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Chemical and Drug Use in Dairy Farms of Hawassa Town, Southern Ethiopia

Haben Fesseha, MVSc, DVM*; Saliman Aliye, MVSc, DVM; Temesgen Kifle MVSc, DVM; Mesfin Mathewos, MVSc, DVM

School of Veterinary Medicine, Wolaita Sodo University, P. O. Box 138, Wolaita Sodo, Ethiopia

****Corresponding author***
Haben Fesseha, MVSc, DVM
Assistant Professor, Department of Veterinary Surgery and Diagnostic Imaging, School of Veterinary Medicine, Wolaita Sodo University, P. O. Box 138, Wolaita Sodo, Ethiopia; Tel. +251910737790; E-mail: tseyon.h@gmail.com

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ABSTRACT

Aim

The current study was conducted to assess chemical and drug use in dairy farms of Hawassa town, Southern Ethiopia.

Methods and Materials

A total of 45 dairy farms were selected based on the willingness of the owner and the availability of information using a cross-sectional study from December 2017 to April 2018. Besides, data were collected through a questionnaire survey and close observation.

Results

Accordingly, based on observational assessment, most farms commonly used savlon (88.9%) iodine (60%) and detergent (20%) as antiseptics. Albendazole was the common anthelmintic by all dairy farms. Besides, Diazinon is used as acaricides (51.1%) and 57.8% of farms used sulfa drugs as an antiprotozoal agent. Similarly, all dairy farms in the study area used penicillin-streptomycin combination injection and ampicillin-cloxacillin combination for the treatment of mastitis. Based on a questionnaire assessment on 24 animal health assistants from different farms in of the study area, most (79.2%) did not remind owners to avoid the use or sale of animal products during withdrawal time. Out of the total, 27 (60%) of them offer or sell products to the public from animals treated with any of drugs without holding the withdrawal period of the drug.

Conclusion

The current study revealed that there was a high risk of drug and chemical residues in dairy products in the study area which can be a great threat to public health. Consequently, awareness creation through mass education, training and extension service should be promoted in the study area in order to ensure better chemical and drug use and minimize its public health hazards.

Keywords

Assessment; Chemicals; Dairy farms; Drugs; Milk.

INTRODUCTION

Human health is directly related to the environment and in particular the nature and quality of the food. Quality of food from animal products is widely concerning public health agencies around the world since veterinary drugs and chemicals have played an important role in the field of animal husbandry and agro-industry.[1-3] Even though human beings consume protein-rich foods mainly of animal origin, in several countries the safety of such food has been focused on avoiding the transmission of zoonotic diseases, but less attention has been paid to potentially present chemical residues. This may be due to the course of the resulting disease. Whilst infectious processes are frequently of the acute type, toxicosis caused by contaminants in foods (more than acute) may be chronic, silent and often lacking a known aetiological agent.[4]

An increasing occurrence of residues and awareness of consumers about a growing chemical usage of animal origin foods (milk and its products) present a challenge to the dairy industry.[5]

A great number of chemical compounds are used either directly or indirectly during the production, processing and storage of it.[6] Environmental pollution due to increased urbanization and industrialization in conjunction with an inappropriate use of veterinary drugs, on the other hand, may induce the presence of residues in food products which can pose a major threat to the public health and this matter is of greatest concern worldwide, as all these factors are causing contamination of food leading to adverse effect of contaminated residue on human health.[7]

The potential for human exposure to hazardous chemical pollutants through the consumption of animal origin foods is an issue wrought with scientific and emotional complexities. Animal origin foods are particularity susceptible to contamination with veterinary drugs, pesticides, heavy metals, aflatoxins, Polychlorinated Biphenyls (PCBs), Polychlorinated Dibenzodioxins and furans (PCDD/Fs), nitrate/nitrite/nitrosamines and detergents/disinfectants to a lesser or greater extent for several reasons. However, the major sources of exposure to hazardous chemical pollutants and environmental chemicals may contaminate animal feed and constitute a hazard not only to animal health but also to humans.[5]

Foods from animals may also be contaminated with naturally occurring toxic substances, including bacterial toxins (botulinum toxins, staphylococcal enterotoxins), mycotoxins (anatoxin and ochratoxin) and algal toxins (saxitoxin in shellfish).[8] All the antimicrobial drugs administered to cows can enter the milk to some degree this leads to an immediate contamination of the prospective food compartments. A drug administered to a milk-producing animal has a withdrawal period, during which the drug residue should fall below a predetermined/maximum permissible level. A residue can be the drug itself or its metabolites.[9-11] The dominating residues in most countries are β-lactam antibiotics and sulfa drugs, but others, tetracyclines, aminoglycosides, chloramphenicol also occur. A lot of hormones like, steroid anabolics and β-agonists which are being used illegally for growth promotion of animal.[12]

