PHENOTYPIC CHARACTERIZATION, ANTIBIOGRAM AND RISK FACTORS OF SALMONELLA ISOLATES FROM LAYING CHICKEN, POULTRY FARM AND MARKET’S EGGS IN JIMMA TOWN, SOUTH WESTERN ETHIOPIA

CURRENT STATUS: ACCEPTED

Diriba Taddese  dirrooballee@gmail.com
Jimma University College of Agriculture and Veterinary Medicine
Corresponding Author

Tadele Tolosa
Jimma University College of Agriculture and Veterinary Medicine

Benti Deresa
Jimma University College of Agriculture and Veterinary Medicine

Matios lakow
National Animal Health Diagnostic and Investigation Center

Abebe Olani
National Animal Health Diagnostic and Investigation Center

Eshetu Shumi
Jimma University College of Agriculture and Veterinary Medicine

DOI: 10.21203/rs.2.11223/v1

SUBJECT AREAS
Food Science & Technology

KEYWORDS
Antibiogram, Egg, Chicken, Salmonella
Abstract

Objectives

Salmonella is the most important cause of foodborne illness especially from poultry and poultry products. So the aim of this study was to carry out phenotypic characterization, antimicrobials susceptibility pattern and risk factors of salmonella isolates from farms and markets eggs, cloacae swabs of chickens and stool of egg collectors. A cross-sectional study was conducted from January 2018 to September 2018. Samples were, processed; salmonella was isolated, Phenotypically identified by OmniLog and antimicrobials susceptibility were carried out.

Result

Over all; 11(2.65%) of salmonella enterica were phenotypically characterized out of 415 samples from farms egg content (n=83), farms eggshell (n=83), cloacae (n=83), market eggshell (n=83) and market egg contents (n=83) with 2.4%, 0%, 2.4%, 4.8% and 3.6% prevalence, respectively. Out of isolates, 8(72.72%) displayed multidrug resistance. All isolates showed susceptibility to Gentamicin, Kanamycin and Streptomycin. Lack of separating cracked eggs, washing hand, eggs stay longer unsold, and mixing excreta with feed were associated risk factors for salmonella presence (p-value<0.05). The presence of drug resistant salmonella enterica within egg/chicken can pose serious health problem. Good hygienic practices are important to reduce risk factors of salmonella contamination.
isolates from farms and markets eggs, cloacae swabs of chickens and stool of egg collectors. A cross-sectional study was conducted from January 2018 to September 2018. Samples were, processed; salmonella was isolated, Phenotypically identified by OmniLog and antimicrobials susceptibility were carried out.

Result; Over all; 11(2.65%) of salmonella enterica were phenotipically characterized out of 415 samples from farms egg content (n=83), farms eggshell (n=83), cloacae (n=83), market eggshell (n=83) and market egg contents (n=83) with 2.4%, 0%, 2.4%, 4.8 % and 3.6% prevalence, respectively. Out of isolates, 8(72.72%) displayed multidrug resistance. All isolates showed susceptibility to Gentamicin, Kanamycin and Streptomycin. Lack of separating cracked eggs, washing hand, eggs stay longer unsold, and mixing excreta with feed were associated risk factors for salmonella presence (p-value<0.05). The presence of drug resistant salmonella enterica within egg/and chicken can pose serious health problem. Good hygienic practices are important to reduce risk factors of salmonella contamination.

Key word: - Antibiogram, Egg, Chicken, Salmonella

Introduction

Salmonella is one of the major causes of foodborne disease outbreaks globally [1]. Outbreaks due to Salmonella have been associated with a wide variety of foods, like; meat, chicken and egg [2, 3]. Infections can occur via ingestion of contaminated meat, eggs, raw and milk. Contamination of these foods can occur during production, processing and distribution [4]. Eggshells and egg contents can be contaminated by this bacterium during egg formation in the hen reproductive system or from environmental including fecal contact. Several outbreaks of salmonellosis have been reported where the eggs is the source of human infection [5, 6, 8].
The World Health Organization reports that, the incidence and severity of cases of salmonellosis have increased significantly [9,10]. Some studies reported varying level of salmonella prevalence (0.2%-69%) in poultry [11, 12]. Bayu and his collaborators [13] report 4.69% prevalence of salmonella species from egg. There was report of 41.9% prevalence of Salmonella from chicken farm in Jimma town [4]. Additionally antimicrobial resistance of salmonella was also reported [7].

