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Pesticide Residues in Whole Milk: Public Health Concerns

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Abstract: Milk is an important part of our daily diet and contributes to the intake of important nutrients. Large scale applications of different pesticides in agriculture have resulted in retaining of pesticides in the form of residues in the natural resources, including milk also. Contamination of fodder and other natural resources with pesticides results in entry of pesticides in the body of cattle, including the milk. Presence of pesticides in milk contributes to the serious issue of human health. Various pesticide residues detected in milk include carbamates, organochlorines, organophosphates, and synthetic pyrethroid. General symptoms of pesticide residue toxicity of milk include excessive salivation, sweating, tearing, muscle twitching, weakness, tremor, headache, dizziness, nausea, vomiting, abdominal cramps, diarrhoea, respiratory depression, tightness in chest etc. Present review focuses on whole milk/full fat milk (definition, composition, nutritional value, therapeutic benefits); pesticides (definition, types, benefits, adverse effects); and pesticide residues. Emphasis is also given on public health concerns and safety measures for pesticide residues in milk for general public. This study recommends establishing pesticide residue monitoring programs for analysis of milk, to improve food safety and decrease exposure risks for consumers, and to create awareness among general public and owners of dairy farms regarding health hazards by pesticide residues in milk.

Keywords: Milk, Dairy products, Endosulphan, Organochlorine, Organophosphate, Pesticide residues, Public health

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Introduction

Milk is a whitish liquid containing proteins, fats, lactose, and various vitamins and minerals, produced by the mammary glands of all adult female mammals after childbirth and serves as food for their young (Mourad *et al*., 2014). Milk is the product of the total, full and uninterrupted milking of a dairy female in good health, also nourished and not overworked. It must be

Table 1: Average proximate composition of full fat milk (per 100 g of milk) (Source: Konte, 1999; Medhammar *et al*., 2011; FAO, 2013)

Proximates	Human	Cow		Buffalo		Goat		Sheep	
	Average	Average	Range	Average	Range	Average	Range	Average	Range
Ash	0.2	0.7	0.7-0.7	0.8	0.7-0.8	0.8	0.8-0.8	0.9	0.9-1.0
Energy (kcal)	70	62	59-66	99	71-118	66	58-74	100	93-108
Energy (kJ)	291	262	247-274	412	296-495	270	243-289	420	388-451
Lactose (g)	6.9	4.7	4.5-5.1	4.4	3.2-4.9	4.4	4.2-4.5	5.1	4.5-5.4
Total fat (g)	4.4	3.3	3.1-3.3	7.5	5.3-9.0	3.9	3.3-4.5	6.4	5.8-7.0
Total protein (g)	1.0	3.3	3.2-3.4	4.0	2.7-4.6	3.4	2.9-3.8	5.6	5.4-6.0
Water (g)	87.5	87.8	87.3-88.1	83.2	82.3-84.0	87.7	86.4-89.0	82.1	80.7-83.0

collected properly and not contain colostrum (milk secreted in the first days after parturition) (Adib and Bertrand, 2009). Milk has been known as nature's most complete food and play an important role in the diet of over 6 billion people in the world (Cashman, 2006; Hanna *et al*., 2019; Widyastuti and Febrisiantosa, 2021).

On average, bovine milk is composed of 87% water, 4% to 5% lactose, 3% protein, 3% to 4% fat, 0.8% minerals, and 0.1% vitamins (Table 1) (Haug *et al*., 2007). The composition varies among animal species and breeds within the same species, and also from one dairy to the other, depending on the period of lactation and diet (Mourad *et al*., 2014). Therefore, milk is considered to be a basic food in almost all dietary guidelines worldwide. Major constituents of milk are as follow:

- Milk sugar: Lactose
- Milk protein: Crude protein, protein, insoluble proteins/whole casein etc.
- Milk fats: Triglycerides, Di-glycerides, Mono-glycerides, Phospholipides, Cerebrosides, Steroides, Free fatty acid, Cholesterol esters, Vitamin etc.
- Minerals and Trace elements: calcium, phosphorus, magnesium, sulphur, nitrogen, sodium, potassium, chloride, and iron, copper, zinc, cobalt and iodine.
- Vitamins: Vitamin A, Aneurin, thiamine (vitamin B_1), Riboflavin (vitamin B*2*), Nicotinic acid, Pyridoxine, Biotin, Folic acid, Vitamin C, Vitamin D and Vitamin E.
- Enzymes: Esterase, Lactase, Lipase, Protease, Catalase, Hydrolase, Oxidase, Reductase, Peroxidase etc.

