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Review on pesticide residues levels in fruits, vegetables, cereals and legumes food products in Ethiopia

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Abstract
Food safety is an area of growing worldwide concern on account of its direct bearing on human health. Pesticides are widely used in agriculture mainly to increase crop yields to cater huge supply of food products for increasing world population as well as to protect crops from pests and control insect-borne diseases. Increased use of pesticides results in contamination of the environment and the excess accumulation of pesticide residues in food products, which has always been a matter of serious concern. Pesticide residues in food and crops are directly related to the irrational application of pesticides to the growing crops. Considering this, present review is presented with the objective to determine which pesticides are being used by the farmers and also the presence of different pesticide residues in different food crops. This review paper analysed a total of 16 research articles published in journals in quantification of different pesticide residues in different food crops grown in Ethiopia. Most of the pesticide residues which are studied repetitively in Ethiopia are Heptachlor, Aldrin, Chlordane, Endosulfan sulphate, Dimethoate, Diazinon, Malathion, Chlorpyrifos, p,p'-DDE, o,p' DDT and p,p' DDT. Accumulated pesticide residues in food products have been associated with a broad variety of human health hazards, ranging from short-term effects to long term toxic effects. The impact of pesticide residues can be minimized by taking certain measures such as the rational use of pesticides, promoting organic farming, exploit natural and bio-pesticides, and proper implementation and amendment of pesticide-related laws.

Keywords: Pesticide, pesticide residue, food crops and health

1. Introduction
Food crops, fruits and vegetables are attacked by pests and diseases during production and storage leading to damages that reduce the quality and the yield. In order to reduce the loss and maintain the quality of fruits and vegetables harvest, pesticides are used together with other pest management techniques during cropping to destroy pests and prevent diseases. The use of pesticides have increased because they have rapid action, decrease toxins produced by food infecting organisms and are less labour intensive than other pest control methods. However, the use of pesticides during production often leads to the presence of pesticide residues in fruits and vegetables after harvest.

A pesticide is a substance or mixture of substances that is used to prevent, destroy, repel or mitigate any pest, ranging from insects (insecticides), rodents (rodenticides) and weeds (herbicides) to microorganisms (fungicides, algaecides, or bactericides) [15]. Pests and diseases are the drivers that encourage the application of pesticides in agricultural production because without the application of pesticides, the loss of fruits, vegetables and cereals from pest injury would reach 78%, 54% and 32%, respectively [6].

Food safety is an important issue that attracts all of us. While the consumers are concerned about the safety of what they eat, the governments on their side are concerned with finding ways to reduce food related risks and illnesses. From a viewpoint of food safety, the consumers would prefer no or as little pesticide residues in the food as possible. Safe food indirectly contributes to health and productivity thereby providing effective platform for development and poverty alleviation [37].

The use of agrochemicals is both beneficial and harmful. Beneficial effects are associated with increased plant yields, an increase in animal crops and less spoilage during storage. Agrochemicals combined with genetically improved varieties of crop species have contributed positively to the successes of the "green revolution" that has helped to increase food supply to the rapidly increasing world population.

Negatively, agrochemicals (pesticides) have produced contamination which involves the widespread presence of pesticide residues in virtually all wildlife, well water, and food and even in humans. The major concerns are their toxic effects such as interfering with the reproductive systems and foetal development as well as their capacity to cause cancer and asthma [17]. Some of the pesticides are persistent and therefore remain in the body causing long term exposure.

However, their excessive use/misuse especially in the developing countries, their volatility, long-distance transports eventually results in widespread environmental contamination. In addition many older, non-patented, more toxic, environmentally persistent and inexpensive chemicals are used extensively in developing nations, creating serious acute health problems and local and global environmental impacts [10]. Further while remarkable progress has been made in the development of effective pesticides, the fact remains that a very small fraction of all applied pesticides is directly involved in the pesticidal mechanism. This implies that most of the applied pesticides find their way as "residue" in the environment into the terrestrial and aquatic food chains where they undergo concentration and exert potential, long term, adverse health effects [39].

The losses of crops caused by pests and plant diseases are quite high both in developed and developing countries. These are reported to be in the range of 10-30% in the former and 40-75% in latter case [29]. Even greater losses occur after the crop is harvested which are caused by the pests that attack the stored products, particularly in the tropics. During the last 3-4 decades, chemical control of pests aimed at minimizing these losses has been introduced throughout the world. Approximately 70% of the pesticides used in the world are applied in developed countries and 30% in the developing countries [26].

