positively charged group relative to the linker. The most effective inhibitor contains amidinohydrazone groups in meta-position relative to the linker. The mechanism of enzyme inhibition was found to be uncompetitive while other isomers had a mixed mechanism. The antifurin activity decreases almost 2.5-fold with introduction of methyl groups.

The cation affinity of cadmium, cesium and strontium to furin was shown to decrease 18-390-fold in comparison with Ca<sup>2+</sup> affinity. Since under normal conditions 19–90 mM concentration of these ions in cells can be hardly reached, they might have influence on furin activity in biological systems.

## Application of Pd–zeolite catalyst in proton field transistor for biological purposes

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The interest in the development of proton field transistors is caused by their ability to control proton current. Such control allows management of process of signals formation, their transition and procession in biological systems. In the near future the development of such transistors can help to manufacture equipment that will enable the user to monitor energy exchange processes within cells and direct information reading from the organs. Main problem of this equipment is to find the material that is best suited for high efficient proton generation and its further transportation.

Our work was aimed to construct a model of proton field transistor for measuring activity of proton generating catalysts based on Pd-zeolite and to study the ability to control the generated proton current by changing potential on the gate-electrode.

The method has been developed to create proton field transistors to research the ability of proton current modulation. A bench model of proton field transistor was constructed based on MF-4-SK proton conducting film. The research of influences of different potential on ability of the gate electrode to transport protons showed the effectiveness of the constructed model.

## Design of protein kinase inhibitors CK2 on the base of flavone derivatives

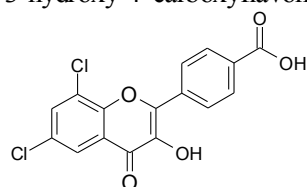
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Protein kinase CK2 is a promising molecular target for development of new anticancer drugs.

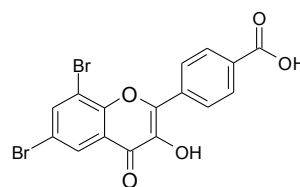
We have identified a number of novel inhibitors of protein kinase CK2 among flavones derivatives using receptor-based virtual screening, biochemical testing and chemical optimization. Compounds were synthesized according to a two-step procedure. Treatment of 2'-hydroxy acetophenones with 4-carboxybenzaldehyde in the presence of alkali produces halkones. Oxidation of halkones by H<sub>2</sub>O<sub>2</sub> in methanolic alkali leads to 3-hydroxy-4'-carboxyflavones in moderate yields. After structural optimization, 13 compounds showed high inhibitory activity towards CK2 (inhibition concentration IC<sub>50</sub> 0,009–0,720 μM).

It was revealed that inhibitory activity depends on hydrophobicity of substituent in position 6 of the heterocycle and escalates in the series of Me < MeO < Cl < Et < Br. Introduction of additional hydrophobic substituent in position 8 also increases inhibitory activity of 3-hydroxy-4'-carboxyflavones.



FLC21

IC<sub>50</sub>: 0.04 μM  
K<sub>i</sub>: 0.013 μM



FLC26

IC<sub>50</sub>: 0.009 μM  
K<sub>i</sub>: 0.0025 μM

## Design of biologically active compounds on the base of 4-aminoquinazoline and 3-carboxyquinoline derivatives

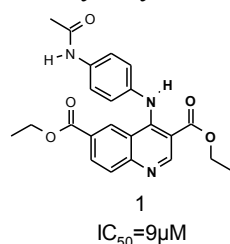
*V.M. Sapelkin, V.G. Bdzholo, S.M. Yarmoluk*

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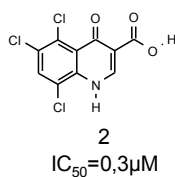
CK2 inhibitors are used as lead compounds in drug formulas for cancer, viral, immune and Alzheimer's diseases.

The main aim of this paper was the directed search of CK2 inhibitor among 4-aminoquinazolines and 3-carboxyquinolines. 181 derivatives of 4-aminoquinazoline and 3-carboxyquinoline were synthesized. Their CK2 inhibition activity was studied. We have found 18 new CK2 inhibitors (IC<sub>50</sub> from 20 μM to 0,3 μM). Structure – activity relationship of the synthesized compounds was studied.

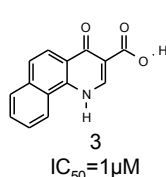
We have obtained 4-anilinoquinazolines and 4-anilino-3-carboxyquinolines with acetamidoglucose residue to increase solubility of synthesized CK2 inhibitors (Fig., Compound 4).



