NEW TECHNOLOGIES USED TO REMOVE THE RESIDUAL PESTICIDES FROM AGRO – FOOD PRODUCTS. A REVIEW

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Summary: Fresh fruits and vegetables and the grains are important components for a healthy and equilibrate diet and represent a valuable source of vitamins and minerals. At present, the global population growth led, inevitably, to an increase in demand for food, especially agro – food products. Thus, to obtain a stable and mass production of agricultural products the use of pesticides is required. Pesticides are toxic substances released intentionally into environment to decimate different kinds of pests (weeds, insects, fungus, rodents), that may affect large areas of agricultural production. However, intensive use of pesticides has resulted in an increase of residual pesticides content in foods based on vegetables, fruits and grains. The studies performed over the last decade had shown that residual pesticides causes serious health problems. This study present a several new technologies which can be effectively applied on agriculture products to minimize the risk of pesticide on human health.

Keywords: Pesticide, agro – food products, new technologies.

Introduction

The safety and quality of food products are among the most important factors influencing consumer choices in modern times; they are also the most important considerations of food manufacturers and distributors (Cardello, 2007). Food is the basic necessity of life and food contaminated with toxic pesticides is associated with severe effects on the human health (Geetanjali Kaushik, 2009).

Fresh fruits and vegetables are important components of a healthy diet as they are a significant source of vitamins and minerals. However, fresh fruits and vegetables can also be a source of noxious toxic substances – pesticides (Basfar A.A., 2012).

Residual pesticides on fresh vegetables and fruits decrease by various culinary applications or with time, depending on the type and properties of the pesticides. Several investigators have found that levels of some pesticide residues were reduced by the pre-harvest intervals and/or culinary application, such as washing, peeling, cooking, boiling and storage (Cengiz, 2007)

Moreover, these techniques in some cases are unsuitable for removal of residual pesticides adhering to surfaces of vegetables and fruits and/or present in plant tissues

Agricultural pesticides can have an adverse effect on the environment in addition to being harmful to humans, animals and fishes. The health hazard to the farmer as well as the residue in crops is also a global problem. Recently, the safety of crops including contamination with agricultural pesticides is a major concern to both the producer and consumer, and the development of a method to remove the pesticides before marketing has been eagerly awaited. (Masahiko T., 2012).

The present review is focused on the application of several new methods including, ionizing radiation, ozone microbubbles and nonthermal plasma degradation in food.

Ionizing radiation

The radiolytic degradation of pollutants was employed in recent years for treatment of natural waters and wastes of different origins and it was also used for drinking water treatment (Basfar, 2005b). In addition, gamma irradiation becomes an important technology in food industry, including preservation of a variety of fruits and vegetables (CAST, 1996).

Ionizing radiation in the form of electromagnetic radiance or high–energy particles creates ions by breaking chemical bonds (Hallman, 2013). Ionizing radiation from electron beam accelerators or gamma ray sources is an efficient process for oxidation removal of organic pollutants.

Three common pesticides namely, malathion, pirimiphos–methyl and cypermethrin were considered commonly used as broad–spectrum pesticides.

The role of ionizing radiation in removal of pesticide residues in contaminated vegetables and fruits are presented in (Tables1 and 2). The data indicate that the selected absorbed doses varied in their efficiency of decontamination of malathion, pirimiphos–methyl and cypermethrin pesticide residues at targeted concentrations.

Table 1. Removal (%) of pesticide residues in distilled water and selected vegetables after irradiation at 1 kGy , after (Basfar A.A., 2012).

Pesticide type	Targeted concentration (MRL, ppm)	Vegetables	
		Concentration(ppm)	Removal(%)
Potatoes			
Malathion	0,5	*NE*	0
Pirimiphos– methyl	0,05	0,041	18
Cypermethrin	0,05	*NE*	0
Onions			
Malathion	8	*NE*	0
Pirimiphos– methyl	1	*NE*	0
Cypermethrin	0,1	*NE*	0

NE – no effect

Examination of the results from Table 1 shows no effect of irradion with absorbed dose of 1kGy for onions. Moreover, the residues of pirimiphos– methyl in potatoes were slightly removed (18%). (Lepine, 1991) demonstrate that the degradation of pesticides is generally greater in irradiated aquenous solutions that in aliphatic solvents or in food. Limited studies have been performed on removal of pesticides residues in food.

Table 2. Removal (%) of pesticide residues in grapes and dates after irradiation up to 7 kGy, after (Basfar A.A., 2012)

Pesticide type	Absorbed dose (kGy)	Targeted concentration (MRL, ppm)	Fruits	
			Concentration (ppm)	Removal (%)
Grapes				
Malathion	1		*NE*	0.00
	2	8	*NE*	0.00
	7		7.694	3.83
Pirimiphos–	1		*NE*	
methyl	2	1	0.941	5.9
	7		0.809	19.1
Cypermethrin	1		*NE*	0.0
	2	2	*NE*	0.0
	7		1.948	2.6
Dates				
Malathion	1	8	*NE*	0.0
Pirimiphos–methyl	1	0.1	0.0556	44.4

NE – no effect

Ozone microbubbles

O_3 is considered to be most suitable for removing residual pesticides from vegetables and fruits and controlling microbes of food safety concern (Gabler & Smilanick, 2010).

Although there are many studies on the removal of pesticides using O_3 for water purifications in waste water, there are several reports on the use of O_3 to remove residual pesticide in vegetables and fruits (Daidai & et al., 2008) (Wu & et al., 2007a).