Currently, the application of various pesticides in agriculture has escalated, resulting in better food production to meet population demands globally; nevertheless, the fact that the environment and farms produce contamination via residues cannot be denied. Moreover, developing countries in the tropics are guilty of increased usage of pesticides. Accordingly, residues of pesticides remaining in the soil, water, and crops eventually enter the food chain and are therefore ingested by humans [10]. The objective of this review is that to assess available information's on the levels of different pesticide residues in fruits, vegetables and food crops in Ethiopia.

2. Classification of pesticides

The word "pesticide" is an umbrella term for all insecticides, herbicides, fungicides, rodenticides, wood preservatives, garden chemicals and household disinfectants that maybe used to kill some pests. Since a pesticide varies in identity, physical and chemical properties, it is therefore logical to have them classified and their properties studied under their respective groups. Synthetic pesticides are classified based on various ways depending on the needs. However, there are three most popular ways of classifying pesticides which are; classification based on the mode of action, classification based on the targeted pest species and classification based on the chemical composition of the pesticide [9].

3. Pesticides fate after application to food crops

Fate refers to the pattern of distribution of an agent, its derivatives or metabolites in an organism, system, compartment or population of concern as a result of transport, partitioning, transformation or degradation. After pesticides are applied to the crops, they may interact with the plant surfaces, be exposed to the environmental factors such as wind and sun and may be washed off during rainfall. The pesticide may be absorbed by the plant surface and enter the plant transport system (systemic) or stay on the surface of the plant [22]. While still on the surface of the crop, the pesticide can undergo wash-off, volatilization, and photolysis, chemical and microbial degradation. All these processes can reduce the original pesticides concentration but can also introduce some metabolites in the crops.

Although degradation of pesticides is influenced by different environmental processes [7], concluded that under natural field conditions volatilization is the main process that affects surface deposits of pesticides. Adsorption is the chemical process that results in a pesticide being chemically bound or adsorbed to a soil particle. For example, portions of a positively charged pesticide molecule may bind electrically to the negatively charged clay minerals or organic matter [23]. The adsorption depends on the properties of the soil and the pesticide. Transfer refers to the processes that move the pesticide away from the application site and includes volatilization, runoff, leaching, and absorption and crop removal. Sometimes transfer of the pesticide is essential for pest control.

Volatilization occurs when a liquid or solid goes to the gas phase and moves away from the initial application site. Volatilization of the pesticide usually occurs immediately after application in the field. The process depends on the vapor pressure of the pesticide. Pesticides with high vapor pressure tend to volatilize rapidly into the air while those with low vapor pressure remain longer on the surface. Absorption, the pesticide residue may be broken down or remain in the plant or animal until harvest. Degradation is the process of pesticide breakdown after application by microbial action, chemical action or photo-degradation. This process may take hours, days, weeks or years, depending on the environmental conditions and the chemical characteristics of the pesticide. Some pesticides may be degraded by microbial metabolism. Micro-organisms can use pesticides as nutrients thereby breaking them into carbon dioxide and water or they can form metabolites [21].

4. Localization of pesticide residues in fruits and vegetables commodities

Composition and properties of various food commodities vary according to their nature and group they belong. The same is true for pesticides. There are numerous factors that affect the extent of pesticide absorbance, penetration and degradation and differ from one category of food to another. The rate at which pesticides are moved and dissipated is closely related to the physicochemical parameters of pesticide itself and surrounding environmental conditions. The ability to resist degradation (persistence) under various conditions is measured as half-life of the pesticide. The retention of pesticides depends on the physiochemical properties of the pesticide molecules as well as food. In fruits and vegetables, most of the pesticide residues are retained on peel surface. This is the reason that majority of the residues are removed by washing, peeling or treatments with chemical solutions like vinegar, turmeric, sodium bicarbonate, common salt or alcohol.

