Journal of Agriculture and Technology Management (JATM)
25(1): 174-181 (January-June 2022)

Original article

Antimicrobial usage implementation and awareness of poultry layer producers in Cebu, Philippines

Hershey P. Mondejar[1]*, and Melvin B. Contratista[2]

[1]Faculty, College of Veterinary Medicine, Cebu Technological University-Barili Campus, Barili, Cebu, Philippines, 6036
[2]Graduate School Office, Cebu Technological University-Barili Campus, Barili, Cebu, Philippines, 6036

ABSTRACT

Antimicrobial resistance is resistance in different types of organisms facilitated by inappropriate use of medicines. A face to face survey questionnaire applied to 30 poultry layer producers located in Bantayan, Sta.Fe, and Madridejos, Cebu, Philippines was conducted. Most of the surveyed farms were large scale, operated by well-educated individuals who have extensive experiences in layer business operation. Based on the results, the antimicrobial use (AMU) of all antibiotics considered in this study have satisfactorily implemented for poultry layer medication as feed supplement and for therapeutic use except with fair implementation on quinolones and fluoroquinolones. Layer chicken producers and managers have high level of awareness on the classification of antibiotics on β-Lactams, aminoglycosides and aminocyclitols, quinolones and fluoroquinolones, tetracyclines, and macrolides and lincosamides; while a medium level of awareness on polypeptides, amphenicols, sulphonamides and trimethoprim. On the average, there have had high level of awareness on proper dosage use of antibiotics and practicing drug withdrawal period; medium level of awareness on presence of antibiotic residues in table eggs, on effects of antibiotic residues to human health, and rotation of antibiotic usage to avoid antimicrobial resistance (AMR) effects; and lack of awareness on residues may have direct effect to consumers and on the effects that the ingestion of food on the intestinal microflora of humans. It is proposed that the issues of AMU and AMR can be overcome by communicating with all stakeholders and discussing the need for surveillance of AMU and AMR.

KEYWORDS: *antimicrobial use, antibiotic knowledge, antimicrobial resistance, awareness, poultry layer*

1 INTRODUCTION

The poultry sector contributes significantly to the Philippines' food and economic security with this contribution being expected to rise with a growing population, urbanization, and preferences for animal-source foods. However, occurrence of bacterial diseases is a risk factor in the overall health management. Diseases of poultry can adversely affect egg production and their subsequent effect on mortalities, productivity, and profitability. This is the reason why layer production under intensive management systems is characterized by the routine use of antimicrobials. Antimicrobial agents exhibit activity that inhibits the growth of microorganisms. Antimicrobials are often used in sub-therapeutic doses by adding them to feed and water for prophylaxis, growth promotion and as a risk-management strategy. In layer hens, antibiotics are only used to treat and prevent bacterial infections (Stolker and Brinkman, 2005). The use of antimicrobials has facilitated the efficient production of poultry. They are applied by the poultry industry and poultry veterinarians to enhance growth and feed efficiency and reduce or prevent bacterial diseases (Donoghue, 2003; Muhammad et al., 2009). However, the indiscriminate application of antimicrobials results in the emergence and spread of antimicrobial resistance, which is becoming a global human health threat (Garcia-Migura et al., 2014; Kumar, 2019). Antimicrobial resistance (AMR) occurs when microbes evolve mechanisms that protect them from the effects of antimicrobials and the bacteria become resistant to antibiotics. The heavy reliance of antimicrobials in animal production has resulted in bacterial resistance to many modern antibiotics used for life-threatening diseases in humans (Manyi-Loh et al., 2018). As a consequence, the transfer of antimicrobial resistance from food animals to humans or the presence of antimicrobial residues in food of animal origin is now perceived to be a threat to human health (Hao et al., 2014; Founou et al., 2016; Mund et al., 2017; Manyi-Loh et al., 2018). No quantitative monitoring data of antibiotic usage in layers are currently available in most large poultry-producing countries (Roth et al., 2018). Even though limited, the available data support that food production from the animal industry has significant responsibility on antibiotic use (Landers et al., 2012). However, long-term

*corresponding author: hershey.mondejar@ctu.edu.ph
p-ISSN: 2599-4875 e-ISSN: 2599-4980

data for detection of antibiotics usage in individual animal species are unavailable, more so in animals on the farm level so there is the need for research on factors that cause antibiotic resistance development, although, sufficient data are not available to make a definitive conclusion about these issues (Phillips et al., 2004) but, less attention has been given in knowing how antibiotic use in animals contributes to the overall problem of antibiotic resistance (Landers et al., 2012). Some countries established strategies for surveillance and monitoring programs that concern AMR and its determinants. Currently, Cebu has no monitoring or regulations regarding the use of antimicrobials, thus the objectives of this study were to investigate the antimicrobial usage implementation of selected commercial layer egg producers in Cebu, Philippines as well as assess the level of awareness of poultry producers regarding effects of AMR.

