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ԲՈՒՅՍԵՐԻ ԳԵՆՈՖՈՆԴԻ ԵՎ ՍԵԼԵԿՑԻԱՅԻ ԼԱԲՈՐԱՏՈՐԻԱՅԻ EX SITU ՀԱՎԱՔԱԾՈՒՈՒՄ ՀԱՑԱԶԳԻՆԵՐԻ ՏԵՍԱԿԱՅԻՆ ԲԱԶՄԱԶԱՆՈՒԹՅՈՒՆԸ ԵՎ ԴՐԱՆՑ ԿԱՐԵՎՈՐՈՒԹՅՈՒՆԸ ՍԵԼԵԿՑԻՈՆ ՊՐԱԿՏԻԿԱՅՈՒՄ

Մ.Գ. Հարությունյան, Ա.Շ. Մելիքյան, Մ.Ց. Հովհաննիսյան, Լ.Գ. Ավետիսյան
Հայաստանի ազգային ագրարային համալսարան

ՀԱԱՀ-ի բույսերի գենոֆոնդի և սելեկցիայի լաբորատորիան ունի մշակաբույսերի և դրանց վայրի ազգակիցների սերմերի հարուստ հավաքածու: Լաբորատորիայի գործառույթն է գենոֆոնդի հարստացումը, սերմերի ծլունակության պահպանումը, գենետիկական բազմազանությունից արժեքավոր հատկություններով օժտված դոնորների առանձնացումը, սելեկցիոն ելանյութի ապահովումը, ինչպես նաև հետազոտական նպատակներով գիտական կազմակերպությունների հետ գենետիկական նյութի փոխանակումը:

ВИДОВОЕ РАЗНООБРАЗИЕ ЗЕРНОВЫХ КУЛЬТУР В КОЛЛЕКЦИИ EX SITU ЛАБОРАТОРИИ ГЕНОФОНДА И СЕЛЕКЦИИ РАСТЕНИЙ И ЕГО ЗНАЧЕНИЕ ДЛЯ СЕЛЕКЦИОННОЙ ПРАКТИКИ

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Функция лаборатории генофонда и селекции растений НАУА, располагающей богатой семенной коллекцией культурных растений и их диких сородичей, состоит в пополнении генофонда, поддержании всхожести семян, выделении источников и доноров ценных признаков из генетического разнообразия, обеспечении селекционных программ исходными формами, а также в обмене генплазмойс научными организациями для исследовательских целей.

UDC:635.13/479.25

DETERMINING THE PRESENCE OF RESIDUAL DDT IN CARROT GROWN IN VILLAGE OF ARAMUS AND ASSESSING HEALTH RISKS TO CONSUMERS (ARMENIA)

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Center for Ecological-Noosphere Studies (CENS) NAS RA

Keywords: organochlorine pesticides (OCP), DDT, carrot, health risk assessment, carcinogenic and non-carcinogenic risks.

Residual organochlorine pesticides (OCPs) and particularly dichlorodiphenyltrichloroethane (DDT) and its isomers are the most frequent environmental pollutants occurred in the result of extensive application of these chemicals for pest control during the latter half of XX century (Waliszewski et al., 2008). Due to their ability to last in soil for a long time, travel across the environment and finally enter food chains (Wanget al., 2011) these chemical compounds are included in the group of persistent organic pollutants (POPs)(UNEP, 2001). Besides, due to lipophilicity and ability to build up in the human body (Wanget al., 2011) these compounds can be exclusively toxic even in low concentrations, causing thus different diseases. DDT is also in the list of potential carcinogens to humans (Chourasiya et al., 2015). Its residues are found in animal-based food (Letta&Attah, 2013), fruits and vegetable semphasizing root vegetables (carrot, beetroot, potato, etc.) which are in direct contact with soil (Waliszewski, 2008). These facts make it urgent to identify such contamination in order to assess probable environmental and health risks in a timely manner.

In Armenia OCPs and mainly DDT were used in large quantities for pest control for almost 30 years (Sargsyan&Sargsyan, 2006). However, in the light of ecological problems emerged from long-term and intense application of these chemicals, in 2003 Armenia joined the Stockholm Convention and undertook the obligation not to use DDT and other OCPs in agriculture. And yet, Armenia has had no comprehensive information regarding the presence of OCPs in agricultural soil and grown fruits and vegetables. The latter constitute a substantial part of the diet of local consumers. Environmental and health risks have never been assessed either.