5. Commonly used pesticides in vegetables, fruits and food crops in Ethiopia

Pesticide use in Ethiopian State farms is estimated at 7.76 kg/ha, and less than 0.1 kg/ha in smallholder farms. Cotton on commercial farms uses 90% of imported insecticides. Government extension services promote packages of chemical inputs to improve the productivity of smallholder agriculture and achieve food security. The Pesticide Registration Council of Ethiopia has registered a total of 171 pesticides consisting of 86 insecticides, 45 herbicides, 22 fungicides and 18 miscellaneous groups. Of these, 159 are currently in use. The largest proportion of pesticide use in Ethiopia has been for the control of bollworms and other pests such as the cotton aphid and the cotton whitefly in cotton. Horticultural crops such as vegetables and fruits have also become heavy users of pesticides in recent years [34]. But POPs in general Organochlorine pesticides in particular pollution in Ethiopia is anticipated mainly from two sources namely obsolete pesticides and agricultural uses. These are significantly affected the ecosystem and the health of the people [1].

Under the current institutional arrangement, the Ministry of Agriculture and its counterparts in the agricultural bureau of regional states are the major government agencies responsible for regulating, implementing, and monitoring pesticide policies: pesticide registration, importation, distribution and use. State environmental and social institutions and private actors (farmers and pesticides traders) could play important roles in pesticide governance to overcome failures of the state in pesticides policies. However, in Ethiopia, the role- played by these actors in pesticide governance is weak.

Policy plays a vital role in the implementation of any regulatory framework. In view of this, and by considering the overall issues associated with pesticide, the government of Ethiopia has formulated pesticide legislation (Pesticide Registration and Control Proclamation No. 674/2010) in order to govern pesticide use by farmers. However, it is important to point out that policy alone cannot accomplish these objectives unless they are enforceable. The enforcement of realistic pesticide policy is the most important component to address pesticide problems. In Ethiopia, although there is legislation governing pesticide, it has not been enforced effectively at the federal, regional and grass root or district level. Formulation of pesticide policy by the state is not sufficient by itself.

6. Pesticide residues in different food crops grown in Ethiopia

Over 85% of Ethiopia population live in rural areas and depend on agriculture for food and other basic necessities. Population growth and land degradation contribute most to the increasing risk of food insecurity and famine in Ethiopia. On top of these obvious factors, the average crop loss due to pests was estimated to reach between 30 and 40% annually. These problem and agricultural intensification increased use of pesticides. Actually chemical pesticide use in Ethiopia was historically low, recent developments in increased food production and expansions in floriculture industry have resulted in higher consumption of chemical pesticides [16].

Pesticides in agricultural sector were introduced in Ethiopia in the 19640s. Different types of pesticides were imported by both private and public companies for agricultural uses. Since then, the use of pesticide has increased rapidly for crop protection. currently, pesticide usage by small holder farmers was frequently accompanied by misuse (abuse and overuse) of pesticides and resulted in poisoning users and caused chronic health effects; pesticide residue in food and drinking water. As Belay, (2016) [4] sited recently, Ethiopia has been considered as having the largest accumulations of obsolete pesticides in Africa. It is estimated that there were 1,500 tonnes of obsolete pesticides.

Table 1: Pesticide residue levels in different Ethiopian agricultural food products

Name of pesticide residue	Study area	Food items	Values of pesticide residue levels in foods	Reference
$^{\delta}$-BHC, Dieldrin	Piasa atekelet tera	Orange	ND	[2]
$^{\delta}$-BHC, Dieldrin		Tomato	ND	
$_{\gamma}$-BHC	Piasa atekelet tera	Orange	0.005 mg/kg	
$_{\gamma}$-BHC		Tomato	ND	
Heptachlor	Piasa atekelet tera	Orange	0.010 mg/kg	
Heptachlor		Tomato	0.035 mg/kg	
Aldrin	Piasa atekelet tera	Orange	0.02 mg/kg	
Aldrin		Tomato	0.01 mg/kg	
Chlordane, DDE and DDD	Piasa atekelet tera	Orange	ND	
Chlordane, DDE and DDD		Tomato	ND	
Endosulfan	Piasa atekelet tera	Orange	0.0007 mg/kg	
Endosulfan		Tomato	0.001 mg/kg	
DDT	Piasa atekelet tera	Orange	0.002 mg/kg	
DDT		Tomato	0.003 mg/kg	
p, p′-DDT	Southwest Ethiopia, Gurafarda site	Corn	0.018 mg/kg	[5]
		Rice	0.046 mg/kg	
		Sorghum	0.048 mg/kg	
		Common millet	0.062 mg/kg	
p, p′-DDE	Southwest Ethiopia, Gurafarda site	Corn	0.011 mg/kg	
		Rice	0.035 mg/kg	
		Sorghum	0.054 mg/kg	
		Common millet	0.087 mg/kg	
Endosulfan sulfate	Southwest Ethiopia, Gurafarda site	Corn	ND	
		Rice	0.076 mg/kg	
		Sorghum	0.047 mg/kg	

