Seeking Agricultural Produce Free of Pesticide Residues

Proceedings of an International Workshop held in Yogyakarta, Indonesia, 17–19 February 1998

Editors: **I.R. Kennedy, J.H. Skerritt, G.I. Johnson, and E. Highley**

Sponsored by:

Agency for Agricultural Research and Development (AARD), Indonesia
Australian Agency for International Development (AusAID)
Australian Centre for International Agricultural Research (ACIAR)

Australian Centre for International Agricultural Research
Canberra 1998

Contamination of Animal Products by Pesticides and Antibiotics

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Abstract

Chemicals such as pesticides and antibiotics have been widely used in agriculture to improve product quality and output. However, over-use of those chemicals has caused contamination of animal products either directly or indirectly. While livestock is intentionally given antibiotics for disease treatment or for growth promotion, the exposure of pesticide to livestock usually comes from contaminated animal feed. Pesticide or antibiotic residues above the maximum residue limits are reported from a number of places in Indonesia. For food of animal origin, excessive antibiotic residues are reported more often than pesticide contamination.

NOWADAYS, the demand for high quality food has become as important as the food supply itself. Food quality includes not only highly acceptable organoleptic characteristics and nutritive value, but also the safety of the food. Food safety has been an important criterion of food quality of agricultural products, which includes freedom from chemical residues and contaminants such as antibiotics and pesticides. Pesticides, antibiotics, and other chemicals have been used intensively in agriculture to maximise production. In animal husbandry, antibiotics are used intentionally for disease treatment or growth promotion, while the exposure of animals to pesticides is mostly unintentional through contaminated feed (Sosromarsono 1977; Prescott and Baggot 1988).

In a developing country such as Indonesia, the effort to reduce the use of pesticides and antibiotics through biological control and integrated pest management has not yet had a significant impact. The amount of pesticides and antibiotics used in agriculture increases every year. The number of veterinary medicines registered in Indonesia increases every year. In 1991 there were 1281 registered veterinary medicines, while in 1993 this had increased to 1378. Similarly, the amount of antibiotics used increases every year: it was 27 592 kg in 1992, which increased to 29 525 kg in 1993 (Wiryosuhanto 1994). The number of pesticides registered and approved is also increasing every year (DEPTAN-RI 1997).

In the past few years there has been increasing concern over the extensive use of antibiotics in animal husbandry and their addition to animal feeds. Improper used of antibiotics in food-producing animals has resulted in the presence of antibiotic residues in animal products. Public concern on the hazards of pesticide contamination in food appeared earlier than concern about the hazards of antibiotic residues, probably because pesticides themselves are classified as toxic compounds, while antibiotics are not.

Human exposure to chemicals through food usually occurs at low doses; acute illness rarely occurs. However, continuous low-level exposure to chemical-contaminated food has been reported to cause cancer, allergies, hypersensitivity, and toxic effects. The most frequently reported allergic reactions was to β lactam antibiotic. It was reported that levels of penicillin as low as 5–10 IU are sufficient to produce an allergic reaction in sensitised humans (Paige et al.

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1997). Other antibiotics such as tetracyclines, aminoglycoside, and sulfonamide in a few cases may also cause allergic reactions in sensitised individuals. Prolonged used of antibiotics at low doses has led to antibiotic-resistant bacteria (Smith 1977; Bensink and Botham 1983). In 1968, the Swann Committee established by the British Government made a number of important recommendations on the use of antibiotics in animal husbandry and veterinary medicine. The recommendations were adopted and implemented by many other countries (Brander 1977; Bell 1986).

The degree of toxicity of pesticides to humans and other organisms differs considerably between each type of pesticide: a small amount of one pesticide might cause severe illness or even death, while larger quantities of another pesticide might have little or no effect, even if ingested. A pesticide might also have selective toxicity, causing death of one type of organism, but having little or no effect on other types of organisms (Hassall 1987). Some pesticides degrade quickly on the crop and in the soil, whereas others may persist in one form or another for longer periods. These persistent pesticides, which are mostly lipophilic, accumulate in animal fat and in particular tissues such as liver and kidneys, and the pesticide levels become higher than those in crops. Continuous consumption of either animal fat, liver, or kidney might caused serious health problems (Oudejans 1991).