❖ *Nutritional value of milk* (*FAO, 2013*):

The nutritional richness of milk is unquestionable; it is a good source of high biological value proteins with polyvalent roles in immune function, as well as nutrient transport and absorption and important vitamins and essential minerals. Milk is a nutrient-rich food and provides a significant amount of vitamins and minerals to the diet (Dairy, 2018).

- Milk protein is important for muscles, and calcium for bones.
- Provide calcium, phosphorus and protein for development of bones.
- Good source of dietary fat, energy, protein and other nutrients.
- Source of calcium, sodium and selenium.
- Provide vitamin A, D, E, B_2, B_{12}, C (ascorbic acid).
- Growth, supply of energy, maintenance of body and recovery from disease.
- Reproduction and provide taste and appetite and palatability.

❖ *Therapeutic value of milk* (*FAO, 2013*; *Pereira, 2014*):

- Protective effects in cardiovascular health.
- Some milk components can play a protective role in carcinogenesis.
- Reduce the risks of weight gain, obesity, type 2 diabetes, and metabolic syndrome.
- Calcium from milk cause prevention of osteoporosis.

- Milk intake is globally recommended as a promoter of good bone health.
- Milk proteins are helpful in satiety and appetite control.

Pesticides: *Definition, Types, Benefits and Adverse effects*:

Any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest (insects, mites, nematodes, weeds, rats, etc.), including insecticide, herbicide, fungicide, and various other substances used to control pests are called as pesticides (EPA, 2009). Pesticide is a generic name for a variety of agents that may be classified more specifically on the basis of pattern of use and organism killed (Megha *et al*, 2018).

Hassaan and Nemr (2020) described that pesticides are classified on the basis of mode of action and/or mode of entry or the approach by which a pesticide controls or kills the target pest, chemical structure, the features of pesticides, and the character of the target pests. According to Nayak and Solanki (2021), on the basis of chemical composition, pesticides are categorized into organochlorine (Aldrin, DDT, Lindane, Chlordane, Endosulfan); organophosphate (Malathion, Diazinon, Parathion, Chlorpyrifos); pyrethroids (Pyrethrins, Deltamethrin, Fenpropathrin); Carbamates (Carbaryl, Aldicarb, Carbofuran); and Bio-pesticides (*Bacillus thuringiensis* (Bt) and its subspecies).

According to Textbook of Forensic Medicine and Toxicology, pesticides are classified into acaricides (kill mites, ticks and spiders e.g. Azobenzene, Chlorobenezilate etc.); fungicides (kill fungi and moulds e.g. Captan, Captofol etc.); herbicides (kill weeds or prevent growth of weeds e.g. Parquet, Atrazine etc.); insecticides (kill or repel insects and related species e.g. Organophosphates); molluscicides (kill snails, slugs, etc. e.g. Metaldehyde, Thiacloprid); nematicides (kill nematodes e.g. Ethylene bromide); rodenticides (kill rats, mice, moles and other rodents e.g. Arsenic, Strychnine); and miscellaneous pesticides (kill or repel pests of all types e.g. Compounds of lead, Copper, Mercury, nicotine etc).

Gyawali (2018) stated that pesticides have applications in various sectors such as agriculture (for control of weeds, pests, rodents etc.); domestic (household and garden spray, control of animals and birds); material building (incorporation of paints, glues, plastic protection sheeting, foundation of buildings etc); personal (for application of clothing and skin care); and public health (for control of malaria, dengue fever, cholera).