In many cases, the long-term effects of antibiotics on human health are not known, but they can, for example, provoke strong allergic reactions in a previously sensitized individual. Despite their generally non-toxic nature, β-lactams appear to be responsible for most of the reported human allergic reactions to antimicrobials. Aminoglycosides, sulfonamides, and tetracyclines may also cause allergic reactions. Certain macrolides may be responsible for liver injury caused by a specific allergic response to macrolide metabolite through modified hepatic cells. Anaphylactic reactions to penicillin and streptomycin residues have also been reported.[13,14]

Antibiotics can encourage the spread of antibiotic resistance in bacteria, making treatment of human infection more difficult. It has been documented that humans develop drug-resistant bacteria such as Salmonella, Campylobacter, and Staphylococcus from food of animal origin.[13,15] The resistance of microorganisms, arising from sub-therapeutic uses of penicillin, tetracyclines and sulfa drugs.[16] The widespread use of antimicrobials for animals has been paralleled by an increase in bacterial resistance in those animals. Resistant bacteria then spread among groups of animals through the spreading of manure or through contaminated foods to humans.[17,18]

Antibiotic residues in milk that is used to produce fermented products can interfere with the fermentation process by affecting the growth of desired lactic acid bacteria. Normally this is a technical problem resulting in financial loss, but, when it occurs, pathogens present in the milk may grow and pose a health hazards later.[19] The bacteria that usually live in the intestine acts as a barrier to prevent incoming pathogen from being established and causing diseases. Antibiotics may reduce the total number of bacteria or selectively kill some important species. The broad-spectrum antimicrobials may adversely affect a wide range of intestinal flora and consequently cause gastrointestinal disturbance.[18,20] For example, the use of drugs likes, flunixin, streptomycin,[21] and also the use of tylosin, vancomycin and nitroimidazole are known for this effect.[22]

The potential to cause toxicological harm (teratogenic, carcinogenic and mutagenic effects) to consumers is one characteristic in common for all chemical contaminants.[23] Chemical contaminants in milk and dairy products may known to be contributory factors in several diseases such as cancer, heart disease, Alzheimer's and Parkinsonism.[1,3] The general types of compounds which have been or possibly found in milk are chlorinated pesticides, organophosphates, herbicides, fungicides, anthelminthic drugs, antibiotics and sulfonamides drugs, detergents and disinfectants, poly chlorinated dibenzodioxins (PCBs), poly brominated biphenyles (PBBs), dioxins, mycotoxins, heavy metals and somatotropin hormone. Any of these compounds may persist at the collection, preparation processes of dairy products and they considered residues.[3]

Therefore, the objectives of this study were to assess commonly used chemicals and drugs in selected dairy farms from the study area and to assess the awareness level of producers about the drug withdrawal period and use of milk and milk products during the withdrawal period.

MATERIALS AND METHODS

Study Areas

The current study was conducted from December 2017 to April 2018 in selected dairy cattle farms of Hawassa towns. It is located 275 km south of Addis Ababa. Hawassa is situated at an altitude of 1750 m above sea level and according to an estimate, it lies between 6°83' to 7°17' N and 38°24' to 38°72' E. Hawassa receives an average annual rainfall of 955 mm with mean annual temperature of 20 °C and the city has a total area of about 50 km^2 divided into eight sub-cities and 32 kebeles (kebeles are the smallest administrative unit below the sub-city/woreda level).[24]

Study Methodology

This cross-sectional study was conducted by collecting data through a structured questionnaire format by interviewing farm owners, attendants and managers of dairy processing plants. Close observations were made to farms and animal feed during visits.

The questionnaire was with a target of assessing the chemicals and drugs used for biosecurity and treatment in farms and the awareness level of the farmers about drug withdrawal period, chemical and drug residues. The chemicals included in this study were insecticides, rodenticides, feed additive/supplemental treating chemicals, disinfectants and antiseptics, antimicrobials and other chemicals. The commonly used antibiotics, anthelmintics and antiprotozoal drugs were also considered. Similarly, during the visit of the processing plants and farms, keen observation was made to their sites, presence of nearby industries, way of waste disposal, feed and chemical stores and storages, and other possible conditions that were thought to be the risk of chemical contamination. Accordingly, a total of 45 dairy farms were selected based on the interest in giving a response to the interview. For the questionnaire interview, 45 owners were interviewed to asses the knowledge regarding the utilization of chemicals and drugs in their farms.

