Environmental pollutants in organic farming and organic food

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Abstract

In current world scenario organic farming is a famous agricultural practice and covering a total area of approximately 71.5 Mha worldwide. Due to the involvement of certain practices in organic farming, food safety and human health is threatened by the flows of various environmental pollutants. Persistent organic pollutants, heavy metals, cyclodienes, organochlorine pesticides, hexachlorocyclohexanes, hexachlorobenzene, and nonbrominated flame retardants are some of the contaminants that occur in higher concentration in organic products. As a result, the lasting consumptions of organic products carrying such pollutants cause a considerable risk to human health. This present article decisively deal with the effect of organic farming on unknown and hidden threat due to the use of various composts as the nutrient and amendment sources that augment the phytoaccumulation and trophic transfer of pollutants, the functional diversity of the ecosystems, and poor harmonization among the policies and regulations in different countries for organic farming.

Introduction

Organic farming is widely practiced form of agriculture and suffers from poor attentiveness about the many possible means of entry and flow of pollutants. The flame-retardants (FRs), heavy metals, veterinary antibiotics (VAs), and even antimicrobial-resistant microorganisms are the new threats due to existing organic farming practices (Manyi-Loh et al., 2018). Many antibiotic resistant animal bacteria can be pathogens and furthermore the distribution of these bacteria from animal excretes to the soil and local water body can easily move to the human via the food chain (Manyi-Loh et al., 2018). Various organic compounds and pesticides residues as diffuse pollutants have been found in organic farm produce. The HPLC MS analysis detected many pesticides in organic carrots (Chiarello and Moura, 2018).

This inadvertent flow of pollutants into organic produce can be credited to using a range of farm input like farmyard manure, green waste, compost, domestic waste, sludge, and forage grass at organic farm. These manures are the main sources of VAs, pesticides and their residues, pharmaceutical compounds, microplastics, personal care products, and heavy metals (Umlauf et al., 2011; Meng et al., 2017; Zhang et al., 2020). The sustainable practices of organic farming have expanded enough, while human health benefits require the careful consideration of conventional and emerging pollutants. Knowledge on the probable flow of pollutants in organic farming is vital to develop a system and policy regulations to guaranteed food security and human health.

Composting: unintended piling of pollutants

Farm animal waste based manures that may contain steroid hormone metabolites have shown noteworthy unfavorable effects on the soil (Michelini et al., 2014; Verderame et al., 2016). The uses of antibiotics in farm animals are common worldwide (Tasho and Cho, 2016; Quaik et al., 2020).

Later, the direct livestock excretion on the land and the application of farm manure in agriculture, coupled with surface runoff and infiltration into deep layers of soils or water can release VAs into the soil and water system (Kemper, 2008; Kuppusamy et al., 2018). These reports suggest that the application of farm animal manure in organic farming poses unseen hazard and more importantly, the entry of VAs into the food chain. These threats significantly necessitate the screening of farm yard manures before its application in agricultural fields.

Table 1: Environmental pollutants in the agricultural inputs used as nutrient

Input	Pollutants	Reference
Swine manure	$\sum_{15}$VAs	Zhi et al. (2020)
Dairy manure	∑TCs	Li et al. (2020)
Beef manure	∑TCs	Li et al. (2020
Chicken manure	∑TCs	Li et al. (2020)
Sludge	Heavy metals; Cu, Zn, Cr, Pb, Mn, Ni	Tang et al. (2020)
Dried sludge	Heavy metals; Cu, Zn, Cr, Pb, Mn, Ni	Chen et al. (2019)
Tap water	∑32PPCPs	Liu et al. (2019)

Urban river water	Sulpiride	Tamura et al. (2017)
Dairy cattle manure	Ciprofloxacin	Gros et al. (2019)

Green waste or biological waste is usually consisting of farm and agriculture refuse (e.g., grass clippings and leaves), domestic or industrial kitchen waste. Farm waste is commonly used in organic farming owing to its high nitrogen content, and mitigating potential of greenhouse gas emissions (Diacono et al., 2019). Nevertheless, green wastes that have persistent herbicides residues pose health risks to organic farm produces (CalRecycle, 2020). The pesticides residues have been detected in various foods and the maximum residual level in organic food stuffs were reported more than 0.5% (Tiryaki, 2017). In recent times, the certified organic grains produced in the USA were reported to be contaminated with herbicide glyphosate (Meftaul et al., 2020). In general, use of synthetic pesticides are restricted in organic farming, but however the organic certified produce might contain the trace amount of pesticides which may be about five times lower than the amount detected in the conventional produce (Gómez-Ramos et al., 2020).