This study was initiated in the frames of the State Target Program “Monitoring of residual pesticides in food produced in the Republic of Armenia” (2014-2018) designated for completing the mentioned gaps and currently being implemented by the CENS staff. Village of Aramus located in Kotayk marz was selected in the frames of this program as Armenia's largest carrot producer. The research goal was determining residual DDT and its isomers in Aramus carrot roots, estimating dietary intakes of DDT and assessing non-carcinogenic and carcinogenic risks toconsumers' health.

Carrot roots were sampled in September2017 on a random basis from Aramus carrot fields (Figure 1).

Sampling was done with the purpose of determining residual DDT and its isomers (o,p′-DDT; p,p′- DDT; o,p′- DDE; p,p′- DDE; o,p′- DDD; p,p′- DDD) in carrot roots through SOPs developed by the research team in compliance with ISO 874:1980 standard and FAO requirements (FAO, 2016).

In total, 7 carrot root samples consisting of 12 subsamples each, were collected, then placed into plastic bags, appropriately labeled and transported to the Central Analytical Laboratory CENS(accredited by ISO IEC 17025) at a stable temperature 4°C for subsequent analyses.

Sample treatment, extraction and cleanup was done in compliance with EN 12393-2:2008 standard. Residual DDT in the carrot samples was determined by gas chromatograph supplied with a mass selective detector (GC-MS), (TraceGCUltra;Thermo Electron Corporation, USA). In order to assure the quality of lab work standard solutions for DDT and its isomers were prepared o,p′- DDT; p,p′- DDT; o,p′- DDE; p,p′-DDE using AccuStandard ISO 6468-PEST standards (New Haven, USA).

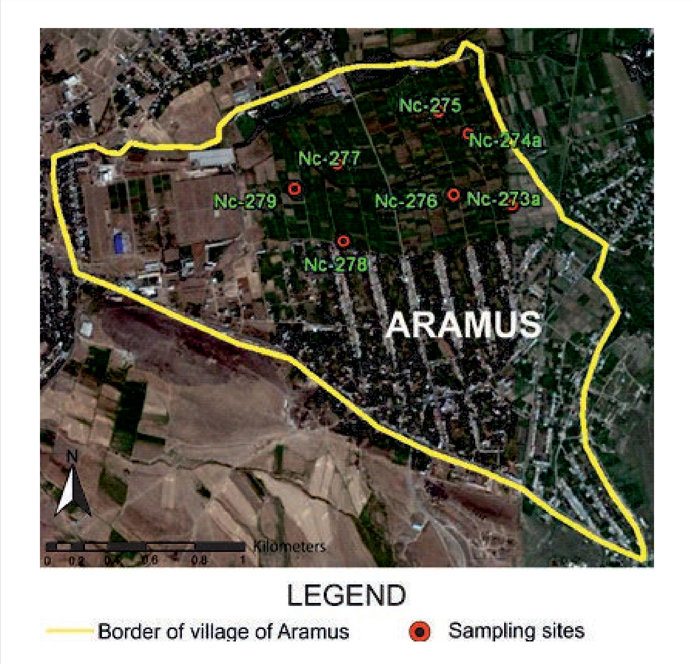

Figure 1.SamplingLocations in Village ofAramus

The quantities of the detected residual DDT (sum) were then compared with maximum residue limits (MRLs) of DDT (sum) in carrot established by the Eurasian Economic Commission (EEC) and European Union (EU) 1.00E-01 mg kg^{-1} and 5.00E-02 mg kg^{-1} respectively (TR CU 021/2011, EU Pesticides database, 2018).

In order to assess health risk from consumption of Aramus carrot contaminated with DDT and its isomers information about daily consumption rates of carrot in Armenia was taken from the RA Statistical Committee, whereas daily intake of DDT and its isomers was estimated in accordance with U.S. EPA Guideline (2011) by Equation 1. The estimated daily intake (EDI) was then collated with acceptable daily intake (ADI) 1.00E-02 mg kg^{-1}bw/day (Joint FAO/WHO, 2001).

$$EDI\ (mg\ kg^{-1}bw/day) = C \times DR / BW \quad (1),$$

Where *C* (mg kg^{-1}) is the concentration of pesticide in a carrot sample, *DR* (g day^{-1}) – the average daily consumption rate of carrot (g day^{-1}), *BW*– the average adult body equal to 70 kg.