Poudel *et al.* (2020) reported that, environmental impacts of pesticides include contamination on natural environment (water, soil, air); impact on food safety, non-target organisms; and threats to aquatic and terrestrial biodiversity. According to Shah (2020), impacts of pesticides on human health include neurotoxic, genotoxic, carcinogenic, and reproductive effects.

Pesticide Residues:

Mondal *et al.* (2021) stated that pesticide residues includes any derivative of a pesticide, such as conversion products, metabolites, reaction products and impurities considered to amounts of residues primarily depend on nature of pesticides, environmental conditions, good agricultural practices, waiting periods and storage conditions. The amounts of pesticide residues primarily depend on nature of pesticides, environmental conditions, good agricultural practices, waiting periods and storage conditions (Racke, 2007).

Pesticides are commonly used in agriculture to enhance crop production and control pests. After application of pesticides to soil or used to treat crops, they are capable of migrating within various environments and, ultimately, accumulate in food chains or persist as degradation products (Silva *et al*., 2019). Pesticide residues can persist in the environment and agricultural crops. It can produce long-term negative effects on the health of humans and animals and stability of ecosystems by molecular mechanisms that mediate the start of a cascade of adverse effects (Valeriya *et al*., 2021).

Pesticides have become most essential inputs in modern agriculture for ensuring food security particularly in the developing countries where population far exceeds the agricultural growth (Chauhan *et al*., 2021). Indiscriminate use of pesticides to protect the crop and non-adoption of safe waiting period, leads to accumulation of pesticide residues in edible portion of crop, which may be hazardous to humans beings (Waghulde *et al*., 2011; Al-Nasir *et al*., 2020).

Makadiya and Pandey (2017) recorded that, to control the presence of pesticide residues in fresh milk and milk products is a big issue for producer, consumer and government due to the potential risk. Human milk as well as animal milk is contaminated through the contaminated food. These residues are too much persistent. They accumulate in body fat even in breast milk. Therefore, the objective of present study was to review the concentration of pesticide residues in whole milk and to generate awareness about the lethal effects of these pesticides on human beings as well as to estimate the potential health risks associated with the pesticide residue with regard to consumers.

Articles relevant on pesticide residues in milk were searched in EMBASE, Google Scholar, Medline, NCBI, PubMed, Science Direct, Scopus, and Web of Science databases. Data and information was collected from the thorough study of the journal articles, research papers, reports and various literatures. The keywords used for reviewing the literature were the ones that refer to the issues concerning the 'milk' and 'pesticide residues'. For literature search, keyword "milk" is combined with: pesticide residues, health and safety measures, risk assessment, hazard to human health and the environment.

Pesticide residues recorded in common vegetable crops:

For the collection of primary data on pesticides residues in milk, research articles (scientific papers and review articles) published in reputed journals were reviewed. Details on the milks, pesticides detected, area of the study, and reference is presented in Table 2.

Public Health Concerns: Table 3 illustrates the impacts of pesticide residues in milk on human health.

Safety Measures for pesticide residues in milk and dairy products:

- To analyse the uses and consequences of pesticides on human health.
- To establish pesticide residue monitoring programs for analysis of milk.
- To improve food safety and decrease exposure risks for consumers (Akhtar and Ahad, 2017).
- To create awareness among general public and owners of dairy farms regarding health hazards by pesticide residues in milk (Ishaq, and Nawaz, 2018).
- To identify sustainable solutions to achieve concentrations of pesticides below the highest levels those are legally tolerated (Al-Hawadi, 2020).
- To avoid consumption of raw milk, especially for infants to prevent serious and long lasting public health problems (Rana *et al*., 2021).
- Need of a continuous monitoring programme to check the profile of pesticide residues in animal milk samples (Rai and Bajpai, 2017).