2 MATERIALS AND METHODS

The Study Site and Respondents

The study was conducted in the Province of Cebu, in the Municipalities of Bantayan, Sta Fe, Madredejos, Talisay City and Mandaue City, Cebu, Philippines. A total of 30 poultry layer workers were utilized as respondents of the study. In other words, 1 respondent from the chosen 30 different poultry layer farms was interviewed.

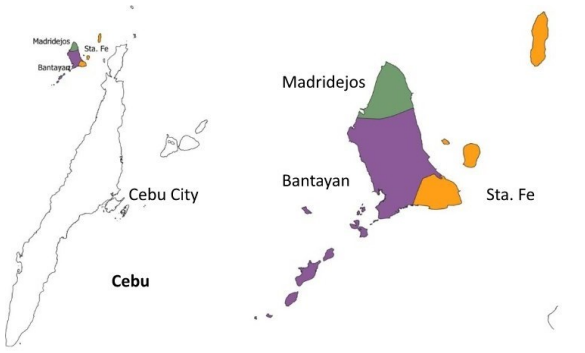

Figure SEQ Figure * ARABIC 1. Map showing the study area in the municipalities Madridejos Bantayan, and Sta. Fe, Cebu, Philippines

Questionnaire survey and analysis

A designed questionnaire was administered to 30 randomly selected respondents for the purpose of collecting information on the demographic profile of poultry farm workers, extent of implementation of antibiotics in the medication program, feed supplementation and therapeutic purposes as well as the level of awareness of the respondents about antimicrobial classification, antimicrobial residues and antimicrobial resistance. The questionnaire was personally distributed accompanied by actual observations to obtain adequate data necessary for the study. To ensure validity of the survey instruments, pretesting the questionnaire was conducted. The questionnaire was composed of three parts: demographic profile of respondents, extent of implementation of antibiotics in the medication program, feed supplementation and therapeutic purposes of the farm as well as questions on the level of awareness of the impact of indiscriminate uses of antimicrobials on the antimicrobial resistance and residue of the table egg industry. The questionnaire was personally handed to each of the respondents with the permission from the owner or manager of the selected layer farms. The study duration was from January to March 2018.

Data Gathering Procedure

The gathering and quantification of data, observed the following: 1.) preliminary preparation and scheduling of the questionnaire distribution 2.) administration of the questionnaire and 3.) informal discussion and observation. The researchers asked permission from the office of the Department of Agriculture to conduct the study in the selected five municipalities where the identified layer farms in the province of Cebu were located. Having secured the information to conduct the study, the researchers proceeded to the distribution of the questionnaires. The questionnaires were personally distributed to the respondents in their respective farm location. The researchers also conducted informal discussion with some of the respondents and conducted ocular inspections, in order to reinforce and supplement the data gathered through the questionnaire.

Scoring Procedures

The responses on the degree of medication, feed supplementation and therapeutic antibiotic implementation were categorized into levels. Each level has a corresponding weighted score and its description as shown in Table 1 and 2 on the assumption that the range between descriptions on the scale is equal $\frac{(n-1)}{n} = \frac{4}{5=0.8}$

Table 1. Description, score and range using 5-point scale for antibiotic implementation.

Description	Score codes	Range
Excellent implementation	5	4.21 – 5.00
Satisfactory implementation	4	3.41 – 4.20
Fair implementation	3	2.61 – 3.40
Partial implementation	2	1.81 – 2.60
No implementation	1	1.00 – 1.80

Table 2. Description, score and range using 5-point scale for level of awareness.

Description	Score codes	Range
Complete awareness	5	4.21 – 5.00
High level of awareness	4	3.41 – 4.20
Medium level of awareness	3	2.61 – 3.40
Low level of awareness	2	1.81 – 2.60
Lack of awareness	1	1.00 – 1.80

Statistical Analysis

p-ISSN: 2599-4875 e-ISSN: 2599-4980

Descriptive statistics was applied in determining the knowing the profile of the respondents. The responses of respondents by municipality were analyzed by simply getting its average.