However, an egg is an important source of food; there is no report on infection/contamination status, antimicrobial susceptibility of salmonella from chicken, farm and market egg in this study area. Therefore this study was designed to carry out phenotypic characterization, antimicrobial susceptibility and risk factors of salmonella isolates from chicken and eggs in Jimma town.

Methods

Study Area

Study was conduct in Jimma town which is situated in south western Ethiopia. Jimma town is located at latitude of 07°41”N and longitude of 36°50” E, and at an elevation average of 1780m above sea level [14].

Study Design

Cross-sectional study design was conduct from January 2018 to September 2018 on egg, stool of egg collectors and cloacae swab of chicken. The number of eggs sample were estimated based on previous reports using Thrusfield formula [15]. Accordingly, 4.69% [13] expected prevalence was taken with 5% desired absolute precision and 95% confidence interval. Samples size was separately calculated for eggs sampled from markets and farms.

Calculated sample size was ≈69 for each. This was increased by 20%; and 83 eggs were
sampled from each (market and farm). From 166 total egg; contents (83) and shells (83) of market egg samples and, content (83) and (83) shell of farm egg samples were analyzed separately. Similarly, 83 cloacae swab samples were collected from chicken those laid sample of egg at farm. Overall, 415 samples were tested for salmonella detection.

Samples from poultry farms were collected using proportional allocation sampling method and allocated samples were collected randomly. Samples of egg from markets were randomly collected. Structured questionnaire was administered to egg collectors and egg sellers at the markets to assess factors favoring contamination of egg with salmonella.

Sample Collection and Transportation

Sample of egg from farms were collected as soon as egg is laid using sterile glove. Cloacae swabs were collected according to [16] and swabs were placed in sterile tube containing 10 ml of Buffered Peptone Water (BPW). Samples of egg from markets were collected using sterile glove. Each sample was coded, packaged separately in an ice box and transported to analyze laboratory.

Sample Processing

Sterile cotton tipped swab was soaked in BPW and external egg was rubbed. Swab was inoculated in 10 ml of BPW. Eggshell was washed and immersed in 70% alcohol. Eggs were cracked and 25 gram of egg content was added into flask. 225 ml of trypticase soy broth (TSB) was added on the egg content in the same flask, mixed and incubated according to [18].

Salmonella Isolation and Identification

Salmonella isolation was performed as recommended by [17]. Briefly, 1 ml of BPW mixture of eggshells, cloacae swabs and 1 ml from incubated TSB with egg content mixture were
transferred to 10 ml Selenite cysteine broth (SCB) and incubated. A loop full from incubated SCB was streaked on XLD and BGA and incubated. Plate was examined for the presence of *Salmonella* [19].

*Salmonella* suspected isolates on BGA and XLD were tested via biochemical test according to [20, 21]. Isolates producing an alkaline slant with acid butt on TSI and H₂S production or no H₂S production, urea hydrolysis negative and indole negative, citrate utilization positive, decarboxylate lysine positive and motile were assumed as *salmonella* species. *Salmonella* isolates confirmed by biochemical test were taken to Biolog OmniLog test. This was by growing *salmonella* isolates on Biolog Universal Growth Agar. Cell suspensions was made and pipette into 96 well of Biolog Plates and incubated [22]. The incubated microplates were inserted in to Biolog OmniLog reader and analyzed. Result was read from computer software [23].

**Antibiogram of Salmonella Isolates**

Phenotypically confirmed *Salmonella* isolates were subjected to twelve (12) antimicrobial discs by agar diffusion method [24]. Culture of isolates were compared with 0.5 McFarland turbidity standards and swabbed on Mueller Hinton Agar [4]. Antimicrobial discs were placed on Mueller Hinton Agar and incubated. For each antimicrobial, inhibition zone was measured.

**Data Collection, Management and Analysis**

Data collected from laboratory investigation and questionnaire survey were stored. In univariable logistic regression, all independent variables with P-value <0.25 were taken to multivariable logistic regression. Independent variables with P< 0.05 in multivariable logistic regression were considered as significant.

