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Microbial Investigation of Animal Product Hygiene in Bali and Nusa Tenggara of Indonesia

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ABSTRACT

Products of animal origin, namely meat, eggs, and milk, must have good value and quality for human benefit and must be monitored regularly. The present study aimed to review the epidemiological mapping of the level of microbial contamination based on surveillance data in the Provinces of Bali and Nusa Tenggara. During 2017, a total of 1875 samples were collected from targeted places that did not have a veterinary control number (VCN) such as slaughterhouses, traditional markets, retail shops and meat supply companies (importers), then brought to the Disease Investigation Center (DIC) Denpasar for analysis. Microbial contamination was tested using the total plate count (TPC) method, according to laboratory procedures for DIC Denpasar. The test results showed that 56.9% of the samples contained germs that exceeded the maximum microbial contamination limit (MMCL) stipulated in SNI 7388: 2009, namely $1x10^6$ colonies/g. The contaminant germs were dominated by *E. coli* (73.8%). There was a highly significant ($P<0.001$) difference in the number of *E. coli* that exceeded the maximum limit microbial contamination (MLMC) values detected between the three provinces, the four types of samples tested, and the type of slaughterhouses/markets. However, all samples tested did not contain pathogenic bacteria such as *Staphylococcus aureus*, *Salmonella spp.*, and *Campylobacter spp*. This data suggested that the hygiene level of animal products in the region was low which can threaten the health of consumers.

Key words: Animal products, Food-borne diseases, Bacterial contamination, Veterinary control.

INTRODUCTION

Microbial contamination in food of animal origin is one of the major concerns in public health associated with pathogenic microorganism contamination (Tesson et al. 2020; Tropea 2022). It was reported by the World Health Organization (WHO) in 2010 that globally more than 580 million people got sick with a mortality of 351,000 due to enteric pathogens that have also been widely reported by others (Lappan et al. 2021; Pakbin et al. 2021; Ginn et al. 2022; Saima et al. 2023). Ideally, food of animal origin, especially meat, milk, and eggs and their processed products, must be healthy and safe (Kiro 2021; Mengistu et al. 2022; WOAH, 2022). However, there are still threats that reduce the quality of animal food, due to high levels of microbial contamination that have been reported widely (Chmielowiec-Korzeniowska et al. 2021; Klaharn et al. 2022; Dias et al. 2023; Nhantumbo et al. 2023). The main pathogenic bacteria in regard with food safety and hygiene are *S. argenteus*, *Clostridium*, *E. coli*, *Salmonella*, and *Staphylococcus* that are still being reported in some developing countries (Khare et al. 2018; Karisma et al. 2021; Tran et al. 2021; Mengistu et al. 2022). Taken together, unhygienic practices in handling food and a lack of knowledge on sanitation are considered to be the main factors in foodborne diseases that can occur at any stage of food processing (Saeed et al. 2021; Klaharn et al. 2022; Negassa et al. 2022; Tropea 2022; Lu et al. 2023). Therefore, to make animal origin food products safer for consumption, it should not contain ingredients that can harm the health of consumers, so apart from the quantity, the quality must also be guaranteed. In Indonesia, this condition is mandated by law # 7 of 1996, that food safety must be endeavored so that it does not contain biological,

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or chemical contaminants and other objects that can harm and threaten or endanger human health (Anonymous 1996).

In the current livestock farming system, the use of chemicals, especially veterinary drugs, tends to increase and lacks rehabilitation in their use practices and is difficult to avoid to maintain animal/livestock health (Kimera et al. 2020; Tiseo et al. 2020; Arsène et al. 2022). In addition to disease prevention and treatment, veterinary drugs are also used as feed additives for growth promoters (Kimera et al. 2020; Pokharel et al. 2020). Excessive and relatively uncontrolled use of antibiotics and growth promoters tends to result in the formation of antibiotic residues in animal products and even more dangerous associated with the rise and spread of antimicrobial resistance (AMR) (Arsène et al. 2022; Naeem et al. 2023; Berman et al. 2023; Pratiwi et al. 2023). The presence of these antibiotic residues in food of animal origin are unsafe for consumption as these can cause resistance, allergic reactions or physiological disturbances in both animals and humans who consume them (Kyuchukova 2020; Arsène et al. 2022; Mulchandani et al. 2023). The use of extensive antibiotics tends to cause AMR that is now considered as one of the most serious threats to human health (Betelhem et al. 2022; Biondo 2023; Tang et al. 2023). This fact requires efforts to prevent and reduce risks that can endanger the safety of human life and the inner peace of society, including halal, and encourage business sectors and the public to produce animal products that meet the safety and quality requirements of the animal products produced. For this reason, according to the mandate of Law # 7 of 1996, supervision must be carried out by the relevant government before the animal product is imported/distributed domestically from and/or exported abroad. For these reasons, the aim of this work was to investigate the status of animal product hygiene in the Provinces of Bali and Nusa Tenggara.