Microbubbles (MB) are less than 50 μm in diameter and have special properties such as generation of free radicals, self–pressurization and negative charge, and their use in the field of food science and agriculture is attracting attention (Sumikura & et. al., 2007).

There are two types of O_3 MB (OMB) generators, a decompression type and a gas–water circulation type. In the former, a sufficient amount of gas is dissolved in water under a 3–4 atmospheric pressure to cause a supersaturated condition (Figure 1A). Under such a condition, supersaturated gas is unstable and escapes from the water generating a large amount of air bubbles, which are MB. In the latter, gas is introduced into the water vortex, and the formed gas bubbles are broken into MB by breaking the vortex (Figure 1B) (Takahashi, 2009).

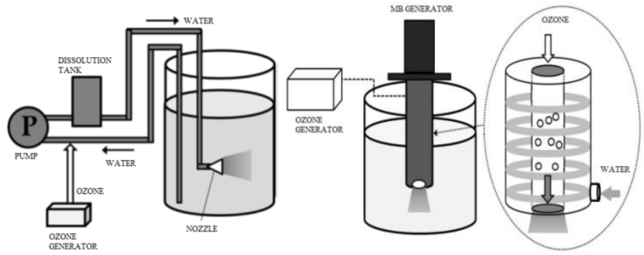

Figure 1. Schematic diagrams used for MB generation. (A) The decompression–type MB generator, (B) the gas–water circulating–type MB generator.

The effectiveness of OMB for removal of residual pesticides varies with the methods of the OMB generation. The decompression type was more effective than the gas–water circulation type on removing the residual pesticide in vegetables, which could be attributed to the larger number of small OMB that could more easily infiltrate into vegetables than the gas water circulation type.

OMB quickly and effectively removed high concentrations of residual FT from lettuce. In addition, continuously bubbled OMB effectively removed residual FT from fruity vegetables with a thick pericarp and sarcocarp, such as cherry tomatoes and strawberries. Unlike millibubbles, MB allow O3, which is highly insoluble in water, to be easily dissolved in water at high concentrations. As a result, OMB solutions are more effective than OMLB solutions at removing residual pesticides from vegetables because the OMB solutions combine the oxidative power of O3 with the generation of hydroxyl radicals from the collapsing OMB. (Masahiko T., 2012).

In–package non–thermal plasma degradation

In–package nonthermal plasma (NTP) technology is a novel technology for the decontamination of foods and biological materials. It involves generation of a NTP inside a sealed package containing the food or biomaterial intended for treatment. The reactive species generated by plasma persist up to a few hours inside the packaging, during which time there is a significant antimicrobial effect. (D. Ziuzina, 2013) .

Organophosphorus (OP) pesticides have been widely used as an alternative to organochlorine compounds for the control of insecticide in a wide range of fruit, vegetables, and grain all over the world. (Yanhong Bai, 2010)

Non–thermal plasma (NTP), such as dielectric barrier discharge (DBD), corona discharge, and glow discharge, is a highly potential alternative for degradation of organophosphorus (OP) pesticides molecules (Chen, 2009).

In case of degradation of 4 types of pesticides in strawberries (Misra, 2014) showed a maximum decrease of 69%, 45%, 71% and 46 % for azoxystrobin, cypronidil, fludioxonil and pyriproxifen after 300 s treatment an applied voltage of 80kV.

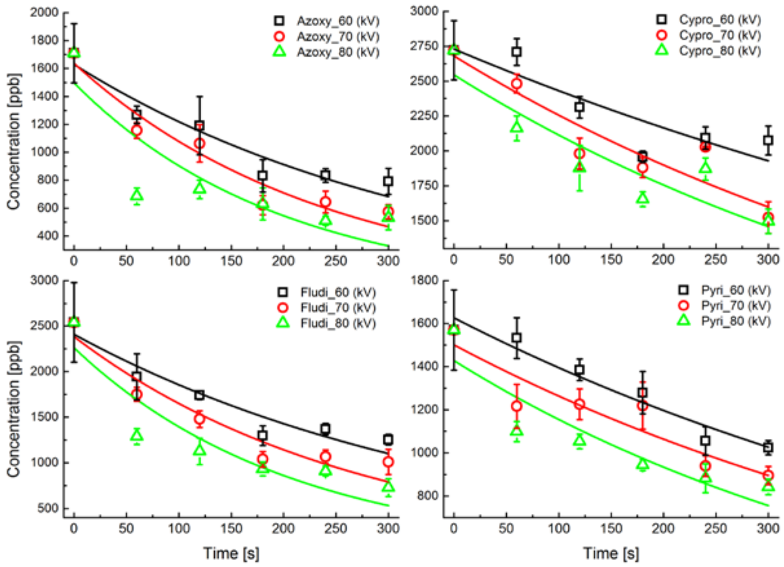

Fig.2. Residual pesticide concentrations in strawberries before and after plasma treatment (Misra, 2014)

Conclusions

Irradiation at an absorbed dose of 2kGy can reduce the pirimiphos–methyl levels to below maximum residues limits (MRLs) in contaminated grapes (5,9 % removal).

OMB solutions are more effective than OMLB solutions at removing residual pesticides from vegetables because the OMB solutions combine the oxidative power of O3 with the generation of hydroxyl radicals from the collapsing OMB.

Nonthermal plasma treatment using a dielectric barrier discharge successfully degraded pesticide residues on strawberries. Nontermal plasma irradiation could be use in food industry to improve food safety in terms of agrichemicals.

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