Data Management and Statistical Analysis

The collected data were coded and entered into Microsoft Excel 2016 Spread Sheet. Descriptive analysis and Chi-square tests were done using STATA version 13. The significance level was set at a *p*-value of less than 0.05.

Ethical Considerations

Ethical clearance and approval was obtained to conduct the research from the Institutional Review Board (IRB).

RESULTS

Proportion of Chemicals and Drugs Used in Dairy Farms

Out of 45 dairy farms, the majority of dairy farms did not use chemicals in their farms; however, detergents (20%), hydrogen peroxide (13.3%) and Sodium hypochlorite (11.1%) were used commonly in farms. Moreover, 23 (51.1%) of the dairy farms were utilized diazinon as an acaricide whereas 8.9% of farm was used Malathion beside diazinon. Only 8 (17.8%) of the dairy farms were used the sole rodenticide, zinc phosphide, to kill rodents like rats and mice. The most commonly used antiseptics were savlon, which was used by 40 (88.9%) farms; then followed by iodine and alcohol 27 (60%) and 26 (57.8%) of farms respectively. Even though 15 (33.3%) of the dairy farms did not use any antiprotozoal agents, 26 (57.8%) of the dairy farms sulfa drugs were used in and 4 (8.9%) were used diaminazine aceturate.

The assessment revealed that dairy farms use different anthelmintic drugs, albendazole was used in all studied dairy farms. Ivermectin, oxyclozanide and tetramisole were used by 34 (75.6%), 17 (37.8%) and 16 (35.6%) farms respectively. The assessment done on the study areas revealed that dairy farms use different antibacterial drugs. Among these, penicillin-streptomycin combination (penstrep) injection, oxytetracycline injection and ampicillin cloxacillin combination (intramammary infusion) are the most frequently used (Table 1).

Table 1. *Proportions of Different Drugs and/or Chemicals Used in Dairy Farms*

Name of Chemical and/or Drug Used	Number of Farm	Percentage (%)
Antibacterial Agents		
Alamacine	6	13.3
Ampicillin-cloxacillin combination	45	100
Oxytetracycline	41	91.1
Penstrep	45	100
Sulfa drugs	28	62.2
Antiprotozoal Agents		
Diaminazine aceturate	4	8.9
Sulfa drugs	26	57.8
Anthelmintic Agents		
Albendazole	45	100
Ivermectin	34	75.6
Oxyclozanide	17	37.8
Tetramisole	16	35.6
Acaricides		
Diazinon	23	51.1
Malathion	4	8.9
Rodenticides		
Zink phosphide	8	17.8
Antiseptics		
Denatured alcohol	26	57.8
Iodine tincture	27	60
Savlon	40	88.9
Disinfectants		
Detergent	9	20
Hydrogen peroxide	6	13.3
Sodium hypochlorite	5	11.1

Perception of Owners' Regarding Chemical/Drug Residue on Animal Products

According to this study, out of total, most farm owners (46.7%) preferred veterinary doctors and above professionals for the health care of their animals and 20 (95.2%) of them were told about the drug withdrawal period. Out of 24 farms that preferred animal health assistants 19 (79.2 %) of them were not told to avoid the use and/or sell of the dairy products during the withdrawal period. There is a significant difference ($p<0.05$) between informed and non-informed farms about the drug withdrawal period in selling the product to the public within the withdrawal period (Table 2).

From all studied dairy farms, 27 (60%) of them sold animal products while their animals were in treatment and 36 (80%) of farms were sold their products after the end of treatment but before the withdrawal period. In the use or sale of animal products while their animals were in treatment there is a significant difference ($p<0.05$) between farm preferences among veterinarians and assistant veterinarians. 30 (66.7%) of dairy farms are aware of drug and chemical residue. There is also a significant difference in using the product of animals under withdrawal time ($p=0.022$) between

Table 2. *Role of Awareness of Farm and Animal Health Workers on the Sold Products During Drug Withdrawal Period*

Sold (offered) Product to the Public							
Variable	Proportions	During Treatment			End of Rx to End of WDP		
		No (%) of farms	X^2	*p*-value	No (%) of farms	X^2	*p*-value
Who treats your animal							
VET	21(46.7)	5(23.8%)	21.488	0.000	16(76.2)	3.874	0.144
AHA	24(53.3)	22(91.7%)			23(95.85%)		
Did he/she told you not to use							
Yes	25(55.6%)	4(23.5%)	17.269	0.000	12(70.6%)	6.254	0.04
No	20(44.4%)	23(82.1%)			27(96.4%)		
Awareness about drug withdrawal times							
Aware	30(66.7%)	14(46.7)	7.667	0.022	26(86.7)	0.600	0.741
Non aware	15(33.3%)	13(86.7%)			13(86.79)		