MATERIALS AND METHODS

Ethical Statement

We did not use any living creatures as samples in this study.

Materials

We tested 1835 samples comprising 725 fresh meat (beef, pork, chicken), 198 liver (beef and pork), 178 processed meat chicken sausages, 40 fresh milk, 664 fresh eggs (chicken, duck, quail) and 30 salted duck eggs, as presented in Table 1. All samples were taken based on the food safety key indicators approach that had relatively low hygiene level such as slaughterhouses, traditional markets/retailers. The samples were collected from targeted locations in the provinces of Bali and Nusa Tenggara and brought to the Animal Diseases Investigation Center (ADIC) Denpasar for analysis. A number of specific reagents were required as showed on Table 2, to test various bacterial contaminants and also to increase the efficiency in the plate counting techniques.

Methods

Sampling was determined based on risk analysis which has a fairly high risk in districts/cities where slaughterhouse, market/retail and business units were available. In Bali, samples were taken in four regencies/cities namely Badung, Tabanan Buleleng and Denpasar. Meanwhile, in West Nusa Tenggara samples were collected in two Cities of Mataram and Bima, and in Eastern Nusa Tenggara it was carried out in 2 regencies/cities of Sikka and Kupang. The fresh meat samples were taken at regional and traditional slaughterhouses, and traditional markets while samples of eggs, milk and processed meat were taken at traditional and retail markets (retailers). Sampling was carried out using a purposive method, by selecting predetermined locations based on the existence of slaughterhouses, modified markets, and stalls (meat, processed meat, milk, eggs). The method for sample collection was done based on a simple random sampling by calculating the minimum number of (n) samples according to the formula of Lemeshow (in Riduan and Akdon, 2010):

$$n = \frac{[Z\alpha/2]^2 xPxQ}{L^2}$$

Description: n = Number of samples; Z = Normal standard value (standard); P = proportion = prevalence; Q = Probability of no contamination; L = Degree of accuracy; α = confidence level. In this case the P value (prevalence) was 34% (TPC prevalence in 2014), α was 5%, with degree of accuracy (L) was 5%. Calculation: n = [2]2x0.34x(1-0.34) = 35.9 round 36. To improve accuracy, the sample size is calculated as 36x3 = 108 (Martin et al. 1987). All samples were taken aseptically, stored, and transported at cold temperatures, while the egg samples were placed in egg containers. In addition to primary (meat) samples, secondary samples were also taken, including water samples at slaughterhouses, knife swabs, tables (meat mats) and scales at traditional markets.

The current study targeted the bacterial contamination that commonly pathogenic bacteria found in animal freshly products such as *E. coli*, *S. aureus*, *Salmonella spp*, and *Campylobacter spp*. as mandated by the law of the Republic of Indonesia # 7 of 1996 concerning safety food of animal product must meet the requirements of safe, healthy, whole, and halal (ASUH). The targeted bacterial contamination were tested using laboratory procedures for DIC Denpasar (Anonymus, 2008). Briefly, 25g of each sample was put in a sterile container and mixed with 225mL of 0.1% buffered phosphate water, homogenized for 1-2min, then serially diluted in multiples of 10. One mL each of these dilutions was poured into a sterile petri dish containing 15mL of plate count agar, incubated at 35°C for 24-48hr. Growing colonies were counted as TPC. The *E.*

Table 1: Types and number of each sample tested for microbial contamination

Type of sample	Total
Beef	237
Pork	148
Chicken meat	340
Beef liver	161
Pork liver	37
Processed meat	178
Fresh milk	40
Chicken eggs	560
Salted duck eggs	30
Duck egg	9
Quail eggs	95
Total	1835

Table 2: Type of pathogenic bacteria be tested as mandated by law # 7 of 1996, and reagents to be used

Type of bacteria	Reagents required
Salmonella spp.	0.1% plate count agar (PCA). Lactose broth, tetra thionate broth, bismuth sulfite agar, xylose lysine deoxycholate agar, hektoene enteric agar, triple sugar iron agar, lysine iron agar
E. coli	Lauryl sulfate tryptose broth (LSTB), brilliant green lactose bile broth, *Escherichia coli* (EC) broth, Levine's eosin methylene blue (L-EMB) agar, plate count agar, MR-VP broth, Koser' citrate broth, tryptone broth, Kovac's reagent, gram stain reagent, methyl red indicator reagent, Voges Proskauer reagent
S. aureus and *Campylobacter spp.*	Baird parker agar, egg yolk tellurite emulsion, heart infusion broth, TSA, rabbit plasma coagulase with EDTA 0.1%, campylobacter enrichment broth, modified campy blood -free agar (MCBDA), peptone 0.1%.