Antibiotics in Food-producing Animals

In food-producing animals, antibiotics have therapeutic and non-therapeutic uses. Therapeutically, they are used for disease treatment and non-therapeutically as growth promoters. Ideally, the choice of antibiotic for disease treatment should be based on the identification and known sensitivity of the causal organism. However, in practice the treatment often does not wait for laboratory examination, as the aim is to return the acutely ill animals to optimal production as rapidly as possible. The infected animal might also spread the disease to other animals in the flock or herd. And, to achieve an effective therapeutic effect, antibiotics should be administered at a therapeutic dose rate (Bell 1986). Legally, antibiotics for disease treatment are available only on prescription, and only those antibiotics registered and approved are available in the market. However, antibiotics are easily obtainable without any prescription.

As growth promoters, antibiotics are usually added to feed at low concentrations, below therapeutic dose rate. Antibiotics added to the feed of the growing animal improve the growth rate and feed efficiency. The growth response of animals to antibiotics is a complex interaction of nutritional, physiological, and disease factors. It varies with animal species, age, the feed environment, and other factors. The growth-promoting properties of antibiotics have led to improper use of antibiotics. Farmers have been using any antibiotics available in the market, with no consideration for the hazards of those antibiotics to the animals or to the consumers of animal products.

When antibiotics are administered to food-producing animals, the appropriate withholding period should be observed before the animal products are consumed. Withholding time is the time taken for the concentration of a drug to fall below the acceptable level after the last dose has been administered. The withholding time for drugs given to farm animals affects the presence of residues of the particular drug in the animal products. Thus, it is expected that no residue will be detected or the residue will be below the recommended maximum residue limit (MRL) if the animal products are consumed after the withholding period. The withholding time is influenced by a number of factors, such as the dose rate, the dosage form of the drug, the route of the administration, the physical and chemical properties of the drug and the patho-physiological status of the animal (Baggot 1977; Debackere 1990). Table 1 lists the recommended use and withholding periods for antibiotics approved for use in food-producing animals in Indonesia.

Antibiotics added to animal feed have increased the exposure of animals to the antibiotics, as animals would be exposed to the antibiotics for their life time. Treatment with antibiotics should be terminated a few days before the animals are killed. In animals producing egg and milk, the products should not be consumed while the animals were on medication. In practice, for economic reasons, farmers have been selling all products, even those from animals which are under medication. Reports from Australia, the USA, and Indonesia indicated that most likely the appearance of antibiotic residues in animal products is the result of failure to observe withholding times (Herrick 1993; Spence 1993; Kusumaningsih 1996).

Like those antibiotics for medication, only antibiotics registered and approved as feed additive are allowed to be marketed for that purpose. Table 2 lists

Table 1. Recommended usage and withholding period for antibiotics registered for food-producing animals in Indonesia

Antibiotic	Form	Animal species	Withholding period (days)
Ampicillin	injectable	poultry	5
	injectable	cattle	6
Amprolium	oral	cattle	1
Dihydrostreptomycin	injectable	cattle	30
	injectable	pigs	30
Streptomycin	oral	poultry	4
	oral	cattle	2
Furazolidone	oral	poultry	5
	oral	pigs	5
Nitrofurazon	oral	poultry	5
	oral	pigs	5
Carbadox	oral	pigs	70
Chlortetracycline	injectable	poultry	15
Oxytetracycline	injectable	poultry	15
Tetracycline	injectable	poultry	15
	oral	cattle	5
Penicillin G	injectable	cattle	5
	injectable	poultry	5
Penicillin + streptomycin	injectable	cattle	30
	injectable	pigs	30
Erythromycin	injectable	pigs	7
	injectable	cattle	14
Sulfonamides	oral	cattle	7–15
Monensin	oral	poultry	3
Tylosine	oral	pigs	2

compounds approved as feed additives, classified as either non antibiotic and antibiotics (Anon. 1994). Attempts to minimise production costs, have led farmers to use the cheapest antibiotics available on the market. For example, chloramphenicol is used despite the fact that it is banned for use in food-producing animals. Exposure to even small quantities of chloramphenicol may result in fatal aplastic anaemia in such animals. Nevertheless, chloramphenicol remains the drug of choice for treating certain diseases, especially typhoid, where the advantages appear to outweigh the potential risk (Bell 1986).