Finally, the hazard quotient (HQ) was calculated with a purpose of evaluating non-carcinogenic risk by Equation 2.

$$HQ=EDI/RfD \quad (2),$$

where *EDI* (mg kg^{-1} bw/day) is the estimated daily intake of pesticide, *RfD*– the Reference Dose for chronic oral exposure (US EPA, 2011, US EPA, 1988).

Hazard ratio (HR) was calculated by the following equation for evaluating the carcinogenic risk (Equation 3) (Wang et al., 2011):

$$HR = EDI/CBC \quad (3),$$

where *HR* is a hazard ratio, *EDI* (mgkg^{-1} bw/day) – the estimated daily intake, *CBC*– the cancer benchmark concentration calculated by Equation 4:

$$CBC = BW/\ OSF \times DR \quad (4),$$

where *OSF* is oral slop factor derived from the Intergraded Risk Information System (IRIS) (US EPA, 2011, US EPA, 1988), *BW* – the average adult body weight equal to 70 kg, *DR*– the average daily consumption rate of carrot (g day^{-1}).

The data obtained were treated using the SPSS versionof 20.0 statistical program (SPSS, IBM, NewYork, USA).

The outcomes of lab analyses have indicated that all the seven carrot samples contain at least one DDT isomer. This can be explained by deposition of this pesticide in soils (Waliszewski et al., 2008) as earlier this chemical in large quantities was used all over the country (Sargsyan&Sargsyan, 2006). According to the published sources, residual OCP are taken up by plants and particularly by root vegetables sitting deep in soil (Waliszewski et al., 2008). Due to the so-called osmotic pressure residual pesticides move upward from soil into plants and then build up in plant tissues (Waliszewski et al., 2008, Wang et al., 2011). The most frequent isomers in the studied carrot samples were p,p′- DDE and p,p′- DDT, respective mean concentrations being 1.801E-02 mg kg^{-1} and 9.619E-04 mg kg^{-1} (Table).

Table.Concentration and Frequency of Detection of DDT and Its Isomers in Aramus Carrot Samples (n=7)

Residues	Frequency of Detection, %	Average Concentration, mg kg^{-1}	Range of Variation,mg kg^{-1}
p,p? DDT	57.14	9.619E-04	6.174E-04 - 1.322E-03
o,p? DDT	28.57	1.425E-02	1.279E-02 - 1.571E-02
p,p? DDE	100	1.801E-02	7.234E-03 - 4.178E-02
?DDT	**100**	**2.264E-02**	-

However, ∑DDT in 6 out of 7 samples did not exceed allowable concentrations set up by the EEC and EU, in one sample ∑DDT (5.38E-02 mg kg^{-1}) was insignificantly excessive against the EU MRL (5.00E-02 mg kg^{-1}) alone (Figure 2).