		Common millet	0.039 mg/kg	
Aldrin	Southwest Ethiopia, Gurafarda site	Corn	ND	
		Rice	0.06 mg/kg	
		Sorghum	0.037 mg/kg	
		Common millet	0.042 mg/kg	
Dimethoate	Southwest Ethiopia, Gurafarda site	Corn	ND	
		Rice	0.065 mg/kg	
		Sorghum	0.068 mg/kg	
		Common millet	0.080 mg/kg	
p, p′-DDT	Southwest Ethiopia, North Bench site	Corn	0.064 mg/kg	[5]
		Rice	0.059 mg/kg	
		Sorghum	0.031 mg/kg	
		Common millet	0.133 mg/kg	
p, p′-DDE	Southwest Ethiopia, North Bench site	Corn	0.066 mg/kg	
		Rice	0.058 mg/kg	
		Sorghum	0.044 mg/kg	
		Common millet	0.057 mg/kg	
Endosulfan sulfate	Southwest Ethiopia, North Bench site	Corn	0.045 mg/kg	
		Rice	0.061 mg/kg	
		Sorghum	0.049 mg/kg	
		Common millet	0.018 mg/kg	
Aldrin	Southwest Ethiopia, North Bench site	Corn	0.065 mg/kg	
		Rice	0.040 mg/kg	
		Sorghum	0.082 mg/kg	
		Common millet	0.027 mg/kg	
Dimethoate	Southwest Ethiopia, North Bench site	Corn	ND	
		Rice	0.077 mg/kg	
		Sorghum	0.04 mg/kg	
		Common millet	0.039 mg/kg	
p,p′-DDT	Southwest Ethiopia, South Bench site	Corn	0.056 mg/kg	[5]
		Rice	0.035 mg/kg	
		Sorghum	0.075 mg/kg	
		Common millet	0.038 mg/kg	
p, p′-DDE	Southwest Ethiopia, South Bench site	Corn	0.059	
		Rice	0.057 mg/kg	
		Sorghum	0.078 mg/kg	
		Common millet	0.074 mg/kg	
Endosulfan sulfate	Southwest Ethiopia, South Bench site	Corn	0.081 mg/kg	
		Rice	0.065 mg/kg	
		Sorghum	0.059 mg/kg	
		Common millet	0.044 mg/kg	
Aldrin	Southwest Ethiopia, South Bench site	Corn	0.074 mg/kg	
		Rice	0.069 mg/kg	
		Sorghum	0.130 mg/kg	
		Common millet	0.045 mg/kg	
Dimethoate	Southwest Ethiopia, South Bench site	Corn	ND	
		Rice	0.060 mg/kg	
		Sorghum	0.051 mg/kg	
		Common millet	ND	
o, p'-DDT	Hararge, Gelemso	5 Khat sample	139.3-399. 0µg/kg	[8]
p, p'-DDT			141.2-973.0 µg/kg	
Total DDT			280.5-1,372 µg/kg	
Diazinon	Jimma, BadaBuna	5 Khat sample	686.9-173.9 µg/kg	
o, p'-DDT	Butajera, Aseno	5 Khat sample	68.0-224.8 µg/kg	
p, p'-DDT			194.3-199.0 µg/kg	
Total DDT			329.0-1,223.8 µg/kg	
Diazinon	East Arsi, Lole	5 wheat sample	66.5-173.0	[8]
Malathion, p, p'- DDE, o, p' DDT and p, p' DDT			ND	
Aldrin			BQL	
Diazinon	Bale zone, Sinana	5 wheat sample	51.0-378.1 µg/kg	
Malathion, Aldrin, p, p'-DDE, o, p' DDT and p, p' DDT			ND	
Malathion, Aldrin, p, p'-DDE, o, p' DDT and p, p' DDT	East Shoa Zone, Adami Tulu	5 wheat sample	ND	
Chlorpyrifos	Amhara Region, North West Ethiopia	28 khat	75.4 µg/kg	[32]
Dimethoate		24 khat	130.0 µg/kg	
Profenofos		6 khat	242.5 µg/kg	