Table 3: Results of the total plate count test of fresh and processed food (chicken sausages and salted eggs) samples from different location of sampling

Sample Origin	Sample Type	Total plate count (TPC) Test Results					
		Regional slaughterhouse		Traditional slaughterhouse		Markets/retail stores	
		Samples tested	>MLMC	Samples tested	>MLMC	Samples tested	>MLMC
Bali	Beef	17	6 (35)	0	0	17	15 (88)
	Pork	4	0 (0)	5	5 (100)	27	20 (74)
	Processed meet	0	0	0	0	42	10 (24)
	Total	21	6 (27)	5	5 (100)	86	45 (52)
Western Nusa Tenggara	Beef	10	9 (90)	0	0	30	22 (73)
	Processed meet	0	0	0	0	10	10 (100)
	Salted eggs	0	0	0	0	10	0
	Total	10	9 (90)	0	0	50	34 (68)
Eastern Nusa Tenggara	Beef	12	5 (42)	0	0	10	6 (60)
	Pork	5	5(100)	0	0	9	4 (44)
	Processed meet	0	0	0	0	10	5 (50)
	Total	17	10(59)	0	0	29	15 (52)
Grand Total		48	25(52)	5	5 (100)	165	94 (57)

Maximum limit for microbial contamination (MLMC) for TPC were $1x10^6$ colonies/g for fresh meat samples and $1x10^5$ colonies/g for processed meats (National Standard of Indonesia 7388-2009). Values in parenthesis are percentage.

Table 4: The result of *E. coli* contamination test of fresh meats taken from different locations of sampling

Sample Origin	Sample Type	*E. coli* Contamination					
		Regional slaughterhouse		Traditional slaughterhouse		Markets/retail stores	
		Samples tested	>MLMC	Samples tested	>MLMC	Samples tested	>MLMC
Bali	Beef	16	5 (31)	0	0	0	0
	Pork	4	0	5	5 (100)	21	17 (81)
	Processed meet	0	0	0	0	55	51 (93)
	Total	20	5 (25)	5	5 (100)	76	68 (89)
Western Nusa Tenggara	Beef	10	8 (80)	0	0	10	4 (40)
	Processed meet	0	0	5	5 (100)	25	18 (72)
	Salted eggs	10	8 (80)	5	5 (100)	35	22 (63)
	Total	12	8 (67)	0	0	0	0
Eastern Nusa Tenggara	Beef	5	5 (100)	0	0	9	5 (56)
	Pork	0	0	0	0	10	7 (70)
	Processed meet	17	13 (76)	0	0	19	12 (63)
	Total	47	26 (55)	10	10(100)	130	102 (78)

Maximum limit for microbial contamination (MLMC) for *E. coli* was $1x10^1$ colonies/g for fresh meat samples (National Standard of Indonesia 7388-2009). Values in parenthesis are percentage.

coli was also cultivated using the procedure using an EC broth in a Durham tube incubated at 45.5ºC for 24-48hr. For the detection of *Staphylococcus aureus*, *Salmonella spp.* and *Campylobacter spp.* we implemented specific culture condition for each of the bacteria tested following the DIC procedure. The Chi-Square Test was applied to know the difference between E. coli of various origins, various sample origination (Province), type of samples and type of Slaughterhouse where from samples were collected.

RESULTS

Total plate count (TPC) test results for pork and beef and chicken sausages originating from slaughterhouse, and markets/retails in Bali showed 52% of the tested samples contained microbial contamination exceeding the maximum limit of the National Standard of Indonesia (SNI) ($1x10^6$ colonies/g for fresh meat. All samples (100%) contained total microbial contaminations exceeding the maximum limit. While the fresh meats (beef and pork) and the chicken sausages obtained from the market/retail, 57% sample contained total germs exceeding the maximum of microbial contamination (Table 3).

