

INOPTEP 2013  PTEP 2013

THIRD INTERNATIONAL CONFERENCE  
SUSTAINABLE POSTHARVEST AND  
FOOD TECHNOLOGIES  
INOPTEP 2013

and

XXV NATIONAL CONFERENCE  
PROCESSING AND ENERGY  
IN AGRICULTURE  
PTEP 2013

April 21<sup>st</sup> – 26<sup>th</sup>, 2013, VRNJAČKA BANJA, SERBIA

# PROCEEDINGS ZBORNIK

---

TREĆA MEĐUNARODNA KONFERENCIJA  
ODRŽIVE POSLEUBIRAJUĆE I  
PREHRAMBENE TEHNOLOGIJE  
INOPTEP 2013

i

XXV NACIONALNA KONFERENCIJA  
PROCESNA TEHNIKA I ENERGETIKA  
U POLJOPRIVREDI  
PTEP 2013

21 – 26. april, 2013, VRNJAČKA BANJA, SRBIJA

## SCIENTIFIC COMMITTEE / NAUČNI ODBOR

### INTERNATIONAL MEMBERS:

- Prof. Dr. Costas Akritidis**, Emeritus Professor, Aristotle University, Thessaloniki, Greece,  
**Prof. Dr. Silva Cristina**, Portuguese Catholic University, Porto, Portugal,  
President of ISEKI-Food Association  
**Prof. Dr. Harris Lazarides**, Aristotle University, Thessaloniki, Greece, coopresident  
**Dr. Gerhard Schleining**, BOKU University, Vienna, Austria,  
Secretary General of ISEKI-Food Association  
**Prof. Dr. Tajana Krička**, University of Zagreb, Croatia,  
**Prof. Dr. Zuzana Hlavačova**, University of Agriculture in Nitra, Slovakia,  
**Prof. Dr. Zsuzsanna Füstös**, Central Agricultural Office, Budapest, Hungary,  
**Prof. Dr. Marko Dalla Rosa**, University of Bologna, Italy,  
**Prof. Dr. Richard Gladon**, Iowa State University, USA,  
**Prof. Dr. Elisabeth Demoulin**, Agroparistech, Paris, France,  
**Prof. Dr. Costas Billaderis**, Aristotle University, Thessaloniki, Greece,  
**Prof. Dr. Vlasta Vozárová**, University of Agriculture in Nitra, Slovakia,  
**Prof. Dr. Vangelče Mitrevski**, University "St Kliment Ohridski" Bitola, FYR Macedonia,  
**Dr. Stavros Vougioukas**, Aristotle University, Thessaloniki, Greece,  
**Prof. Dr. Selim Škaljić**, Faculty of agriculture, Sarajevo, Bosnia and Hercegovina.

### NATIONAL MEMBERS:

- Prof. Dr. Mirko Babić**, Faculty of Agriculture, Novi Sad, General Secretary of National Society of Processing and Energy in Agriculture, coopresident  
**Prof. Dr. Ljiljana Babić**, Faculty of Agriculture, Novi Sad, Vice-president of National Society of Processing and Energy in Agriculture, coopresident  
**Dr. Jovanka Lević**, Institute of food technology, Novi Sad,  
**Prof. Dr. Milica Radosavljević**, Maize Research Institute "Zemun Polje", Belgrade, Vice-president of National Society of Processing and Energy in Agriculture,  
**Prof. Dr. Dragan Škorić**, Serbian Academy of Science and Arts, Belgrade  
**Prof. Dr. Mirjana Đurić**, Faculty of Technology, Novi Sad,  
**Prof. Dr. Anđelko Bajkin**, Faculty of Agriculture, Novi Sad,  
**Prof. Dr. Dušan Milić**, Faculty of Agriculture, Novi Sad,  
**Prof. Dr. Filip Kulić**, Faculty of Technical Science, Novi Sad,  
**Prof. Dr. Dragan Marković**, Mechanical Faculty, Belgrade,  
**Prof. Dr. Miloš Tešić**, Faculty of Technical Science, Novi Sad,  
**Dr. Milka Vujaković**, „Poljoprivredna stanica” Ltd, Novi Sad, Serbia,  
**Dr. Mirjana Milošević**, Institute of field and vegetable crops, Novi sad,  
**Dr. Vladeta Pavasović**, Faculty of Agriculture, Zemun,  
**Dr. Svetlana Balešević-Tubić**, Institute of field and vegetable crops, Novi sad,  
**Dr. Branislav Karadžić**, Faculty of Agriculture, Novi Sad.  
**Dr. Ivan Pavkov**, Faculty of Agriculture, Novi Sad.

---

### Publisher / Izdavač

National Society of Processing and Energy in Agriculture, Novi Sad, Serbia  
Nacionalno društvo za procesnu tehniku i energetiku u poljoprivredi, Novi Sad,  
Trg Dositeja Obradovića 8