3 RESULTS AND DISCUSSION

Respondents' Demographic Profile

This portion presents the profile of the 30 poultry layer farm workers in the selected study areas in the Province of Cebu, Philippines. In terms of age, 15 respondents were below 41 to 45 years old, 2 respondents were within 41 to 45 years old, and 13 respondents were above 41 to 45 years old. In terms of gender, 23 males while only 7 were female. Twenty-eight were married while only 2 were single. Regarding the degree or level of education, all the respondents have completed or achieved an undergraduate degree. Data shows that 27 respondents graduated college with 2 of them majored in business administration or marketing; while 1 graduated veterinary medicine. In terms of years of experience in poultry laying management, 13 respondents have already rendered 26 to 30 years in poultry layer farming; 7 respondents rendered 21 to 25 years; 6 respondents rendered 16 to 20; 2 respondents rendered 11 to 15 years; while 2 respondents rendered 6 to 10 years. In terms of training and seminars, the respondents attended training and seminars relevant to their field of poultry business to keep them abreast with the latest innovations in poultry layer farming. Data shows that the most attended training/seminar by the respondents were on vaccination and medication program, ranked one by the respondents followed by the chicken layer and egg production; poultry nutrition on the third rank; and lastly, about management and diseases respectively. The data further shows that poultry layer producers gave more emphasis on medication and vaccination programs, being the most basic and important need of the farm. In terms of the layer population, the data shows that 11 farms were able to reach 50,000-100,000, 9 farms with 30,000-50,000 heads, and another 10 farms with less than 30,000 heads.

Antimicrobial usage implementation in the medication program of layer producers in Cebu, Philippines

Preventative medicine programs are needed for layer farms if optimum production and health are to be maintained. Figure 2 shows the antimicrobial usage implementation in all study areas in terms of antibiotics used for the medication program. All poultry layer farms have had satisfactory implementation on the usage of β-Lactams, aminoglycosides and aminoglycitols, tetracyclines and polypeptides. On the usage of quinolones and fluoroquinolones, poultry farms in Sta. Fe and Madridejos have had fair implementation, while farms at Bantayan have had satisfactory implementation. On the usage of sulphonamides and trimethoprim, and macrolides and lincosamides, poultry farms in Bantayan have had fair implementation, while farms at Sta. Fe and Madridejos have had satisfactory implementation. On the usage of amphenicols, poultry farms in Bantayan and Madridejos have had fair implementation, while farms in Sta. Fe have had satisfactory implementation. On the average, the usage of all antibiotics considered in this study have had satisfactory implementation except with fair implementation on quinolones and fluoroquinolones. Results of the study are in agreement with Poole and Sheffield (2013) that the use of antibiotics in poultry is generally administered to the entire flock for the treatment of disease, disease prevention and growth promotion.In fact, Roth et al. (2018) stated that antibiotic usage for disease prevention is permitted in all large poultry-producing countries.This is because intestinal infections such as colibacillosis, necrotic enteritis, and other diseases generally caused by Salmonella, E. coli, or Clostridium spp. are the major concern among poultry growers and antibiotics are applied for the prevention of these infections to avoid economic losses (Sneeringer et al., 2015). The antibiotics used by layer producers for medication purposes is in consonance with the study of Roth et al. (2018) that antibiotic classes belonging to tetracyclines, aminoglycosides, sulfonamides, and penicillins are registered for use in poultry in all countries. Moreover, ANSES-ANMV (2017), the French agency for food environmental and occupational health and safety for veterinary medicinal products, as cited by Roth et al. (2018) elaborated that in France, poultry herds were basically treated with polymyxins, penicillins, and tetracyclines; then with sulfonamides and trimethoprim. Tetracyclines and penicillins are approved for use as well. The fluoroquinolones enrofloxacin and flumequine are allowed for use in poultry in Spain (Roth et al., 2018). Colistin, on the other hand, as a representative of the polymyxins, and tylosin, as representative of the macrolides, are both allowed for poultry use in all countries for oral treatment or injection (Roth et al., 2018).

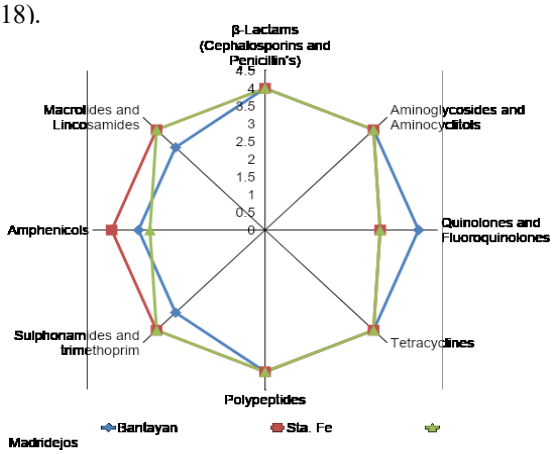

Figure 2. Antimicrobial usage implementation in the medication program of poultry layer production in Bantayan, Sta. Fe, and Madridejos, Cebu, Philippines