Conclusion

Presence of pesticide residues in milk is an issue of concern as it poses serious threats to health of the consumers and also to the cattle. Possible ways of contamination of milk with pesticide residues are un-hygienic handling of milk, contamination of natural resources, and excessive use of pesticides in agriculture. This study recommends development of 'rapid tests' affordable to consumers to detect the presence of pesticide residues in milk. Also, sustainable solutions to reduce the concentrations of pesticides below the highest levels, to avoid consumption of raw milk, and continuous monitoring programme to check

Table 2: Pesticide residues detected in milk samples

Sample	Detected pesticides	Area	Reference
Human milk	b-HCH, g-HCH, d-HCH, Endosulfan, Malathion, Chlorpyrifos, Methyl-parathion	Bhopal, Madhya Pradesh, India	Sanghi *et al.* (2003)
Breast milk	Organophosphates (Lindane, DDT, DDD/ DDE)	Armenia	Artashes *et al.* (2007)
Milk and Dairy Products	Σ DDT, γ HCH, total PCB,	Poland	Radzymińska *et al*. (2008)
Milk and Dairy Products	Alpha-HCH, Gamma-HCH, Beta-HCH, DDT, DDE, DDD, Heptachlor, Heptachlor epoxide, Dieldrin, Endrin	Sharkia Governorate, Egypt	Ayoub *et al*. (2012)
Cow's milk	Azinphos, Chlorfenvinphos, Chlorpyrifos, Chlorpyrifos-methyl, Fenitrothion, Diazinon, Methacrifos, Methidathion, Parathion, Parathion-methyl, Pirimiphos-methyl, Pyrazophos, Triazophos	Pulawy, Poland	Kiljanek *et al.* (2013)
Cow, Buffalo, Goat, Camel and Sheep milk	Organophosphorous (Chlorpyrifos), Pyrethroid (Bifenthrin, Deltamethrin and lambda-cyhalothrin), Insecticide (Imidacloprid) and Carbamate (Carbofuran)	Lahore, Pakistan	Shahzadi *et al.* (2013)
Dairy cattle's milk	Cypermethrin, Chloropyrifos, Profenofos	Peshawar, Pakistan	Iftikhar *et al.* (2014)
Raw Cow milk	Fenthion, Dimethoate, Malathion, Coumaphos, Aldicarb, Carbofuran, Carbaryl	North of Parana State, Brazil	Silva *et al.* (2014)
Fodder and milk	Dicofol and Organophosphorus compounds (Dimetheoate)	Musi river belt, Andhra Pradesh, India	Kotinagu and Krishnaiah (2015)
Buffalo and Cow milk, Feed	Endosulfan, Endosulfan-sulphate, Dieldrin, DDE, DDT, Permethrin, γ-HCH, Acephate, Chloripyriphos, Malathion, Monochrotophos, Methamedophos, Profenophos, Parathion-methyl, Bifenthrin, Cyfulthrin, Cypermethrin, Deltamethrin, Fenvelrate, Acetamiprid, Imidacloprid, Aflatoxin M1, Aflatoxin B1	Faisalabad, Pakistan	Sajid (2015)
Raw buffalo milk	Organochlorine (Alachlor, Dieldrin, Hexchlorobenzene, Lindane, Methoxychlor) and Organophosphorus (Chlorpyrifos, Malathion, and Parathion-methyl)	Assiut, Egypt	Shaker and Elsharkawy (2015)
Raw, Fresh and Pasteurised cow milk and Sour cream	Organochlorine pesticides (OCPs): Hexachloro-cyclohexane (α-HCH, β-HCH and γ-HCH), DDT,	Bacau District. Romania	Rusu *et al.* (2016)
Buffalo milk	Organophosphorous: DDT, Chlorpyrifos, Dichlorovos	Gandhinagar and Ahmedabad, Gujarat, India	Makadiya and Pandey (2017)
Fresh bovine milk	α-Endosulphan, β-Endosulphan, DDT, DDE, Endosulphan sulphate, Dieldrin, γ-HCH	Sahiwal region	Zubaria *et al.* (2017)
Bovine milk	Endosulphan sulphate, Cypermethrin, Ethion, p,p'-DDE, Lindane, Malathion, Fenvalerate, Chlorpyrifos	Punjab (India)	Bedi *et al.* (2018)
Ultra-Heated Treatment and Pasteurized Cow milk	Chlorpyrifos, Cyproconazole, Cypermethrin, Fluquinconazole, Prometrin, Tebuconazole	Brazil	Ciscato *et al.* (2018)
Bovine milk	Organochlorines: DDT, DDE, Dieldrin, ɣ-HCH,	Sahiwal region,	Ishaq, and