Diazinon		2 khat	81.5 µg/kg	
p, p'-DDE	Different parts of Ethiopia (Agaro, Bonga, Dedo, Ela, Goro, Kersa, Limu, Nanda, Seka, Sekoru, Shebe, Tocha,Woliso, Wonchi, Yebu, and Yem)	CoBPuR COB, teff, red pepper, and maize	0.00-0.086 mg/kg	[31]
p, p'-DDD		Maize, CoBPuR, teff, COB, Red pepper and CoPu	0.049-0.128 mg/kg	
o, p'-DDT		COB, CoBPuR, CoPu, teff, maize, and red pepper	0.085-0.193 mg/kg	
p, p'-DDT		CoBPuR, teff, maize, CoB, red pepper, and CoPu	0.099-0.461 mg/kg	
Chlorpyrifos		CoBPuR or CoPu, teff, maize, red pepper, and CoB	0.011-0.063 mg/kg	
Endosulfan		CoBPuR, teff, maize, CoB, CoPu, and red pepper	0.0042-0.0332 mg/kg	
Cypermethrin		maize, CoBPuR, teff, CoPu,red pepper, and CoB	0.156-0.553 mg/kg	
Permethrin		maize, teff, CoPu, CBPR, Red pepper, and CoB	0.157-1.15 mg/kg	
Deltamethrin		Red pepper, CoBPuR, CoPu, and CoB	0.069-0.157 mg/kg	
DDT	Tekeze dam	Fish muscle tissue sample	3.50-5.56 ppb	[35]
DDE			4.18-8.26 ppb	
Chlordane			0.35-0.56 ppb	
Heptachlor			0.28-0.58 ppb	
Lindane			0.65-1.47 ppb	
Endosulfan			0.94-2.14 ppb	

DDE = dichlorodiphenyldichlorethylene; DDT = dichlorodiphenyltrichloroethane; DDD = dichlorodiphenyldichlorethane; CoB = green coffee bean; CoPu = coffee pulp; CoBPuR = coffee bean after removal of the pulp; LOD = limit of detection; ND = none detectable; ppb = parts per billion

7. Effects of different processing approaches on pesticide residue

Fruits and vegetables are generally perishable by nature. This can lead to substantial losses to both farmers and consumers. The main objective of processing fruits and vegetables is to supply wholesome, safe, nutritious and acceptable food to the consumers throughout the year [15]. Food processing refers to those methods and techniques that are applied to raw ingredients to transform them into a consumable form. Food processing also includes basic raw material preparation such as washing, removing contaminants and foreign bodies as well as peeling and trimming (removing non-consumable parts of the raw agricultural commodity).

Unit operations normally employed in processing food crops reduce or remove residues of insecticides and other pesticides that are present in them. These operations such as washing, peeling, blanching and cooking play a role in the reduction of residues [11]. Each operation has a cumulative effect on the reduction of the pesticides present. Washing removes loose surface residues and major portions of polar compounds such as carbonyl. Hot water blanching increases pesticide removal and may hydrolyse substantial fractions of non-persistent compounds. Non-polar pesticides are tenaciously held in the waxy layers of the peel of fruits and vegetables. Peeling and juicing operations usually result in almost complete removal of chlorinated hydrocarbons.

There is an increasing need for information about the effects of various processes on the fate of pesticide residues in foods both from a regulatory and public concern perspective. The various aspects of food processing methods which are used for reducing the pesticide reside in different foods are, preparatory steps, thermal processing, products manufacture and post-harvest handling and storage for a large number of pesticides [36].

8. Health effects of pesticide residues in food crops

Pesticides commonly take the form of liquids, wettable powders, emulsifiable concentrates and dusts, and when they are sprayed; they move through the air and eventually end up in the environment. Only 1% of sprayed pesticides actually reach the target pest, while the remaining 99% should be considered a direct human health threat or a pollutant to the environment (bodies of water, soil, air, and non-target organisms) via drift, volatilization, leaching and run off [6]. Although the use of most organochlorine insecticides came to an end 10-25 years ago, even today they remain in the environment at concerning levels. Very common contaminants of surface and groundwater such as endosulfan sulphate, the metabolite of endosulfan, are still in use in many countries [24].

The presence of pesticide residues is a concern for consumers because pesticides are known to have potential harmful effects to other non-target organisms than weeds, pests and diseases. The major concerns are their toxic effects such as interfering with the reproductive systems and foetal development as well as their capacity to cause cancer and asthma [18]. Some of the pesticides are persistent and therefore remain in the environment causing long term exposure. The concern has led to governments setting up monitoring systems in order to assess the safety situation and make informed decisions when passing legislation.