p-ISSN: 2599-4875 e-ISSN: 2599-4980

Figure 3 shows the antimicrobial implementation as feed supplement in all surveyed areas. All poultry farms have had satisfactory implementation of β-Lactams, aminoglycosides and aminocyclitols, and tetracyclines as feed supplement. On the application of quinolones and fluoroquinolones as feed supplement, poultry farms at Bantayan and Madridejos have had fair implementation, while farms at Bantayan have had satisfactory implementation. On the application of polypeptides and amphenicols as feed supplement, poultry farms at Sta. Fe and Madridejos have had satisfactory implementation, whole farms at Bantayan have had fair implementation. On the application of sulphonamides and trimethoprim, and macrolides and lincosamides as feed supplement, poultry farms at Bantayan and Sta. Fe have had satisfactory implementation, while farms at Madridejos have had fair implementation. On the average, the application of all antibiotics considered in this study as feed supplements have had satisfactory implementation. Antibiotics have been widely adapted in the poultry industry since their discovery more than 50 years ago (Kirchhelle, 2018). They provide an extremely important tool in the efficient production and preservation of animal products such as meat (Kirchhelle, 2018) and eggs (Hao et al., 2014; Mund et al., 2017). They are utilized by the poultry industry and poultry veterinarians, firstly to enhance growth and feed efficiency and reduce bacterial diseases (Donoghue, 2003; Hao et al., 2014; Mund et al., 2017). Developing countries continue to employ the antimicrobial agent for growth promotion to maintain the healthy state of the animals, to increase productivity, and raise incomes for the producers (Braykov et al., 2016; Manyi-Loh et al., 2018). Antibiotic feeding has been implemented among poultry farms as farmers have known its growth promoting effects (Brüssow, 2015). Antibiotic growth promoters (AGP) are widely recognized, but are phased out in some parts of the world, as the "gold standard" of performance-enhancing feed additives, which had become integral and valuable components of modern, efficient animal production (Broom, 2018).

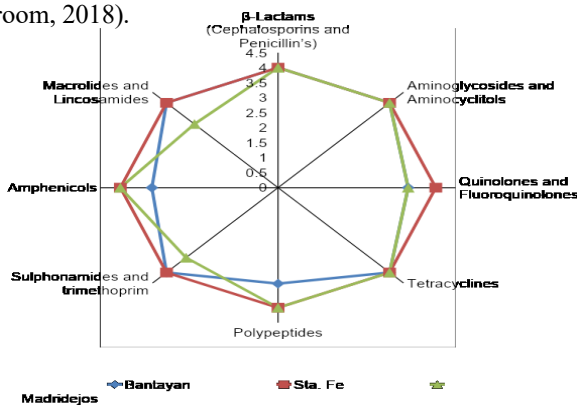

Figure 3. Antimicrobial usage implementation as feed supplementation among poultry layer producers in Bantayan, Sta. Fe, and Madridejos, Cebu, Philippines

Figure 4 shows antimicrobial application as therapeutic use in all surveyed areas. The results show that on the application of all antibiotics considered in this study as antimicrobial therapeutic use, all poultry farms have had satisfactory implementation, while farms at Madridejos on quinolones and fluoroquinolones have had fair implementation. The use of antibiotics for therapeutic uses refers to the treatment of disease or disorders by remedial agents or methods. Antimicrobial classes used as therapeutics in the poultry industry include: aminoglycosides, tetracyclines, B-lactams, fluoroquinolones, macrolides, polypeptides, amphenicols, sulphonamides and trimethoprim (Stolker & Brinkman, 2005). Many antimicrobial drug classes are used in animals for prophylaxes and therapy. This use tends to increase where farm management is not optimum or when endemic diseases are not properly controlled. The problem of infectious diseases with the huge livestock population have raised extensively antimicrobial use in the developing countries (Clement et al., 2019). Several guidelines are available for appropriate use of antimicrobial drugs in animals, but very little is being done in developing countries (Byarugaba, 2004).

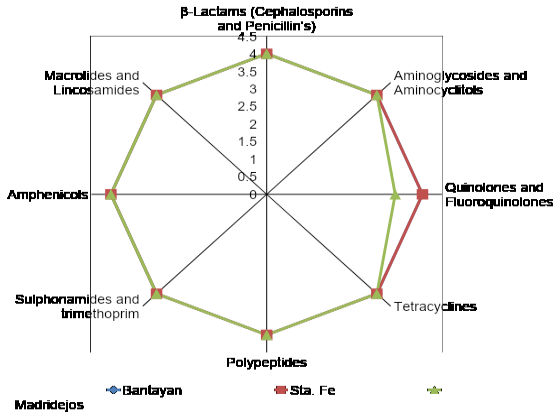

Figure 4. Antimicrobial implementation as therapeutic use among layer producers in Cebu, Philippines