Rx- Treatment, WDP- Withdrawal period, VET- Veterinarian, AHA- Animal health assistant

Table 3. *Comparison of Products Used or Sold to the Public in Different Types of Production System and Location of Farms During Drug Withdrawal Period*

Product Usage (sell) to Public							
Variable	Proportions	During Treatment			From the End of Rx to End of WDP		
		No (%) of farms	X^2	*p*-value	No (%) of farms	X^2	*p*-value
Type of production system							
Intensive	25(55.6%)	11(55%)	4.375	0.112	15(75%)	0.600	0.741
SI	20(44.4%)	16(64%)			24(96%)		
Location of the farm							
Urban	26(57.8%)	16(61.5)	0.061	0.970	24(92.3%)	2.242	0.326
PU	19(42.2%)	11(57.9)			15(78.9)		

Rx: Treatment, WDP: Withdrawal period, SI: Semi-intensive, PU: Peri-urban

aware and non-aware farms on the presence of drug withdrawal time (Table 2).

Animal Product Sold or Offered to the Public During a Drug Withdrawal Period

Twenty-five (55.6%) of the dairy farms are under intensive production systems and 20 (44.4%) semi-intensive. All intensive farms were offered or sell milk for public use during treatment and 16 (64%) from semi-intensive farms were offer milk for public use during treatment. There is no significant difference ($p>0.05$) between intensive and semi-intensive farms by offering milk for public use. Twenty-six (57.8%) of the total dairy farms located in urban areas and 19 (42.2%) were found in peri-urban areas. There is no significant difference ($p>0.05$) between urban and peri-urban located farms in selling or offering milk for public use (Table 3).

DISCUSSION

In this study, most dairy farms were not used chemical disinfectants and this result may show that the probability of occurrence of residues from chemicals used as disinfectants is low except for detergent which was used by some farms. Among the common acaricides, diazinon had the highest probability to be as a chemical residue in milk since it was used by 23 (51.1%) farms if appropriate milk discarding times are not followed after diazinon spray while the probability of malathion is less since it was used only by 4 (8.9%) of farms. The possibility of the occurrence of rodenticides residue might be low because only 8 (17.8%) farms use zinc phosphide to kill rats. Entirely all dairy farms use one or more chemicals that serve as antiseptic. Among the antiseptics, the highest probability to be residue in milk was savlon which used in 40 (88.9%) farms. Besides savlon, iodine also had the possibility to occur as residue in milk since it was used in 27 (60%) farms for teat dipping. The common antiprotozoal drug that was used by 26 (57.8%) dairy farms was sulfonamides and 4 (8.9%) were used diaminazine aceturate. Fifteen (33.3%) farms were not used any antiprotozoal drugs and also the use of other antiprotozoal drugs for blood parasites is low. This may be due to the low prevalence of blood parasites in central Ethiopia.[25]

In the present study, all assessed dairy farms used three or more antibacterial drugs. The most commonly used antibacterial was penicillin-streptomycin combination (penstrep) injection which is used in all dairy farms for treatment of septicemia diseases. There is a high prevalence of clinical and subclinical mastitis in central Ethiopia[26] and to treat them Ampicillin cloxacillin combination intramammary infusion were used in all studied dairy farms. This shows that the possible occurrence of residues of penicillin, streptomycin, cloxacillin and ampicillin and their degraded metabolites is far more common than other antibacterial drugs which agree with Modi et al[5] who stated that the dominating residues in most countries are β-lactam antibiotics and sulfa drugs if appropriate milk discard and strict refusal of milk processing plants and customers to buy such milk is not done. Oxytetracycline injection is used in 41 (91.1%) farms and its possible occurrence in residue form in milk should not be neglected, which agrees with Smith et al[27] who stated that the tetracyclines are the most widely used antimicrobials in the dairy industry. This is largely due to a wide margin of safety, affordability and broad-spectrum. Besides their antiprotozoal effect sulfa drugs are also used to treat bacterial infection and used in 28 (62.2%) farms as antibacterial agents. There is a possibility of residue for these drugs as investigated by Darwish et al[17] due to failure in observing the withdrawal periods drug, extra-label dosages for animals and contamination of animal feed with the excreta of treated animals.