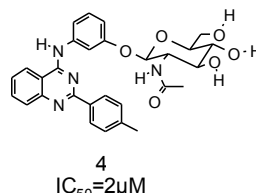
1  
IC<sub>50</sub>=9μM



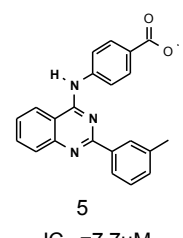
2  
IC<sub>50</sub>=0,3μM



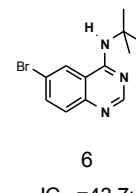
3  
IC<sub>50</sub>=1μM



4  
IC<sub>50</sub>=2μM



5  
IC<sub>50</sub>=7,7μM



6  
IC<sub>50</sub>=43,7μM

Consequently, derivatives of 4-aminoquinazoline and 3-carboxyquinoline were found as new classes of CK2 inhibitors.

## Directed synthesis of protein kinase CK2 inhibitors based on 3-substituted quinoline derivatives

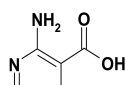
*A.R. Syniugin, M.O. Chekanov, S.M. Yarmoluk*

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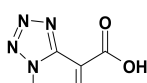
Inhibitors of protein kinase CK2 are promising compounds for development of new anticancer drugs, including its inhibitor CX-4945 (Silmitasertib) which is being tested and undergoes the second phase of clinical trials.

The main aim of the paper was the directed synthesis of 3-substituted quinoline derivatives as CK2 inhibitors using methods of computer modeling and biochemical testing.

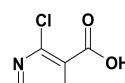
The new derivatives of 2-quinolinone-3-yl acetic acid, 2-quinolinone-3-yl propionic acid 3-(amino-methyl)quinoline-2-ones and 3-(aminoethyl)quinoline-2-ones were synthesized according to our methods [1]. 34 substances out of more than 150 synthesized derivatives were found to inhibit kinase CK2 with  $IC_{50}$  values ranging within 0.65  $\mu\text{mol}$  – 20  $\mu\text{mol}$ .



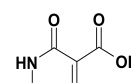
**1**  
 $IC_{50}$  0.65  $\mu\text{M}$



**2**  
 $IC_{50}$  1.0  $\mu\text{M}$



**3**  
 $IC_{50}$  1.5  $\mu\text{M}$



**4**  
 $IC_{50}$  6.8  $\mu\text{M}$

Derivatives of benzo[*h*]-quinolin-3-carboxylic acids (1–4) displayed high activity towards CK2. Compound 2 – amino-benzo[*h*]quinoline-3-carboxylic acid (1) inhibit kinase CK2 with an  $IC_{50}$  equal to 0.65  $\mu\text{mol}$ .

[1] A.R. Syniugin *et al.*, *Ukrainica Bioorganica Acta*, 2012, 1, 151–160.

## Expedient synthesis of 3-(cyclo)alkylpiperidines – building blocks for lead-oriented synthesis

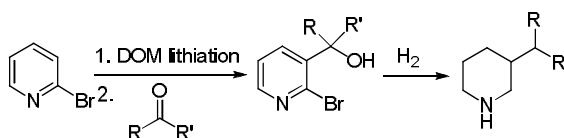
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Challenge of the so-called lead-oriented synthesis (LOS) which had emerged in medicinal chemistry called for revision of synthetic methods available for generation of compound libraries for drug discovery. In this approach, potential lead compounds as well as building blocks for their construction are subject to a set of rigorous criteria, including, among others, limited molecular weight, high fraction of  $sp^3$  atoms and limited conformational flexibility. Most synthetic approaches to introduction of substituents into  $sp^3$ -enriched conformationally restricted cores rely on carbon–heteroatom bond formation; unlike their  $sp^2$ - $sp^2$  and  $sp^2$ - $sp^3$  counterparts,  $sp^3$ - $sp^3$  C–C couplings are less common.

In this paper, we use the idea of formal “ $sp^3$ - $sp^3$  through  $sp^2$ - $sp^3$  coupling” to introduce (cyclo)alkyl substituents at the C-3 atom of the piperidine ring. The idea is implemented through a two-step reaction sequence: directed *ortho*-metallation of a pyridine derivative followed by addition of a carbonyl compound, and catalytic hydrogenation. This simple but efficient method allows for multigram preparation of 3-(cyclo)alkylpiperidines which are valuable building blocks for drug discovery programs.