Determining the level of awareness is one of the instruments which poultry layer producers can use to realize the objectives of its agricultural policy. It is an effective instrument to help layer producers to reach their goals better. An awareness of farmers' attitudes should have an important influence on these objectives. Farmers' knowledge and expectations, risk perception and attitude towards AMU and AMR affect on-farm AMU (Kramer et al., 2017). The succeeding section shows the degree of awareness rendered by respondents in the selected research areas in terms of usage and classes of antibiotics, and antimicrobial residue awareness, as well as awareness on the effects to public health. Figure 5 shows the level of awareness of poultry layer producers in Cebu, Philippines on usage and classes of antibiotics. On the classification of antibiotics belonging to β-Lactams and amphenicols,

p-ISSN: 2599-4875 e-ISSN: 2599-4980

poultry farms at Bantayan have had a high level of awareness, while farms at Sta. Fe and Madridejos have had a medium level of awareness. On the classification of aminoglycosides and aminocyclitols, quinolones and fluoroquinolones, tetracyclines, and macrolides and lincosamides, poultry farms at Bantayan and Sta. Fe have had a high level of awareness, while farms at Madridejos have had medium level of awareness. On the classification of sulphonamides and trimethoprim, and polypeptides, poultry farms at Madridejos have had a high level of awareness, while farms at Bantayan and Sta. Fe have had a medium level of awareness. On the average, there have been high level of awareness on the classification of antibiotics on β-Lactams, aminoglycosides and aminocyclitols, quinolones and fluoroquinolones, tetracyclines, and macrolides and lincosamides; while a medium level of awareness on polypeptides, amphenicols, sulphonamides and trimethoprim.

Three aminoglycosides are used in poultry, namely, gentamycin, neomycin and streptomycin. Neomycin is commonly used to treat enteric infections and is administered either in feed or water. Gentamycin is the most widely used aminoglycoside and it is used in day-old chicken or turkey chicks. Streptomycin is partially absorbed from the intestine and, therefore, can be used to treat systematic E. coli infections. Spectinomycin and hygromycin are the poultry approved aminocyclitols. Spectinomycin is highly effective for E. coli infections when combined with lincomycin. The tetracyclines are one of the most commonly used classes of antimicrobial drugs within the scope of veterinary practice (Cornejo et al., 2018). This is largely due to their affordability, a wide margin of safety and broad spectrum (Mycoplasma, Gram positive and Gram-negative bacteria) and intracellular activity. They are easily administered in mass in either feed or water. The three tetracyclines most commonly used in poultry are chlortetracycline, oxytetracycline and doxycycline (Granados-chinchilla & Rodríguez, 2017). Sulphonamides are bacteriostatic that are used as veterinary drugs for prophylactic and therapeutic purposes; they also act as growth promoting substances and are commonly administered in drinking water as coccidiostats. Erythromycin is most frequently used in poultry to treat Staphyloccus aureus arthritis. Tylosin and tiamulin are considered to be highly effective in the treatment of mycoplasma infections in laying hens to restore egg production and reduce transovarian transmission. The only poultry approved lincosamide is lincomycin, it is primarily used to treat infectious coryza and infectious synovitis. It is commonly used to treat clostridium perfringens induced necrotic enteritis and also to enhance poultry performance. Globally, the classes of drugs that are more widely used in agriculture and is causing a rising scientific concern with regards to their potential adverse effects and risk management include the tetracyclines, aminoglycosides, β-lactams, lincosamides, macrolides, pleuromutilins, and sulphonamides (Abou-raya et al., 2013; Finley et al., 2013; Briyne et al., 2014; Baynes et al., 2016; Manyi-Loh et al., 2018). Gelband et al. (2015) noted that these antibiotics have the same mode of actions and the same general classes as those used for humans; creating a situation that demands the judicious use of these drugs in animal farming, as there is bound to be a degree of interaction between animals and humans.