Controls on pesticide residues in crops are based on Maximum Residue Limits (MRLs). Maximum residue levels are the highest levels of residues expected to be in the food when the pesticide is used according to authorized agricultural practices (European Union Report on Pesticide Residues in Food, 2009) [11]. MRL's are typically range between 0.01 mg/kg and 10 mg/kg and are a useful means of enforcing acceptable pesticide inadequate as a guide to human health risks from residues. Pesticide residues that are below the MRL set by the European Commission are considered by regulators not to pose risk to consumers or the environment, as they are significantly lower than concentrations for which negative health or environmental impacts can be detected in the regulatory pesticide safety testing carried out as part of the pesticide approval process (European Union, 2005) [12].

Similar to many technological developments that improve the quality of human lives, pesticides can pose risks if they are not used thoughtfully. Persistent organic pollutants (POPs), Movement of long distances, taken up the food chain, and accumulate everywhere. Examples: DDT, Endrin, Lindane, Endosulfan, drifting and contamination of land and waterways, Pesticides in contaminated crops used as animal feed eventually are found in meat and dairy products, Pesticides in soil eventually contaminate ground water, the source of drinking water, Pesticides kill non-target organisms, wildlife, birds, fish, bees, beneficial insects, and pest's natural enemies.

Pesticides can also be hazardous for human health when the degree of exposure exceeds safety levels. This exposure can be direct, such as the exposure of farm workers applying pesticides to various crops, or indirect, such as consumers using agricultural products containing chemical traces and bystanders near application areas [33]. Although developing countries use only 25% of the pesticides produced worldwide, they experience 99% of the deaths. This is because the use of pesticides in these countries tends to be more intense and unsafe, while regulatory systems are generally weaker [20]. A number of studies have highlighted the severity of occupational health problems related to pesticide use [19]. For example, according to a WHO and UNEP report, there are more than 26 million human pesticide poisonings worldwide, with approximately 340,000 deaths per year [3, 30].

Another report by Rao *et al*., 2005 [28] and Pimentel, 2009 [27] state that approximately 3 million cases of pesticide poisonings were hospitalized annually with nearly 220,000 cases resulting in death and nearly 75,000 in chronic illnesses. Nearly 18.2 acute pesticide poisoning cases per 100,000 agricultural workers occurred [38]. A recent study by PAN International assumes that currently, among the total of 1.3 billion farm workers worldwide, approximately 41 million suffer from pesticide poisoning each year with an average poisoning rate of 32%. In Africa, PAN-Africa and Pan-UK documented 16 suicide cases in Benin, Senegal, Ghana and Ethiopia in the years 2002-2006 [25].

Among the typical symptoms of acute (short-term) poisoning in humans are fatigue, headaches and body aches, skin irritation, eye irritation, irritation of the nose and throat, feelings of weakness, dizziness, nausea, vomiting, excessive sweating, impaired vision, tremors, panic attacks and cramps. Chronic (long-term) poisoning leads to severe health problems, such as cancer, damage to the reproductive system, the liver, the brain, and other parts of the body [37].

9. Conclusion and Recommendation

The excess consumption of pesticides contributes in the accumulation of pesticide residues in food grains and vegetables associated with variety of human health hazards, including damage to central and peripheral nervous systems, cancer, allergies and hypersensitivities, reproductive disorders, and disruption of the immune system. Pest management is one of the major inputs in agricultural production; therefore, this area needs great attention to economize the production, to provide safe foods and to lower the medical expenses for treatment of resulting ailments. Moreover, the alternative means for pest management should be explored. In the present scenario of globally competitive trade, all concerted efforts should be made to ensure food safety as it has a direct bearing on human health and for boosting the export of food commodities.

In Ethiopia, there is no maximum residue limit set by the concerned bodies. Therefore, establishment of the national maximum residue limits is recommended. In addition, the use of organophosphate and organochlorine pesticides are common in cereal crop production; hence, monitoring of these chemicals should be done at regular interval to determine the extent of the release of these compound's to environmental compartment and food products. Moreover, strict regulations on this pesticides and also further monitoring should be implemented that dietary pesticide exposures from other food products and should be investigated and cumulative risk assessment should be done from collective consumption.

Conflict of interest

The authors declare no competing interest.

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