	α-Endosulphan, β-Endosulphan, Endosulphan sulphate	Pakistan	Nawaz (2018)
Cow Milk	β-BHC, ϒ-BHC, δ-BHC, ΣBHC, Heptachlor, Heptachlor-epoxide, Σheptachlor, DDE, DDT, Aldrin, Dieldrin,	Ado-Ekiti, Nigeria	Ibigbami *et al.* (2019)
Cow milk and Dairy products	Prothiofos, Diazinon, Chlorpyrifos, Profenofos, Fipronil, Phenthoate, Dimethoate, Tebuconazole	Sri Lanka	Jayasinghe *et al.* (2019)
Cattle milk	Organophosphorus pesticides (Dimethoate and Chloropyrifos)	Khartoum state, Sudan	Sara *et al.* (2019)
Milk of Cattle	DDT, HCHs, Aldrin, Dieldrin, Endrin, Heptachlor, Hheptachlor epoxide, and Hexachlorobenzene (HCB),	Jordan	Al-Hawadi (2020)
Cow and buffalo milk	Carbaryl, 4'4' DDT, Deltamethrin	Chhattisgarh, India	Chandrakar *et al.* (2020)
Bovine Milk	HCH, DDT, Endosulfan, Cypermethrin, Cyhalothrin, Permethrin, Chlorpyrifos, Ethion, Profenophos	Bangalore, Bhubaneswar, Guwahati, Ludhiana and Udaipur in India	Gill *et al.* (2020)
Raw milk from urban areas and dairy farms	Endosulfan, Dieldrin, DDE, cHCH Endosulfan-sulphate,	Lahore district, Pakistan	Arif *et al.* (2021)
Bovine and Caprine Milk	Azimsulfuron, Cypermethrin, Thiabendazole, Crotonolactone, Fluoxastrobin, Aldicarb and Carbofuran	Western Uttar Pradesh (India)	Rana *et al.* (2021)
Cow milk and Camel milk	Organophosphates (Chlorthiophos-2, Coumaphos, Fenchlorphous, Leptophos, Malathion, Tetrachlorvinphos, Profenefos) and Organochlorines (DDT, Endosulphans, Dieldrin, Heptachlor)	Kiambu, Isiolo, and Laikipia, Kenya	Wanjiku *et al.* (2022)

Table 3: Impacts of pesticide residues in milk on human health

Health Concerns	**References**
• Little sperm count, increased testicular cancer, birth defects and reproductive defects.	Shahzadi *et al.* (2013)
• Dermal toxicity - Excessive salivation, sweating, rhinorrhea and tearing, muscle twitching, weakness, tremor, headache, dizziness, nausea, vomiting, abdominal cramps, diarrhea, respiratory depression, tightness in chest, and cholines-terase inhibition.	Iftikhar *et al.* (2014)
• Heart disease, cancers, Alzheimer's disease and parkinsonism.	Kotinagu and Krishnaiah (2015)
• Affects the vital organs (thyroid, heart, kidneys, liver, mammary gland and testicles). • Affects cardiovascular and respiratory systems, leading to genotoxicity. • Carcinogenic to humans and disrupts the endocrine system.	Rusu *et al.* (2016)
• Genotoxicity, carcinogenity and hormonal disturbance. • Toxic for infant's nervous, reproductive and immune system.	Akhtar and Ahad (2017)
• Heart problems, endocrine disruption and cancer. • Development of acute and chronic, may also cause death. • Little sperm count, increased testicular cancer, different birth defects and reproductive defects. • Block the nerve impulses.	Makadiya and Pandey (2017)

• Respiratory, myocardial and neuromuscular transmission impairment.	Jayasinghe *et al.* (2019)
• Nausea, vomiting, and gastrointestinal disturbance. • Kidney damage, brain tumour, cardiovascular disease, hepatocellular carcinoma, hypertension, blue baby syndrome, leukemia etc. • Aplasia of the bone marrow and cancer. • Harms on central nervous system, reproductive and endocrine.	Ray and Sen (2019)
• Cancer, reproductive malfunctioning, disturbance of hormones, neurotransmitters, enzymes along with behavioural changes.	Al-Hawadi (2020)
• Birth defects in infants, neurological disorders, behavior changes, reproductive defects, gastrointestinal problems and cancer.	Arif *et al.* (2021)

the profile of pesticide residues in milk samples will minimize the issue to great extent.