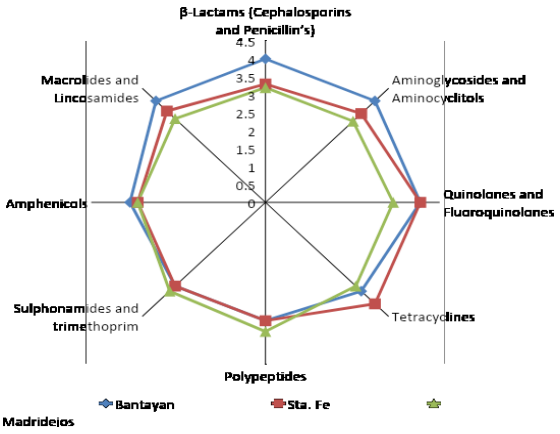

Figure 5. Level of awareness of poultry layer producers in Cebu, Philippines on classification of antibiotics

Figure 6 shows the level of awareness of poultry layer producers in Cebu, Philippines on antibiotic residue and AMR. On proper dosage use of antibiotics, poultry farms at Bantayan, and Madridejos have had high levels of awareness, while farms at Sta. Fe have had a medium level of awareness. On practicing drug withdrawal periods, all poultry farms considered in this study have had a high level of awareness. On the presence of antibiotic residues in table eggs and on the effects of antibiotic residues to human health, poultry farms at Sta. Fe and Madridejos have had medium level of awareness, while farms at Bantayan have had low level of awareness. All poultry farmers lacks awareness that the ingestion of food of animal origin may have an effect on the intestinal microflora of humans, by either colonization with multi resistant bacteria which can lead to certain infections becoming untreatable. On the rotation of antibiotic usage to avoid AMR effects, poultry farms at Bantayan have had a high level of awareness, while farms at Sta. Fe and Madridejos' medium level of awareness. On the average, there have had high level of awareness on proper dosage use of antibiotics and practicing drug withdrawal period; medium level of awareness on presence of antibiotic residues in table eggs, on effects of antibiotic residues to human health, and rotation of antibiotic usage to avoid AMR effects; and lack of awareness on residues may have direct effect to consumers and on the effects that the ingestion of food on the intestinal microflora of humans. All respondents administered proper dosage of the

p-ISSN: 2599-4875 e-ISSN: 2599-4980

antibiotics and have been practicing drug withdrawal period in their farms as well as antibiotic rotation. Several antibiotics for animals require a veterinary subscription, however, treatments are often administered by lay farm workers with the guidance of a veterinarian (Landers et al., 2012). A substantial relationship between level of education and knowledge of antibiotic use has been found in previous studies (Ozturk et al., 2019). Also, younger farmers had higher knowledge level on antibiotic use than older ones. Farmers' knowledge and expectations, risk perception and attitude towards antimicrobial use (AMU) and AMR affect on-farm AMU (Kramer et al., 2017). Inspiring young individuals with good education to engage in the livestock sector will improve the understanding and awareness of antibiotic resistance (Ozturk et al., 2019). The lack of awareness of the effects that the ingestion of food of animal origin may have on the intestinal microflora of humans could be due to the fact that such issue is new to the respondents as to the case found by (Sadiq et al., 2018). The result is in similarity with the study conducted by Eltayb et al., (2012) wherein, some of the respondents heard and provided their own definition of antibiotic resistance. Studies also showed that animal farmers were aware of the resistance problem (Busani et al., 2004; Ozturk et al., 2019), however, many don't consider it as an essential public health concern (Sadiq et al., 2018; Ozturk et al., 2019). An indication that the problem of antibiotic resistance is not well apprehended by the farming community (Ozturk et al., 2019).

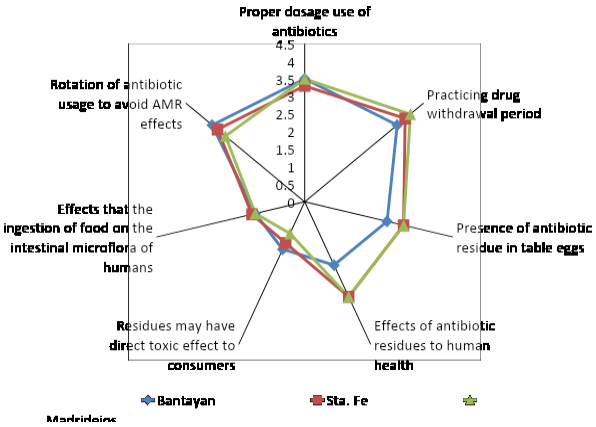

Figure 6. Level of awareness of poultry layer producers in Cebu, Philippines on antibiotic residue and AMR