E. coli contamination showed that samples of fresh meats (beef, pork and chicken) obtained regional slaughterhouse, traditional slaughterhouse, and market/retails had contamination of 55, 100, and 78%, respectively. Surprisingly, data described in Table 4 showed that the level of contamination exceeded the maximum limit for *E. coli* contamination of $1x10^1$ colonies/g sample based on the SNI 7388-2009 standard. However, the total 72 animal products tested were found negative for *S. aureus* growth. Similarly, the test results for *Salmonella spp.* revealed that all of the 537 samples, 59 originated

Table 5: The result of *S. aureus* contamination test of processed meats and salted eggs prepared from different locations

Sample Origin	Sample Type	The test result of *S. aureus*			
		Business units		Markets/retails	
		Samples tested	>MLMC	Samples tested	>MLMC
Bali	Processed Meats	0	0	42	0
		0	0	42	0
Western Nusa Tenggara	Processed Meats	5	0	5	0
	Salted eggs	0	0	10	0
		5	0	15	0
Eastern Nusa Tenggara	Processed meats	0	0	10	0
		0	0	10	0
Total		10	0	67	0

Maximum limit for microbial contamination (MLMC) for *S. aureus* were $1x10^1$ colonies/g for salted eggs and $1x10^2$ colonies/g processed meats (National Standard of Indonesia 7388-2009). None of the tested sample showed any *S. aureus* growth.

Table 6: The result of *Salmonella spp.* contamination test of samples collected from different locations

Sample origins	Type of samples	Test result for *Salmonella sp*			
		Regional and Traditional slaughterhouse		Markets/Retail	
		Samples tested	>MLMC	Samples tested	>MLMC
Bali	Beef	16	0	20	0
	Pork	9	0	26	0
	Chicken	0	0	55	0
	Chicken eggs	0	0	98	0
	Duck eggs	0	0	5	0
	Quail eggs	0	0	2	0
	Total	25	0	206	0
Western Nusa Tenggara	Beef	10	0	30	0
	Chicken	5	0	25	0
	Chicken eggs	0	0	80	0
	Salted eggs	0	0	10	0
	Total	15	0	145	0
Western Nusa Tenggara	Beef	12	0	10	0
	Pork	5	0	9	0
	Chicken	2	0	8	0
	Chicken eggs	0	0	100	0
	Total	19	0	127	0
Grand Total		59	0	478	0

Maximum limit for microbial contamination (MLMC) for *Salmonella spp.* should be negative/25g for fresh meats, fresh eggs and salted eggs (National Standard of Indonesia 7388-2009). None of the tested sample showed any *Salmonella spp.* growth.

Table 7: Comparative test of the number of *E. coli* contamination

Parameter	Chi-Square value	df	P value
E. coli	54.257	1	0.001
Sample Origin (Province)	12.575	2	0.002
Type of samples	64.533	3	0.001
Type of Slaughterhouse	174.920	2	0.001

P value indicated significant difference at each parameter studied.

from slaughterhouse and 478 samples from markets/ retails, were also negative for *Salmonella spp.* contamination. The test results of *S. aureus* and *Salmonella spp* are demonstrated in Table 5 and Table 6 respectively. The Chi-Square analysis showed that the number of *E. coli* with values of >MLMC detected among the three provinces, within the four types of samples tested and the type of slaughterhouses/market was highly significant different ($P<0.001$), as illustrated in Table 7.

DISCUSSION

Detection of bacteria in animal products origins is critically important for food safety and environment sanitation. The microbial agents mainly coliform, i.e., *E. coli*, *S. aureus*, *Salmonella spp.*, *Campylobacter spp.* and *Listeria monocytogenes* are microbes that potentially contaminate foods, and pose public health threat (Osafo et al. 2022; Rafiq et al. 2022; Gume et al. 2023). The present study was undertaken based on the law of the Republic of Indonesia # 7 of 1996 concerning food that food of animal products must meet the requirements of safe, healthy, wholesome, and halal (ASUH) for human consumption and the inner peace of the society. Here, however, only four commonly bacterial pathogens were prioritized to be investigated namely *E. coli*, *S. aureus*, *Salmonella spp*, and *Campylobacter spp*. These microbials have been frequently investigated by others as safety indicators associated with animal health and food borne pathogens (Cocco et al. 2023; Guyard-Nicodème et al. 2023). In the present study, bacteria were firstly propagated using a set of varied selected media (Balestra and Misaghi 1997).