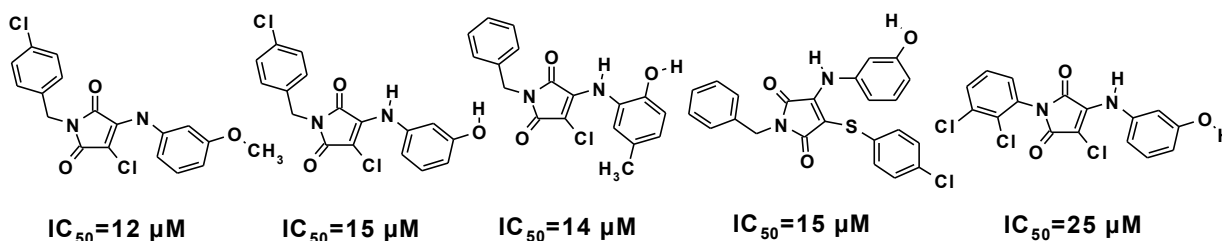
## Synthesis of the series of 4-phenylamino-2,5-dihydro-1H-2,5-pirolidione (maleimide) derivatives and investigation of their inhibitory activity toward protein kinase CK2

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The derivatives of maleimide belong to the promising compounds for development of novel anticancer drugs. Earlier, we had synthesized novel derivatives of 4-phenylamino-2,5-dihydro-1H-2,5-pirolidione that exhibited anti-cancer effect in 58 cell lines of 9 cancer types ( $GI_{50}$  values ranged within 0.01–0.40  $\mu\text{M}$ ) [1].

The aim of this paper was to determine possible mechanism of antitumor activity of maleimide derivatives. Based on the results of virtual screening we synthesized and tested 55 compounds for the ability to inhibit activity of protein kinase CK2, which is involved in the development of cancer. We investigated structure-activity relationships of the studied compounds towards CK2. Besides, it was revealed that five most active compounds ( $IC_{50}$  values ranged within 12–25  $\mu\text{M}$ ) demonstrated significant anti-tumor potential.



Therefore, the possible mechanism of antitumor activity for the studied maleimide derivatives may include inhibition of protein kinases.

[1] *Tarnavskiy S.S. et al., Ukrainica Bioorganica Acta*, **1**, 51–56 (2010).

## Liquid materials obtaining from some agriculture waste

*T.V. Tkachenko, D.S. Kamenskyh, V.O. Yevdokymenko,  
V.I. Kashkovskiy, D.A. Matviychuk, V.V. Vakhrin*

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Lignocellulosic biomass is mainly composed of three bio-polymers: cellulose, hemicellulose and lignin together with small amounts of other components. Thus, one of the most important goals of lignocellulosic biomass refining is to fractionate lignocellulose into its three major components: cellulose, hemicelluloses and lignin. As we reported earlier we chose steam explosion (SE) as the pretreatment method. The common goal of this method is to reduce the biomass in size and to open its physical structure. Further processing of the pretreated biomass is aimed to separate lignin from the carbohydrates and to carry out hydrolysis of the cellulose/hemicellulose fraction to  $C_5$ – $C_6$  sugars. Subsequently the aim of our work was to separate agriculture waste into three bio-polymers: cellulose, hemicellulose and lignin.

Corn cobs, switch grass and rice husk were our objects. Hemicellulose fraction was removed by SE. A green one-step catalytic process of separation of microcrystalline cellulose (MCC) from lignin in the medium “acetic acid–hydrogen peroxide–water–sulfuric acid” was employed. The yield of cellulosic product was estimated by weighing. The structural characteristics of cellulosic products were studied by XRD, IR and scanning electron microscope (SEM) methods. As calculated from the X-ray data, the crystallinity of the cellulose samples obtained from corn cobs (0,77), switch grass (0,74) without pretreatment and (0,78) and (0,81) after SE are close to the crystallinity of industrial MCC Avicel PH 102 (0,64) and MCC from cotton linter (0,80).

## Peculiarities of formation of acid-base nanocatalysts on the ground of heteropolyacid and lysine

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New acid-base heterogeneous nanocatalysts based on lysine and phosphomolybdic and phosphotungstic heteropoly acids (HPA) were synthesized in their pure form and as part of nanoporous silicate hybrid composites. Method of small angle X-ray diffraction study revealed that pore size of the original silicate skeleton was 12.5 nm, and that of  $H_3PMo_{12}O_{40}/SiO_2$  was 13.6 nm. In the case of  $H_3PW_{12}O_{40}/SiO_2$ , the polydisperse pore structure with an average radius of about 16 nm was identified by Guinier approach. Keggin structure in the spectrum of pure heteropoly acids was affirmed by FTIR spectroscopy. Interaction of lysine with the HPA and deformation of Keggin anions in the structure of acid-base nanocatalysts and in structure of hybrid nanocomposites was confirmed. Dendritic structure of nanocatalyst based on lysine and phosphomolybdic heteropoly acid was established by transmission electron microscopy.