4 CONCLUSIONS AND RECOMMENDATION

A study on determining the antibiotic usage implementation in the medication program, feed supplementation and therapeutic purposes with an aim on determining the level of awareness regarding some aspects of antimicrobial resistance by layer producers in Bantayan, Sta.Fe, and Madridejos, Cebu, Philippines was successfully conducted. Based on the results, the antimicrobial usage of all antibiotics considered in this study have satisfactorily implemented for poultry layer medication as feed supplement and for therapeutic use except with fair implementation on quinolones and fluoroquinolones. This implies that antibiotics are commonly used, intended to maintain the health of the birds, making sure of enhanced productivity and growth. Layer chicken producers and managers have high level of awareness on the classification of antibiotics on β-Lactams, aminoglycosides and aminocyclitols, quinolones and fluoroquinolones, tetracyclines, and macrolides and lincosamides; while a medium level of awareness on polypeptides, amphenicols, sulphonamides and trimethoprim. On the average, there have had high level of awareness on proper dosage use of antibiotics and practicing drug withdrawal period; medium level of awareness on presence of antibiotic residues in table eggs, on effects of antibiotic residues to human health, and rotation of antibiotic usage to avoid AMR effects; and lack of awareness on residues may have direct effect to consumers and on the effects that the ingestion of food on the intestinal microflora of humans. This is attributed to most of the layer producers and managers being well educated and have attended relevant training on antibiotic knowledge, and use. The lack of awareness by the respondents on residues may have direct effect on consumers and on the effects that the ingestion of food on the intestinal microflora of humans were not understood well by the farming community such that they were unaware of this issue. This aspect should be the focus of the program policies to be drafted and submitted to proper government authorities on antibiotic regulation to prevent the harmful effects of antimicrobial resistance.

REFERENCES

Abou-Raya, S. H., Shalaby, A. R., Salama, N. A., Emam, W. H., & Mehaya, F. M. (2013). Effect of ordinary cooking procedures on tetracycline residues in chicken meat. J. *Food Drug Anal, 2*1(1), 80-86.

ANSES-ANMV. (2017). Sales survey of veterinary medicinal products containing antimicrobials in France in 2016. [Internet]. [cited 2017 November 9].

Baynes, R. E., Dedonder, K., Kissell, L., Mzyk, D., Marmulak, T., Smith, G., ... & Riviere, J. E. (2016). Health concerns and management of select veterinary drug residues. *Food and Chemical Toxicology, 88*, 112-122.

Braykov, N. P., Eisenberg, J. N., Grossman, M., Zhang, L., Vasco, K., Cevallos, W., ... & Levy, K. (2016). Antibiotic resistance in animal and environmental samples associated with small-scale poultry farming in northwestern Ecuador. *Msphere, 1*(1),

p-ISSN: 2599-4875 e-ISSN: 2599-4980

e00021-15.

De Briyne, N., Atkinson, J., Borriello, S. P., & Pokludová, L. (2014). Antibiotics used most commonly to treat animals in Europe. *Veterinary Record, 175*(13), 325-325.

Broom, L. J. (2018). Gut barrier function: effects of (antibiotic) growth promoters on key barrier components and associations with growth performance. *Poultry Science, 97*(5), 1572-1578.

Brüssow, H. (2015). Growth promotion and gut microbiota: insights from antibiotic use. *Environmental Microbiology, 17*(7), 2216-2227.

Busani, L., Graziani, C., Binkin, N., Franco, A., Di Egidio, A., & Battisti, A. (2004). Survey of the knowledge, attitudes and practice of Italian beef and dairy cattle veterinarians concerning the use of antibiotics. *Veterinary Record, 155*(23), 733-738.

Byarugaba, D. K. (2004). Antimicrobial resistance in developing countries and responsible risk factors. *International Journal of Antimicrobial Agents, 24*(2), 105-110.

Clement, M., Olabisi, M., David, E., and Issa, M. (2019). Veterinary pharmaceuticals and antimicrobial resistance in developing countries. In S. O. Bekoe, M. Saravanan, R. K. Adosraku, & P. K. Ramkumar (Eds.), *Veterinary Medicine and Pharmaceuticals. IntechOpen.* [Internet]. [cited 2017 November 7].

Cornejo, J., Yevenes, K., Avello, C., Pokrant, E., Maddaleno, A., Martin, B. S., and Lapierre, L. (2018). Determination of chlortetracycline residues, antimicrobial activity and presence of resistance genes in droppings of experimentally treated broiler chickens. *Molecules.* [Internet]. [cited 2017 November 7]; 23, 1264.

Donoghue, D. J. (2003). Antibiotic residues in poultry tissues and eggs: human health concerns?. *Poultry Science, 82*(4), 618-621.

Eltayb, A., Barakat, S., Marrone, G., Shaddad, S., & Stålsby Lundborg, C. (2012). Antibiotic use and resistance in animal farming: a quantitative and qualitative study on knowledge and practices among farmers in Khartoum, Sudan. *Zoonoses and Public Health, 59*(5), 330-338.

Finley, R. L., Collignon, P., Larsson, D. J., McEwen, S. A., Li, X. Z., Gaze, W. H., ... & Topp, E. (2013). The scourge of antibiotic resistance: the important role of the environment. *Clinical Infectious Diseases, 57*(5), 704-710.