### Co-publisher / Suizdavač

Faculty of Agriculture, Novi Sad, Serbia

Poljoprivredni fakultet, Novi Sad, Trg Dositeja Obradovića 8

**Editor in Chief / Glavni i odgovorni urednik:** Prof. dr. Mirko Babić

### Editors / Urednici

Prof. dr. Anđelko Bajkin

Prof. dr. Ljiljana Babić

Dr. Ivan Pavkov

MSc Milivoj Radojčin

**For Publisher / Za izdavača:** Danka Dujović

**Technical editor / Tehnički urednik:** MSc Milivoj Radojčin, Dr Ivan Pavkov

**Printed by / Štampa:** Offsetprint, Novi Sad, Matice Srpske 6

**Edition / Tiraž:** 200

**ISBN:** 978-86-7520-267-7

**E-mail:** ptep@ptep.org.rs

**www.ptep.org.rs**



## VALIDATION OF THE METHOD FOR THE DETERMINATION OF DITHIOCARBAMATES IN FRUITS

Nada GRAHOVAC<sup>1</sup>, Anka KONDIC-ŠPIKA<sup>1</sup>, Sanja LAZIĆ<sup>2</sup>, Dragana ŠUNJKA<sup>2</sup>, Snežana JAKŠIĆ<sup>1</sup>,  
Biljana RADOVIĆ<sup>1</sup>

<sup>1</sup> Institute of Field and Vegetables Crops, 21000 Novi Sad, Serbia

<sup>3</sup> Faculty of Agriculture, University of Novi Sad, 21000 Novi Sad, Serbia

E-mail: [nada.grahovac@nsseme.com](mailto:nada.grahovac@nsseme.com)

Residues of active substances, which were frequently found in fruits and vegetables of market producers belonged to the dithiocarbamate group pesticide. According to their use dithiocarbamates belong to fungicides in terms dithiocarbamic acid. They are a group of compounds that exist as strong complexes with various metal ions, often in a polymeric form. This makes them difficult to analyse directly because of their limited solubility in most organic solvents. It is important to have a reliable method which enables the quick and simple detection of this group for official monitoring. This work reports a simple, rapid and sensitive method for the assessment residues dithiocarbamates in fruits. Dithiocarbamates were determined indirectly by measuring the amount of carbon disulfide (CS<sub>2</sub>) that is liberated by the chemical reaction. The fruit samples in undisturbed condition were heated with a solution of stannous (II) chloride and hydrochloric acid yielding carbon disulphide. Incurred carbon disulfide (CS<sub>2</sub>) are determined "head-space" technique of gas-chromatography with mass detector. Linearity was verified by using the solutions of carbon disulphide in acetone. A linear dynamic range was obtained over a range of concentrations from 0.02 to 0.12 mg/kg for carbon disulfide with correlation coefficient  $r > 0.995$ . The accuracy of the method was acceptable since the average recoveries measured at four fortification levels were in the range of 83-103% (n = 4). The precision of the developed procedure expressed as the relative standard deviations (RSDs) were lower than 3.7% in all cases. Quantification was based on external standard calibration curves made with spiked blank-matrices.

**Key words:** apple, validation, dithiocarbamates, GC-MS

## VALIDACIJA METODE ZA ODREĐIVANJE DITIOKARBAMATA U VOĆU

Nada GRAHOVAC<sup>1</sup>, Anka KONDIĆ-ŠPIKA<sup>1</sup>, Sanja LAZIĆ<sup>2</sup>, Dragana ŠUNJKA<sup>2</sup>, Snežana JAKŠIĆ<sup>1</sup>,  
Biljana RADOVIĆ<sup>1</sup>

<sup>1</sup> Institut za ratarstvo i povrtarstvo, 21000 Novi Sad, Srbija

<sup>3</sup> Poljoprivredni fakultet, Univerzitet u Novom Sadu, 21000 Novi Sad, Srbija

E-mail: [nada.grahovac@nsseme.com](mailto:nada.grahovac@nsseme.com)

Ostaci aktivnih supstanci koje su često nalaze u voću i povrću na tržištu proizvođača često pripadaju ditiokarbamatima. Ditiokarbamati su derivati ditiokarbaminske kiseline i ubrajaju se u fungicide. To je grupa jedinjenja koja se javlja u obliku kompleksa sa različitim jonima metala često u polimernoj formi. Sve su to razlozi zbog čega je ograničena njihova rastvorljivost u većini organskih rastvarača i samim tim ih je teže direktno analizirati. Važno je imati pouzdan metod koji omogućava brzu i jednostavnu detekciju ove grupe jedinjenja za njihovo dalje praćenje. Ovaj rad predstavlja jednostavan, brz i osetljiv metod za procenu ostataka ditiokarbamata u voću.

Ditiokarbamati su određeni indirektno merenjem količine ugljen-disulfida (CS<sub>2</sub>) koji se oslobodio u hemijskoj reakciji. Uzorci voća u nenarušenom stanju su zagrevani sa rastvorom kalaj (II)-hlorida i hlorovodonične kiseline pri čemu je nastao ugljen-disulfid. Nastali ugljen-disulfid je određen "head-space" tehnikom gasne hromatografije sa masenim-detektorom. Linearnost je potvrđena korišćenjem rastvora ugljen disulfida u acetonu. Linearni dinamički opseg je dobijen u opsegu koncentracija od 0,02 do 0,12 mg /kg za ugljen-disulfid sa koeficijentom korelacije  $r > 0,995$ . Tačnost metode je prihvatljiva izmeren je prosečan povrat uz standardni dodatak koji se kretao u opsegu od 83-103% (n = 4). Preciznost razvijene metode izražene kao relativna standardna devijacija (RSDs) iznosio je manje od 3,7% u svim slučajevima. Kvantifikacija je zasnovana na standardnoj kalibracionoj krivi sa spoljnim standardom koja predstavlja standardni dodatak na matriks.

**Ključne reči:** voće, validacija, ditiokarbamati, GC-MS