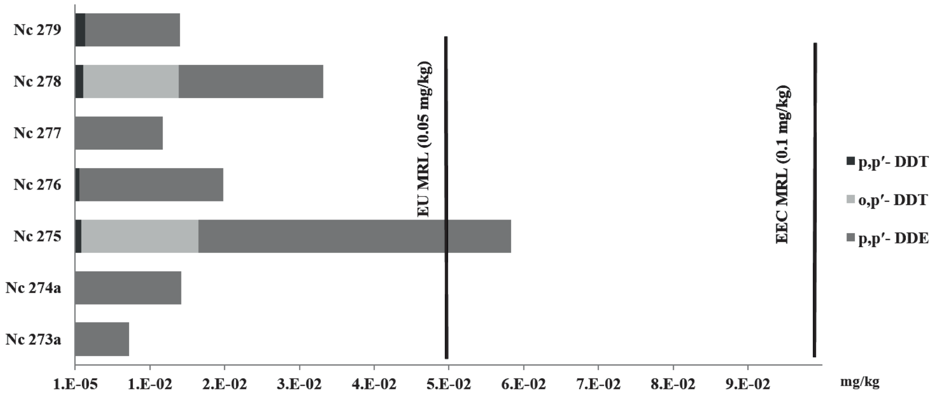

Figure 2.∑DDT Concentration in the Carrot Samples

EDI for ∑DDT (4.69E-06 mg kg^{-1}bw/ day) did not exceed the ADI (1.00E-02 mg kg^{-1}bw/day) which show that the intake level of pesticide is in the safe limits. HQ did not exceed the allowable value >1 either, thus indicating the absence of non-carcinogenic risk. In this study HR value below 10^{-6} is considered acceptable and indicates a potential health risk in the range 10^{-4} to 10^{-6}(Chourasiya et al., 2015). The calculated HR value was ranging between 10^{-4} and 10^{-6} (1.57E-06) which is indicative of a potential risk from consumption of carrot roots contaminated with DDT and its isomers. It should be mentioned that this particular research included assessment of EDI of only one pesticide and one root vegetable. It should also be stressed that these data are too scarce to get a comprehensive vision of pesticide exposure, so relevant data are required which are as yet unavailable. This is another gap to be filled up in our further research to be done to obtain a detailed picture of total dietary exposure of pesticides via plant-based food consumption entirely in Armenia.

The following conclusion derived from this study:

- Residual DDT and itsisomers detected in carrot roots sampled throughout the village of Aramus did not exceed MRLs set up by EEC and EU, with the exception of one sample which insignificantly exceeded the EU MRL.
- Daily intake of DDT-contaminated carrot roots sampled in Aramusdoes not posenon-carcinogenic risk to consumers' health, carcinogenic risk being probable.

Finally, one should stress that identifyingthe entire scope of plant-based health risks will be possible only when supported by regular monitoring data. Data generated from this research are very important for further investigations into dietary exposure of pesticides via consumption of different plant- and animal-based products.

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ՀԱՅԱՍՏԱՆԻ ՀԱՆՐԱՊԵՏՈՒԹՅԱՆ ԱՐԱՄՈՒՍ ՀԱՄԱՅՆՔՈՒՄ ԱՃԵՑՎԱԾ ԳԱԶԱՐԻ ՄԵՋ ԴԴՏ-Ի ՄՆԱՑՈՐԴԱՅԻՆ ՔԱՆԱԿՈՒԹՅԱՆ ՈՐՈՇՈՒՄԸ ԵՎ ՍՊԱՌՈՂՆԵՐԻ ԱՌՈՂՋՈՒԹՅԱՆ ՌԻՍԿԻ ԳՆԱՀԱՏՈՒՄԸ

Ա.Ս. Հովհաննիսյան, Օ.Ա. Բելյաևա, Գ.Հ. Տեփանոսյան, Ա.Կ. Սաղաթելյան
ՀՀ ԳԱԱ էկոլոգանոոսֆերային հետազոտությունների կենտրոն

Հետազոտությունների արդյունքում Արամուս համայնքից նմուշառված գազարում հայտնաբերվել են ԴԴՏ-ի և դրա իզոմերների մնացորդային քանակություններ: Առաջին անգամ գնահատվել է աղտոտված գազարի օգտագործման արդյունքում մարդու առողջությանը սպառնացող ռիսկը: Ըստ ստացված արդյունքների՝ ԴԴՏ-ի օրական ընդունման քանակությունը չի գերազանցում միջազգային թույլատրելի սահմանը, ինչը վկայում է ոչ քաղցկեղածին ռիսկի բացակայության մասին: Այնուամենայնիվ, ողջ կյանքի ընթացքում քաղցկեղածին ռիսկի գնահատման արդյունքում բացահայտվել է մարդու առողջությանը սպառնացող վտանգը:

ОПРЕДЕЛЕНИЕ ОСТАТОЧНОГО КОЛИЧЕСТВА ДДТ В МОРКОВИ, ВЫРАЩЕННОЙ В ОБЩИНЕ АРАМУС РЕСПУБЛИКИ АРМЕНИЯ, И ОЦЕНКА РИСКА ЗДОРОВЬЮ ПОТРЕБИТЕЛЕЙ

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Центр эколого-ноосферных исследований НАН РА

В результате исследований в пробах моркови, отобранных в общине Арамус, обнаружены остаточные количества ДДТ и его изомеров и впервые оценен риск здоровью потребителей. Полученные данные показали, что суточное потребление ДДТ не превышает международной допустимой суточной нормы, что свидетельствует об отсутствии неканцерогенного риска. Однако оценка прижизненного канцерогенного риска указала на наличие угрозы здоровью потребителя.