References

Adib A and Bertrand S. (2009) Risk analysis transfer pesticides to milk. Institute of Livestock. National Interprofessional Centre : 9.

Akhtar S and Karam A. (2017) Pesticides residue in milk and milk products: Mini review. Pak J Anal Environ Chem. 18(1): 37-45.

Al-Hawadi JS. (2020) Banned organochlorine pesticides still in our food: The presence of organochlorine pesticide residues in milk, meat, liver, and kidney in Jordan Cattle. Sys Rev Pharm. 11(11): 1491-1495.

Al-Nasir FM, Jiries AG, Al-Rabadi GJ, Alu'datt MH, Tranchant CC, Al-Dalain SA, Alrabadi N, Madanat OY and Al-Dmour RS. (2020) Determination of pesticide residues in selected citrus fruits and vegetables cultivated in the Jordan Valley. LWT 123: 109005.

Arif AM, Imran J, Muhammad A, Muhammad A, Muhammad I, Muhammad S, Tanweer AG, Muhammad A, Zafar I, Zafar I, Bahare S, Javad SR and Nata M. (2021) Organochlorine pesticide residues in raw milk samples collected from dairy farms and urban areas of Lahore district, Pakistan. J Food Sci Technol. 58(1): 129-137.

Artashes T, Stephen JR, Kevin MK, Laurence F, Albert M, Natalya T, Margarita P and Suren B. (2007) Organochlorine pesticide residues in breast milk in Armenia. J Pre-Clinical Clin Res. 1(1): 84-88.

Ayoub MM, Desoki ME, Hassanin AS, Thabet WM, Mansour MH, Nagwa ML and Amal R. (2012) Detection of pesticide residues in milk and some dairy products. J Plant Prot Path Mansoura Univ. 3(8): 865-880.

Bedi JS, Gill JPS, Kaur P and Aulakh RS. (2018) Pesticide residues in milk and their relationship with pesticide contamination of feedstuffs supplied to dairy cattle in Punjab (India). J Anim Feed Sci. 27: 18-25.

Cashman KD. (2006) Milk minerals (including trace elements) and bone health. Int Dairy J. 16: 1389-1398.

Chandrakar C, Shakya S, Jain T, Ali SL, Patyal A and Kumar P. (2020) Occurrence of carbaryl, DDT and deltamethrin residues in bovine milk in Chhattisgarh, India and risk assessment to human health. J Anim Res. 10(2): 291-297.

Chauhan R, Duhan A and Kumari B. (2021) Pesticide residues in vegetables. In: Pest Management and Residual Analysis in Horticultural Crops, (eds.) Gulati R. and Kumari B., New India Publishing Agency, pp. 261-287.

Ciscato CHP, Barbosa CM, Gebara AB and Ozawa KS. (2018) Dietary milk consumption and the pesticide residues exposure from pasteurized and UHT samples. Adv Clin Toxicol. 3(2): 131.

Dairy UK. (2018) Milk: Nutrition information for all the family. https://milk.co.uk/hcp/wp-content/uploads/sites/ 2/2018/07/MilkConsumerweb.pdf.

EPA. (2009) What is a pesticide? http://www.epa.gov/opp00001/about/.

FAO (Food and Agriculture Organization of The United Nations) (2013) Milk and dairy products in human nutrition. ISBN 978-92-5-107863-1.

Gill JPS, Bedi JS, Singh R, Fairoze MN, Hazarika RA, Gaurav A, Satpathy SK, Chauhan AS, Lindahl J, Grace D, Kumar A and Kakkar M. (2020) Pesticide residues in peri-urban bovine milk from India and risk assessment: A multicenter study. Sci Rep. 10: 8054.