The results showed that all fresh meat and chicken sausage samples had level of TPC values exceeding the MLMC of tolerated values for *E. coli* of $1x10^1$ colonies/g for fresh meat samples as per SNI 7388-2009 procedure. This condition happened in all locations of the study including regional slaughterhouses, traditional slaughterhouses, and market/retail with the proportion of 55.3, 100, and 78.4%, respectively (Table 3). When the colonies were further identified, it turned out that samples contained *E. coli* with TPC values 55, 100, and 78% for samples collected from Bali, Western Nusa Tenggara and Eastern Nusa Tenggara, respectively. The coincidence between the TPC values and the percentage of *E. coli* contamination suggested that the *E. coli* dominated of

almost 100% of the bacterial contamination in the tested samples.

Chi-Square analysis exhibited a highly significant ($P<0.001$) difference between the number of *E. coli* with <MLMC and >MLMC values, among the three provinces, within the four types of samples tested and the type of slaughterhouses/market retails. In short, the present data indicated that the level of hygiene and sanitation in some slaughterhouses and traditional market/retail was relatively insufficient to meet good hygienic conditions and sanitation standards. The high prevalence of *E. coli* in freshly animal products were also reported related to multi drug resistance (MDR) and it has been used as an important hygienic indicator for animal derived products as well as in junction with sanitation levels (Li et al. 2021; Akanbi et al. 2022; Tabaran et al. 2022; Dalal et al. 2023; Abebe et al. 2023). In the current study, we only found the high prevalence of *E. coli*, but the MDR testing was not conducted that the bacteria may possibly belongs to MDR bacteria.

Analysis of TPC demonstrated the number of microbes in a product, and also indicated the adequacy of sanitation and temperature control during the process of transportation and storage of foodstuffs and also determine when a food damage begins and to declare the source of contamination (Yunita et al. 2015). The number of microbes in meat can increase due to several factors including external contamination, microbial development, poor sanitation and hygiene (Ghangrekar and Das 2021; Karanth et al. 2023) and could be due infection during the initial handling process to final handling (Wardhana et al. 2021). It was reported by other workers from Indonesia that the results of TPC tests on food of animal origins, especially fresh meat taken from several slaughterhouse and traditional markets had relatively high microbial contamination, i.e., 52.1% of fresh meat from slaughterhouse, 100% of fresh meat samples from local slaughterhouse and 57% of fresh meat and processed meat from markets/retailers (Purwanti 2006). All the samples tested also had TPC exceeded MLMC values as amended by Indonesian National Standard (SNI) 7388: 2009 i.e., $1x10^6$ colonies/g for fresh meat and $1x10^5$ colonies/g for processed meat. The current data suggested that the sanitation/hygiene levels of location that provides animal product has been very poor that could cause more threatening to health due to the presence of antibiotic-resistant bacteria.

There are several strains of *E. coli* which are pathogenic and even non-pathogenic also. The pathogenic strains can cause severe diarrhea in all age groups through the endotoxins they produced. *E. coli* strains cause lysis of red blood cells. Toxins from these bacteria are absorbed in endothelial cells where there are many toxin receptors (Feuerstein et al. 2022; Pokharel et al. 2023), thus can lead to hemolytic uremic syndrome or may leads to neurological symptoms (Nasir et al. 2019; Mansour et al. 2023). For this reason, it is generally recommended to cook meat at temperature ranging from 63 to 74˚C depending on the type of meat (US Departement of Health and Human Services 2022).

Test results of pathogenic bacteria such as *S. aureus*, *Salmonella spp.* and *Campylobacter jejuni* showed that the meat and egg samples not contaminated, as shown in Table 5 and 6 respectively. Even though *S. aureus* bacteria are still allowed in food of animal origin as much as $1x10^2$ colonies/g, *Salmonella spp.* and *Campylobacter spp.* should not be present (SNI 7388: 2009. *Salmonella* is a normal microflora in some animals, especially pigs and poultry, and sources of these microbes include water, soil, insects, factory environment, kitchen, animal feces, raw meat, raw poultry and others (Munck et al. 2020; Ehuwa et al. 2021). Foods of animal origin in the form of raw meat and eggs are often contained *Salmonella sp*., especially in sporadic cases and outbreaks of Salmonellosis in humans (Schlundt et al. 2004). Based on food safety studies according to SNI 7388-2009, cases of poisoning caused by this bacterium usually occur when humans ingest food containing significant amounts of *Salmonella*. The amount of *Salmonella* that can cause salmonellosis is between 10^7-10^9 colonies/gram (Jay et al. 2005).