Different antiparasitic drugs were used by studied dairy farms; the most commonly used were anthelmintic. Among anthelmintic albendazole was used in all farms. This may be due to relatively available at low price and commonly known by dairy farmers. The probability of getting milk containing albendazole and its metabolite residue is far more common than other anthelmintics. This is in agreement with[6,28] who stated that albendazole is a widely used benzimidazole anthelmintic and rapidly transform to various metabolites, the major metabolites being albendazole sulfoxide, albendazole sulfone, and albendazole 2-amino sulfone. These metabolites can account for all residues found in milk and dairy products at any time point that are both bioavailable and of toxicological significance.

Despite its contraindication ivermectin is used in 34 (75.8%) of farms and the probability of getting ivermectin residue from milk can be more probable than any other anthelmintic which is in agreement with the study of Beyene et al[13] because of its long withdrawal time and its whole secretion with milk.

Eleven (55%) from intensive farms and 16 (64%) from semi-intensive farms were offered milk for public use during treatment. There is no significant difference ($p>0.05$) between intensive and semi-intensive farms by offering milk for public use. However, from the end of treatment to end of milk discard time the above figure was increased to 15 (75%) and 24 (96%) for intensive and semi-intensive farms respectively and there is no statistical difference ($p>0.05$) between them. This may be due to most customers and processing plants do not give focus after the end of treatment for the possibility of presence or absence of residue and producers also sell their milk.

Out of 45 farms assessed and surveyed, 21 (46.7%) of them prefer professionals that have Doctor of Veterinary Medicine (DVM) (Veterinary) and above to treat sick animals. Among these, 20 (95.2%) vets were informing the farm to discard dairy products during treatment and in the withdrawal period. Informing the withdrawal period of drugs is the responsibility of veterinarians.[29] Among 24 farms where animal health assistants treated sick animals, 19 (79.2%) of farms handled by animal health assistants were not informed to discard products from animals under treatment until the withdrawal period.

In the current study, there is a significance difference in using or selling of animal products during treatment between those farms which prefers animal health assistants to veterinarian ($p<0.05$). The farms handled by animal health assistants were using or selling animal products than farms under the supervision of veterinarians. This might be due to the lack of detail knowledge of drug ethics of animal health extension and food safety than veterinarians who offer appropriate information about drug withdrawal period to farms. This finding also agrees with the indication of Muhammad et al[30] that the prevention of drug residue in milk and milk products is majorly the duty of veterinarians.

In the present finding, selling the product to the public within the withdrawal period had a significant difference ($p<0.05$) between informed and non-informed farms about the drug withdrawal period by animal health workers. This is higher in non-informed farms this could be due to the failure of animal health professionals to inform the withdrawal period of the drug after treatment. In addition, there were also significant differences in using the product of animals during treatment ($p=0.022$) between aware and non-aware farms on the presence of drug withdrawal time which was higher in non-aware farms. This might be due to a lack of legal control and awareness in those farms. This shows that if awareness of those farms is increased and legal control is enacted the possibility of chemical residues in animal products that brought to public use can be minimized.

About 60.0% of farms sell their animal products (milk) while their animals were under treatment and the figure was increased to 80.0% from the end of treatment to the withdrawal period. This may be associated with the lack of clear information, awareness, and regulation on drug and chemical residues. This figure agrees with the finding of Darwish et al[17] stated that a clear lack of available information about antibiotic residues in animal-derived foods in Africa.

CONCLUSION AND RECOMMENDATIONS

The current study result which was conducted on an assessment of chemical and drug use in dairy farms in Hawassa town, Southern Ethiopia, showed different drugs include antibiotics, antiprotozoals and anthelmintics are being used in studied dairy farms. Using or selling milk or milk products during the drug withdrawal period can impose public health hazards which gained as residues in animal-derived foods. Different chemicals other than drugs are also being used for different purposes. So, there is a possibility these chemicals or their metabolites contaminate

milk and milk products that brought to the market for public use. This is due to lack of awareness in farms, failure of animal health professionals to determine and to inform withdrawal period after treatment, illegal action of dairy farmers in controlling chemical residue and its public health effects, and possibly due to lack of drug and chemical regulation on farms and prohibition of animal product during withdrawal period of drugs. Accordingly, awareness creation should be done among dairy producers about possible drug withdrawal, drug and/or chemical residues and their public health consequences. Routine laboratory investigation should be done to confirm the presence of drugs and/or chemicals in foods of animal origin (milk and its products). Comprehensive training should be for anima health workers on chemical and drug use and its residual effect on the public. Furthermore, collaborative work should be done between farms, processing plants, agricultural and health offices on control of drug and/or chemical residue and their public health consequences.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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