Gyawali K. (2018) Pesticide uses and its effects on public health and environment. J Health Promotion 6: 28-36.

Hanna GW, Krystyna R, Wacław L and Maksymilian C. (2019) Milk and dairy products and their nutritional contribution to the average polish diet. Nutrients 11: 1771.

Hassaan MA and Ahmed El N. (2020) Pesticides pollution: Classifications, human health impact, extraction and treatment techniques. Egyptian J Aquat Res. 46: 207-220.

Haug A, Hostmark AT and Harstad OM. (2007) Bovine milk in human nutrition – a review. Lipids Health Dis. 6:1-16.

Ibigbami OA, Aiyesanmi AF, Adesina AJ and Popoola OK. (2019) Occurrence and levels of chlorinated pesticides residues in cow milk: A human health risk assessment. J Agricult Chem Environ. 8: 58-67.

Iftikhar B, Samina S and Shafiqur R. (2014) Assessment of the dietary transfer of pesticides to dairy milk and its effect on human health. Afr J Biotechnol. 13(3): 476-485.

Ishaq Z and Nawaz MA. (2018) Analysis of contaminated milk with organochlorine pesticide residues using gas chromatography. Int J Food Properties 21(1): 879-891.

Jayasinghe J, Samudra P, Dhammi D, Senevirathne N, Sinhapura M, Jayasinghe C, Chandrajith R and Marapana U. (2019) Pesticide Residues In Cow Milk And Dairy Products From The Major Milk Producing Area Of Sri Lanka. AGROFOR Int J. 4(3): 83-90.

Kiljanek T, Alicja N and Stanisław S. (2013) Determination Of organophosphorus pesticide residues in milk. Bull Vet Inst Pulawy 57: 185-189.

Konte M. (1999) Le lait et les produits laitiers. Développement de systèmes de productions intensives en Afrique de l'ouest. Université de Nouakchott (R.I.M) Faculté des Sciences et Technologies des aliments, B. P. 5026. ISRA/ URV – LNERV/FEVRIER : 2-25.

Kotinagu K and Krishnaiah N. (2015) Organochlorine and organophosphorus pesticide residues in fodder and milk samples along Musi river belt, India. Vet World 8(4): 545-550.

Makadiya J and Pandey A. (2017) Detection of pesticides in buffalo milk collected from different areas of Gandhinagar and Ahmedabad by thin layer chromatography. Int J Chem Tech Res. 10(1): 231-238.

Medhammar E, Wijesinha-Bettoni R, Stadlmayr B, Nilsson E, Charrondiere RU and Burlingame B. (2011) Composition of milk from minor dairy animals and buffalo breeds from a biodiversity perspective. J Sci Food Agric. 92(3): 445-474.

Megha MA, Uday V P and Ashwin VN. (2018) Classification of pesticides: a review. Int J Res Ayurveda Pharm. 9(4):144-150.

Mondal P, Anita VH, Mukherjee K, Ghosh SK and Karmakar R. (2021) Pesticide residues: analysis, impact and mitigation. In: Handbook of Agriculture, Environment and Biotechnology, (eds.) Rakshit A., Singh H.B., Singh A.K., Abhilash P. C., Sarma B.K., Tripathi V. K. and Parewa H.P., Assoc Agriculture, Environment Biotechnology, New Delhi, India, pp. 425-449.

Mourad G, Guessas B and Medjekal S. (2014) Composition and nutritional value of raw milk. Issues Biol Sci Pharmaceut Res. 2(10): 115-122.

Nayak P and Solanki H. (2021) Pesticides and Indian agriculture- a review. Int J Res - Granthaalayah 9(5): 250-263.

Pereira PC. (2014) Milk nutritional composition and its role in human health. Nutrition 30: 619-627.

Poudel S, Bikash P, Birochan A, Poudel P. (2020) Pesticide use and its impacts on human health and environment. Environ Ecosyst Sci. 4(1): 47-51.

Racke KD. (2007) Pesticide residues in food and international trade: regulation and safety considerations. In: Pesticide chemistry: crop protection, Public Health, Environmental Safety, (eds.) Ohkawa H., Miyagawa H. and Lee P.W., Wiley-vch, Verlag, Weinheim.