Processed meat is often contaminated with *S. aureus*, but in the present study, we did not find any *S. aureus* in the tested samples, probably due to a very low number in nature. These bacteria are often found as normal microflora on human skin and mucous membranes, and potentially causing infection in both humans and animals. In milk, when contained 10^7 colonies/g, these produce enterotoxins that can cause gastroenteritis or inflammation of the lining of the intestinal tract (Chen et al. 2022). *S. aureus* contamination sources could be food processing units, equipment and from environmental (Le et al. 2021; David et al. 2023). Correct hand washing technique, and cleaning of equipment and food preparation surfaces is necessary to prevent the entry of bacteria to food (Yap et al. 2019).

Campylobacter was also did not detected in this study, but it should be continuously controlled because these bacteria have also been found by others in Indonesia who reported the bacteria in 298 chicken samples taken from super markets and traditional markets (Sudarwanto et al. 2013). According to them, presence of *Campylobacter jejuni* was higher (23%) than *E. coli* (18.1%) found in the supermarket and traditional market, respectively. *Campylobacter jejuni* is pathogenic and potentially could contaminate chicken and carcass (Ansarifar et al. 2023). This bacteria did not cause disease in chicken but in humans it causes campylobacteriosis (Ansarifar et al. 2023). The clinical manifestation of the infection are characterized by severe diarrhea accompanied by fever, lack of appetite, vomiting and leukocytosis mainly in immunocompromise in young children and elderly persons (Mehdi et al. 2018; Budiailmiawan et al. 2022; Otsuka et al. 2023).

In general, the results of this study indicated that the hygiene level of animal products mainly meat marketed in Bali and Nusa Tenggara was very low, as shown by the results of the TPC and *E. coli* tests. This can result in a short half-life or shelf-life of the meat. Furthermore, the current data also indicated that the status of hygiene and sanitation in the food chain of animal origin relatively does not meet the requirements of good sanitation, although the food of animal origin does not contain pathogenic bacteria. To be able to produce meat that is ASUH, the meat production process at the slaughterhouse must meet the technical requirements, considering that the slaughterhouse is the location of the transformation of live livestock into food products (meat). It was also noted that a number of slaughterhouses had meet good hygiene and sanitation standards, but most of the conditions in the Provinces of

Bali and Nusa Tenggara had been very worrying, did not meet the technical requirements for both physically (buildings and equipment), human resources and procedures. This was proven by the fact that not all slaughterhouses had a VCN as a standard for implementing hygiene and sanitation in a slaughterhouse.

Likewise, the situation in traditional markets, although there are several markets that already have meat stalls, most traditional markets do not have meat stalls. The situation in traditional markets with all the activities and environmental conditions has the potential for many irregularities or carelessness. It was realized that in order to implement the provision of food of animal origin that is ASUH in traditional markets, the reality is relatively difficult considering the problems faced are not only technical but also social problems which are actually more dominant. Apart from being tested for microbial contamination, food samples of animal origin (meat, liver and eggs) were also tested for 4 (four) groups of antibiotic residues, namely penicillin, tetracycline, aminoglycoside and macrolide groups and showed that the four groups of antibiotic residues were still found in food of animal origin, especially chicken eggs and beef liver and these data are reported separately. However, the presence of antibiotic residues may trigger antimicrobial resistance associated with the high percentage of TPC and *E. coli* found in the current study.

Conclusion and Recommendations

The epidemiological overview of hygiene and sanitation values of animal product origins in Bali and Nusa Tenggara was analyzed. The level of microbial contamination of fresh meat in the provinces of Bali and Nusa Tenggara was still high with TPC exceeding the SNI 7388: 2009 standard. This condition indicates the low level of hygiene and sanitation in the food production process chain which can threaten the health of consumers due to infection with the bacteria, if the meat is not cooked properly. To meet the quality assurance standards for animal products that are ASUH, it is suggested to the Central and Regional Governments through the Animal Husbandry Service to always improve hygiene and sanitation in the production process chain by revitalizing slaughterhouses, counseling/coaching and routine supervision. Officers also need to supervise the distribution and use of medicines on farms to avoid residues in food of animal origin and antibiotic resistance.

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Author's Contribution

All authors were actively involved with different responsibilities. I Wayan Masa Tenaya and Ni Made Handayani: preparing research proposal, sample collection and conducted laboratory work. I Wayan Masa Tenaya, Romy Muhammad Dary Mufa and Ni Made Handayani: write manuscript, Kadek Karang Agustina and I Wayan Masa Tenaya: statistical analyses and write manuscript.

Conflict of Interest

None.

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