Founou, L. L., Founou, R. C., & Essack, S. Y. (2016). Antibiotic resistance in the food chain: a developing country-perspective. *Frontiers in Microbiology, 7*, 1881.

Garcia-Migura, L., Hendriksen, R. S., Fraile, L., & Aarestrup, F. M. (2014). Antimicrobial resistance of zoonotic and commensal bacteria in Europe: the missing link between consumption and resistance in veterinary medicine. *Veterinary Microbiology, 170*(1-2), 1-9.

Gelband, H., Miller, Petrie, M., Pant, S., Gandra, S., Levinson, J., Barter, D., ... & Laxminarayan, R. (2015). The state of the world's antibiotics 2015. *Wound Healing Southern Africa, 8*(2), 30-34.

Granados-Chinchilla, F., & Rodríguez, C. (2017). Tetracyclines in food and feedingstuffs: from regulation to analytical methods, bacterial resistance, and environmental and health implications. *Journal of Analytical Methods in Chemistry*, 2017.

Hao, H., Cheng, G., Iqbal, Z., Ai, X., Hussain, H. I., Huang, L., ... & Yuan, Z. (2014). Benefits and risks of antimicrobial use in food-producing animals. *Frontiers in Microbiology, 5*, 288.

Kirchhelle, C. (2018). Pharming animals: a global history of antibiotics in food production (1935–2017). *Palgrave Communications, 4(*1), 1-13.

Kramer, T., Jansen, L. E., Lipman, L. J., Smit, L. A., Heederik, D. J., & Dorado-García, A. (2017). Farmers' knowledge and expectations of antimicrobial use and resistance are strongly related to usage in Dutch livestock sectors. *Preventive Veterinary Medicine, 147,* 142-148.

Kumar, Y. (Ed.). (2019). Antimicrobial Resistance: A Global Threat. BoD–Books on Demand.

Landers, T. F., Cohen, B., Wittum, T. E., & Larson, E. L. (2012). A review of antibiotic use in food animals: perspective, policy, and potential. *Public Health Reports, 127*(1), 4-22.

Manyi-Loh, C., Mamphweli, S., Meyer, E., & Okoh, A. (2018). Antibiotic use in agriculture and its consequential resistance in environmental sources: potential public health implications. *Molecules, 23(*4), 795.

Muhammad, F., Akhtar, M., Zia-ur-Rahman, J. I., & Anwar, M. I. (2009). Role of veterinarians in providing residue-free animal food. *Pak Vet J, 29*, 42-46.

Mund, M. D., Khan, U. H., Tahir, U., Mustafa, B. E., & Fayyaz, A. (2017). Antimicrobial drug residues in poultry products and implications on public health: A review. *International Journal of Food Properties, 20*(7), 1433-1446.

Ozturk, Y., Celik, S., Sahin, E., Acik, M. N., & Cetinkaya, B. (2019). Assessment of farmers' knowledge, attitudes and practices on antibiotics and antimicrobial resistance. *Animals, 9*(9), 653.

Phillips, I., Casewell, M., Cox, T., De Groot, B., Friis, C., Jones, R., ... & Waddell, J. (2004). Does the use of antibiotics in food animals pose a risk to human health? A critical review of published data. *Journal of Antimicrobial Chemotherapy, 53*(1), 28-52.

p-ISSN: 2599-4875 e-ISSN: 2599-4980

Poole, T., & Sheffield, C. (2013). Use and misuse of antimicrobial drugs in poultry and livestock: Mechanisms of antimicrobial resistance.

Roth, N., Käsbohrer, A., Mayrhofer, S., Zitz, U., Hofacre, C., & Domig, K. J. (2019). The application of antibiotics in broiler production and the resulting antibiotic resistance in Escherichia coli: A global overview. *Poultry science, 98*(4), 1791-1804.

Sadiq, M. B., Syed-Hussain, S. S., Ramanoon, S. Z., Saharee, A. A., Ahmad, N. I., Zin, N. M., ... & Mansor, R. (2018). Knowledge, attitude and perception regarding antimicrobial resistance and usage among ruminant farmers in Selangor, Malaysia. *Preventive Veterinary Medicine, 156,* 76-83.

Sneeringer, S., MacDonald, J., Key, N., McBride, W., & Mathews, K. (2017). Economics of antibiotic use in US livestock production.

Stolker, A. A. M., & Brinkman, U. T. (2005). Analytical strategies for residue analysis of veterinary drugs and growth-promoting agents in food-producing animals—a review. *Journal of chromatography A, 1067*(1-2), 15-53.

p-ISSN: 2599-4875 e-ISSN: 2599-4980