Radzymińska M, Smoczyński SS and Kopec M. (2008) Persistent organochlorine pesticide, lead, cadmium, nitrate (V) and nitrate (III) in Polish milk and dairy products. Polish J Environ Stud. 17(1): 95-100.

Rai S and Bajpai SP. (2017) A Review on levels of organochlorine pesticides in animal milk. Int J Sci Develop Res. 2(4): 647-651.

Rana Suresh VS, Verma Y, Rathi UV and Vashistha LM. (2021) Chemical signatures of new pesticides in the bovine and caprine milk samples collected from western Uttar Pradesh (India). J Ecophysiol Occupational Hlth. 21(1): 1-6.

Ray PR and Sen C. (2019) Biochemical residues in milk and milk products - a review. Indian J Anim Hlth. 58(2-Special Issue): 145-152.

Rusu L, Harja M, Suteu D, Dabija A and Favier L. (2016) Pesticide residues contamination of milk and dairy products. a case study: Bacau District Area, Romania. J Environ Protect Ecol. 17(3): 1229-1241.

Sajid MW. (2015) Pesticides residues and aflatoxins in milk and their dissipation during processing. Thesis Doctor of Philosophy, University of Agriculture, Faisalabad, Pakistan.

Sanghi R, Pillai MKK, Jayalekshmi TR and Nair A. (2003) Organochlorine and organophosphorus pesticide residues in breast milk from Bhopal, Madhya Pradesh, India. Human Exp Toxicol. 22: 73-76.

Sara AM, Afaf IA, Sahar MA, Abubakar AS, Abdelbagi AO and Abdalla AM. (2019) Organophosphorus

pesticides residue in cattle milk from Khartoum state. Scientific Res J. 7(1): 41-46.

Shah R. (2020) Pesticides and human health. In: Emerging Contaminants. doi: http://dx.doi.org/ 10.5772/intechopen.93806.

Shahzadi N, Muhammad I, Mohammad S, Abu SH and Muhammad W. (2013) Identification of pesticides residues in different samples of milk. J Agroalimentary Processes Technol. 19(2): 167-172.

Shaker EM and Elsharkawy EE. (2015) Organochlorine and organophosphorus pesticide residues in raw buffalo milk from agroindustrial areas in Assiut, Egypt. J Dairy Vet Anim Res. 2(5):172-177.

Silva LCC, Vanerli B, Ronaldo T, and Daisy PN. (2014) Milk contamination by organophosphorus and carbamate residues present in water and animal feedstuff. Semina Ciências Agrárias Londrina 35(5): 2485-2494.

Silva V, Mol HGJ, Zomer P, Tienstra M, Ritsema CJ and Geissen V. (2019) Pesticide residues in European agricultural soils – A hidden reality unfolded. Sci Total Environ. 653: 1532-1545.

Valeriya PK, Elena NE, Kseniya VK and Valentina AK. (2021) Pesticides: formulants, distribution pathways and effects on human health – a review. Toxicol Rep. 8: 1179-1192.

Waghulde PN, Khatik MK, Patil VT and Patil PR. (2011) Persistence and dissipation of pesticides in chilly and okra at north Maharashtra region. Pestic Res J. 23(1): 23-26.

Wanjiku Philip S, Madadi Odongo V, Wandiga SO, Omayio DG and Okumu MO. (2022) Estimation and human health risk assessment of organochlorine and organophosphate pesticide residues in raw milk collected in Kenya [version 1; peer review: 1 approved with reservations]. F1000Research 11:14.

Widyastuti Y and Andi F. (2021) Milk and different types of milk products. In: Advances in Food Science and Nutrition, (eds.) Visakh P. M., Laura B. Iturriaga and Pablo Daniel Ribotta, Scrivener Publishing LLC., pp. 49-68.

Zubaria I, Nazish I, Imran I, Abrar H and Muhammad, WS. (2017) Screening of organochlorine pesticide residues in milk collected from Sahiwal region. Int J Scientific Engineer Res. 8(2): 955-968.