## Study impact of derivatives of N-sulfonyl substituted oxazoles and oxazole pyrimidine on acceleration of growth and development of pumpkin, soybean, wheat and flax

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The biological activity of low-molecular heterocyclic compound derivatives of N-sulfonyl substituted oxazoles and oxazole pyrimidine according to their influence on acceleration of growth and development of soybean, wheat and flax crops, and according to specific bioassays for phytohormonal cytokinin activity on the isolated cotyledons of pumpkin was studied. The plant seeds were moistened during 2 days with aqueous solutions of chemical compounds at concentrations of  $10^{-8}M$ – $10^{-9}M$ . After this, the germinated seeds were cultivated in cuvettes with perlite in an aqueous medium during 2–3 weeks. Test for impact of chemical compounds on growth and development of wheat (*Triticum aestivum* L.) of *Zimoyarka* cultivar showed high auxin-cytokinin stimulating effect of these compounds at concentration of  $10^{-9}M$ . It was found that biometric indexes of 2-week old seedlings grown on media with the chemical compounds were averagely higher than analogical indexes of the control plants (grown in distilled water) and averagely higher than the indexes of plants grown on media containing NAA and IAA: by 32–64 % – according to germination of seeds, by 8–20 % – according to length of seedlings, by 15–57 % – according to total length of roots and by 20–85 % – according to total number of roots. Besides, high auxin-cytokinin stimulating effect of these chemical compounds was demonstrated at concentration  $10^{-9}M$  for biometric indexes of 2-week old seedlings of soybean (*Glycine max* L.) of *Valuta* cultivar which averagely exceeded the indexes of both control plants and plants grown on media that contained IAA and NAA: by 8–18 % – according to germination of seeds, by 7–21 % – according to length of seedlings, by 21–95 % – according to total length of roots and by 2.2–7.7 times – according to total number of roots. The results for auxin-cytokinin stimulating effect of the above mentioned compounds at concentration of  $10^{-8}M$  on growth and development of the flax (*Linum usitatissimum* L.) of *Svitanok* cultivar were obtained. It was found that biometric indexes of 3-week old flax seedlings grown on media that contained the chemical compounds were averagely higher than similar indexes of control plants: by 28 % – according to length of the seedlings and by 88–192 % – according to total length of roots, and were averagely higher than plants grown on media that contained IAA and NAA: by 9 % – according to seedlings length and by 14–39 % – according to total length of roots. Testing of chemical compounds according to

specific bioassay for cytokinin activity on the isolated cotyledons of muscat pumpkin (*Cucurbita moschata* Duch. et Poir.) of *Gilea* cultivar showed the expressive cytokinin-like stimulating effect of the tested compounds at concentration of  $10^{-9}$  M on growth and development of the isolated cotyledons of pumpkin. The compound derivative of N-sulfonyl substituted oxazoles which contained tolyl substituent in the second position of oxazole displayed the highest activity. Its activity according to increasing growth of cotyledons biomass during 2 weeks exceeded that of the natural cytokinin – kinetin – by 131 % and the indexes of control cotyledons grown on the distilled water – by 154 %. At the same time, activity of compound which contained phenyl substituent in the second position of oxazole was lower and according to increasing growth of biomass exceeded the control cotyledons grown on the distilled water by 123 %. The obtained data indicate that it is possible to use the selected low molecular weight heterocyclic compounds at very low concentrations only at the stage of plant seed germination (unlike natural phytohormones and their synthetic analogues), as a new domestic eco-friendly and human-friendly stimulants of growth for pumpkin, soybean, wheat and flax plants in the agricultural practice.

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## Modern technology solution treatment of municipal wastewater with nutrients removal

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Existing and the most applicable methods of sediments processing are not in possession of integration, to wit the solving of problem has the incomplete nature of process. Deposition is the accumulation of ash and it has negative influence upon the ecology. Thermal treatment does not require the utilization of ash residue. The volumes of organo-mineral fertilisers and organic soils obtaining are incomparable with the volumes of accumulated sediments. Furthermore the deposition demands enormousness squares that you can use in other way and more useful. In many cases the absence of effective technology of sediments treatment is mean the permanent expansion of sludge bank area with the upsurge in ecological safety. The most popular methods of thermal treatment of sediments have also a number of imperfections.

The aim of our work is the accomplishment of complex approaches which are intended for solving the problem of ecological safety treatment with municipal and manufacturing sediments by creating a flexible technological scheme of complex recycling (aggregate technology) of municipal and manufacturing sediments with the production of marketable products.

We have developed a complex non-waste arrangement of sediments including all lines. Line of thermal recycling of sediments at fast heating conditions. Advantages: High temperature generation for 15–20 seconds. The absence of dangerous pollutant in the gas. Absence of a liquid phase. The resulting products: high-energy gas, carbonaceous (carbon-bearing) ash residue, ash residue. The use of standard equipment in aggregated with optional.