Pesticides in Food-producing Animals

Farm animals are usually exposed to pesticides unintentionally through contaminated animal feed, or a contaminated environment in which the animals were raised. Pesticide contamination of animals products due to direct application of pesticides to the animals for disease treatment is very rare. Ticks, flies, and scabies are the common animal disease usually treated with pesticides. However, in Indonesia, the use of pesticides to control livestock diseases is not common (Sosromarsono et al. 1977).

In Indonesia, as in most other countries, pesticides are more extensively used in crop production than in other areas of agriculture. The intensification program for crop production has brought an increased use of pesticides. Furthermore, efforts to reduce production cost in crop farming have caused more intensive use of pesticides. As a result crop products have been contaminated and some of these products then used as animal feed ingredients. The use of pesticides in stored products is another possible sources of crop contamination with pesticides. A report from the Diagnostic Laboratory of Balitvet supports this argument (Table 3). Feed factories or individual farms sent samples for pesticides analysis only if contamination was suspected (Indraningsih and Yuningsih 1995).

When pesticides are deliberately added to stored crops, the chance of pesticide residues being present is higher than the use of pesticides during the growth of the crops. In addition to the type of application, the type of pesticides applied would also affect the presence of residues in the crop products. A great many types of pesticides are available, each type having different physical and chemical properties. Some pesticides are quite persistent, while others degrade rapidly. Farmers lacking education and knowledge, especially in developing countries, invariably choose the cheapest available pesticide rather than the safest ones. About half of the poisoning cases and nearly three quarters of the human deaths due to pesticides are estimated to occur in developing countries, although they use only 20% of the total world pesticides (Oudejans 1991).

Table 2. Compounds approved for use as feed additives for food-producing animals in Indonesia.

Non antibiotics	Antibiotics
Aklomide	Zinc bacitracin
Amprolium	Virginiamycin
Buthinorate	Flavomycin
Clopidol	Hygromycin
Dequinate	Monensin
Ethopabate	Salinomycin
Levamisole	Spiramycin
Piperazine	Kitasamycin
Tetramisole	Tylosin
Robenidin	Lasalocid
Roxarsone	Avilamycin
Sulfachlorpyridazine	Avoparcin
Sulfadimethoxine	Envamycin
Sulfanitrane	Colistine
Sulfaquinoxaline	Lincomycin
Buquinolate	Maduramycin
Nitrofurasone	Narasin
Furasolidone	Natacyn
Phenothiazine	
Halquinol	
Pirantel tartarte	
Olaquindox	
Aluminum silicate	
Nitrovin	

Antibiotic and Pesticide Contamination

Animal products contaminated with antibiotics and pesticides have been reported not just from Indonesia, but also from developed countries (Spence 1993; Nakazawa 1995; Gibbons et al. 1996). This suggests that there is global concern on the health impact of chemical residues in food. Consumers are concerned more than ever before about the quality and safety of food products, including food of animal origin. Food safety concerns not only consumers, but also veterinarians, producers, processing facilities, and regulatory officials throughout the world (Riviere 1991; Stenholm and Waggoner 1992; Angulo 1996).

A study was conducted by the Food Safety and Inspection Service of the United States Department of Agriculture to describe patterns of chemical residue violations in beef in 12 states of the USA during 1991, 1992, and 1993. The total number of violations fell during the 3 years studied. However, the residues in beef from slaughtered dairy cows increased. In 1991, there were 3249 residues found in 2734 carcasses, in the second year 3132 violative residues were found in 2813 carcasses and, in 1993, there were 2317 violative residues were found in 2051 carcasses. Neomycin was the most frequently identified chemical residue, followed by tetracycline, gentamycin, oxytetracycline, and penicillin (Gibbons et al. 1996).