Urban sewage sludge is used as an organic amendment in organic farming and which provide organic matter and N and P. The presence of high organic matter in the sludge absorbs heavy metals from sewage during the treatment process. Thus, the hidden danger with the use of urban sewage sludge in organic farming is the presence of heavy metals (Table-1). The heavy metals can readily enter the plant system from this type of organic amendments, and their accumulation in plants can exceed the permissible levels for human consumption (Weldegebriel et al., 2012).

Table 2: Heavy metals in foodstuffs

Bovine meat	DL-PCBs	Tressou et al. (2017)
Bovine, poultry and lamb meat	PAHs, PCBs, OCPs	Hernández et al. (2017)
Cold-pressed rapeseed oil	PCBs, PAHs, Pesticides, Trace elements	Wroniak and Rękas (2017)
Vegetables	Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, Zn,Micronutrients	Hattab et al. (2019)
Carrots	Heavy metals	Gawęda et al. (2010)
Cereals, flours and bakery products	Ochratoxin A	Beretta et al. (2002); Biffi et al. (2004)
Cereals and cereal-based products	Mycotoxins	Pleadin et al. (2017)
Eggs	PCBs, PCDD/Fs	Rawn et al. (2012)
Cheese	PCBs, OCPs	Almeida-González et al. (2012)
Infant cereals	Cd	Hernández-Martínez and Navarro-Blasco (2012

Knowledge gaps and future prospects

Knowledge about the various classes of heavy metals in the organic wastes is inadequately presented, limited to a very few research (Kolesnikov et al., 2019). The heavy metals in present different forms may have distinct levels of toxicities (Kolesnikov et al., 2019). In many cases certain pollutants and contaminants below the legal limits are found to be toxic to the plant and human. The extent of heavy metals pollutants in the organic sludge wastes alone can't be associated to toxicities. Regulatory guidelines for eco-toxicity by heavy metals are very tricky to define because of this limitation. Thus, future studies must focus on the speciation of heavy metals pollutants in the organic wastes and manure used in organic farming.

There should be an additional spotlight on the plant uptake of antibiotics from organic wastes. The research with antibiotics in hydroponic system cannot offer complete information about the plant uptake. The inconsistency and doubt between the translocation factors and antibiotic hydrophobicity need more research attention (Miller et al., 2016).

Organic wastes as soil amendment as a fertilizer in organic farming is usually considered secure. Nevertheless, techniques for the detection of pollutants are careful monitoring. The currently available treatment methods may not remove certain environmental pollutants like PPCPs. The emerging analytical techniques such as photoelectrochemical, complex nanocomposites, 3D flower-like ZnO nanoparticles (NPs), aptamer based colorimetric sensing, rhodamine assisted fluorescent approach, Cd-MOF, surface plasmon resonance (SPR) sensor, microbial fuel cell (MFC) biosensors may improve the detection and monitoring of pollutants.

Conclusion

The unintended stream of environmental pollutants can take place through compost and different other organic sources. The trophic transport of pollutants has many serious consequences in the agriculture production

ecosystem. The environmental pollutants including heavy metals, pesticides, PPCPs in the organic compost, green waste, urban and sewage waste can reach to the agricultural fields. The organic plant products were found to have ultra-trace levels of pesticides, antibiotics, and heavy metals. Incompetent treatment methods of sludge and poor treatment of organic wastes can result in the flow and continuous existence of environmental pollutants in the organic farming fields. The validation of organic farming for enhancing the biodiversity becomes difficult to encourage the producers and policymakers. The further research and policy regulations are required to guarantee the unintended flow of environmental pollutants into organic products and keep the health of humans and ecosystems.

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