Balitvet (1990) found residues of oxytetracycline in 65 of 93 chicken meat samples, and 35 of the samples were contamined above the recommended MRL. Chicken meat was collected from slaughterhouses in West Java and the Jakarta area (Table 4). Analyses were carried out only for tetracycline and sulfonamide residues. Pesticide contamination of chicken meat was also reported from the same study. However, although contamination by pesticides was detected, there was no sample with a pesticide level above the MRL. Field studies of farms in West Java found that different types of antibiotics were heavily used on poultry farms (Murdiati and Bahri 1991). Tetracycline residues and sulfonamides were also reported in chicken meat sold in the market in Bali and Kalimantan (Dewi et al 1996; Anon.1996).

While antibiotic tetracyclines have been widely used in poultry farming, β lactams are the antibiotics most widely used in dairy farming in Indonesia. Penicillin residues were detected in fresh milk collected from farmers and milk men in West Java, and in pasteurised milk from the supermarkets. Residues of penicillin were detected in 43% of 31 pasteurised milk samples, while 24% of 416 and 35% of 128 samples residues were detected in fresh milk collected from farmers and milk men, respectively (Sudarwanto 1990). Antibiotic residues were detected in 27 of 120 milk samples collected from dairy farms in Jakarta, 5 samples were positive for penicillin, 6 for tetracyclines, 9 for aminoglycosides, and 7 for macrolides (Lastari and Murad 1995).

Organochlorine pesticide residues were reported in domestic bird eggs obtained from Bogor markets and also from wild bird eggs taken from nest sites on Seribu Island (Indraningsih et al. 1988). The domestic bird eggs included eggs of local chickens, eggs of improved chickens, duck eggs, and quail eggs. The improved chicken eggs had lower levels of pesticides residues than eggs from other species, suggesting that free-ranging birds had access to pesticide contamination, as improved chickens were raised in intensive confined farming. Although the residue levels were below the MRL, the observations indicated that environmental pesticide contamination has occurred in Indonesia. Later reports on the pesticide residues in bird eggs found both organochlorine and organophosphate in more than 50% of 90 samples, with a diazinon level above the MRL in 1 of 30 duck eggs, and 5 of 30 either local chicken eggs or improved chicken eggs (Balitvet 1995).

Conclusions

Agricultural industry, including livestock production depends on drugs and other chemicals to control disease and to improve animal performance. In some cases, this dependence has caused violative residues

Table 3. Pesticides residues in animal feeds and feed ingredients received by the Diagnostic Laboratory Balitvet in 1984–1995

Pesticides	Animal feed (*n* = 31)		Feed ingredients (*n* = 15)	
	Number of positive samples	Range of concentration (μg/g)	Number of positive samples	Range of concentration (μg/g)
Diazinon	11	0.018–0.47	3	0.015–0.12
Malathion	4	0.105–0.99	–	–
Fention	–	–	2	0.69–0.85
Endosulfan	6	0.100–2.50	2	0.66–1.00
Lindane	-	–	2	0.05–0.56
Heptachlor	-	–	2	2.30–4.55
Metoxychlor	1	5.00	–	–

Table 4. Antibiotics and pesticide residues detected in chicken meat collected from slaughterhouses in West Java and Jakarta

Sample	*n*	Residues	Positive samples		Samples above MRL	
			n	%	*n*	%
Chicken meat	93	Oxytetracycline	65	70	35	37
		Chlortetracycline	28	30	15	16
		Tetracycline	–		–	
Chicken meat	61	Lindane	38	62	–	
		Aldrin	18	29	–	
		Endosulfan	15	25	–	
		DDT	20	33	–	
		Dursban	6	10	–	
		Diazinon	3	5	–	
		Heptachlor	37	61	–	

in animal products, especially if the chemicals were used improperly.

Antibiotic residues were detected more often than pesticide residues, since animals are deliberately exposed to antibiotics, while the exposure to pesticides is usually unintentional through a contaminated environment.

Public concerns are continuously growing on the pesticides and antibiotics contamination of animal products, and other aspects of food safety of animal origin.

Consideration of food safety and quality must start at the farm and receive attention at all stages in the food chain of animal products. All segments of the food industry, the regulatory officers, and the scientific communities have attempted to reduce the potential problem of food safety.

The hazard analysis critical control point (HACCP) approach has been a promising concept for controlling contamination of food.

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