**Results**
**Phenotypically Characterized Salmonella isolates**

Over all; 11 (2.65%) out of 415 samples; *salmonella enterica* were phenotypically characterized from farm egg content (n=83), farm eggshell (n=83), cloacae swab (n=83), market eggshell (n=83) and market egg contents (n=83) at a rate of 2.4%, 0%, 2.4%, 4.8 % and 3.6% respectively.

**Antibiogram of Salmonella enterica**

The degree of resistance *Salmonella enterica* ranges from 9.09% to 90.09% was observed to 5 antimicrobials. Of the isolates, 8(72.72%) were multi drug resistance. Isolates susceptible to Neomycin, Ciprofloxacin, Chloranphenicol, Trimethoprim, and Tetracycline, were observed. None of the isolates resistance to Gentamicin, Kanamycin and Streptomycin was observed (Table. 1 in the Supplementary Files).

**Risk Factors of Salmonella at Farm and Market’s Egg**

Risk factors for *Salmonella* contamination at farm and at market were analyzed. Hand washing before and after use of toilet, separation of cracked eggs and excreta mix with feed are factors associated with *salmonella* contamination (p<0.05) at farm (Table 2 in the Supplementary Files).

The rate of *salmonella* isolate is significantly associated (P<0.05) with duration of unsold egg stays and separation of cracked eggs from intact one (Table 3 in the Supplementary Files).

**Discussion**

In the present study, *salmonella enterica* was phenotypically characterized using OmniLog test. In this study, the overall prevalence (2.98%) of *Salmonella enterica* corroborates with the previous report of [25] 2.25%, and [26] 3.3% prevalence’s. However, higher prevalence of 4.64% [4], 4.69 [13], 13.88%, and 41.9% [12] were reported. Differences in
prevalence rates in various studies may be due to geographic and seasonal variation, animal management practices [2] and hygienic conditions [27]. In this study, out of 13 *salmonella enteric;* one from farm egg content and one from cloacae swab was isolated from the same chicken that might indicate as the infection of gastrointestinal gut may reason for infection of reproductive organ [28]. This could be a means for transovarial transmission of this bacterium from chicken to egg. In the present study, occurrence of 2.41% *salmonella enterica* species from cloacae swabs in some farms may be linked to the hygienic status of poultry production [29, 30]. The prevalence of *Salmonella enterica* species from farm egg contents in the present study was in line with 2.9% prevalence report [31]. But it shows lower prevalence when compared with 3.84% [32], 4.64% [4] and 4.69 [13]. This may be due to inadequate storage conditions of egg [33]. But in this study, eggs were collected as soon as egg laid that might minimize the exposure of egg contamination [34, 35]. In this study some of *Salmonella enterica* species from shell and contents of market egg were isolated from the same egg. This suggest as both eggs part can be contaminated with *Salmonella* from the environment [34, 35]. In this study, occurrence of 3.6% and 4.82% *salmonella enterica* from content and shell respectively, out of analyzed sample of market’s eggs, may be due to the difference in handling/ hygienic status of egg at the markets [27, 36]. This finding is in line with the studies of [32, 37]. There are reports showed drug resistances of *Salmonella* [6, 16, 32,38]. In the current study, resistance of *Salmonella enterica* to antimicrobials is concurs with previous reports [11, 39, 40]. Multi-drug resistance observed in this study is consistent with the findings of [41, 42]. This may be due to the bacteria accumulate multiple genes; each coding for resistance [43, 44].
In this study, none of *Salmonella enteric* were resistant to Gentamicin, Kanamycin and Streptomycin is in line with [45, 46] studies. Contrary to these, [4, 40] was report 100% resistance of *salmonella* to Streptomycin. Resistivity of *Salmonella enterica* can be linked to various factors including inappropriate medication and frequent use of antibiotics [47].

In this study, importance of separating cracked egg from the intact, might be due to cracked egg promotes the gross of bacteria [28]. Similarly, mixing excreta with feed influenced the prevalence of *salmonella* contaminates in the feed [34]. Washing hand before and after use of toilet has reduced risk for egg contamination in this study may linked with keeping hygienic status of egg collectors can minimize bacterial contamination [27]. Unsold egg stays for long time has increased risk for egg contamination may be associated with lack of appropriate use of storage and transportation [48]. However, our result suggests that establishment of good hygienic practices in poultry farm and on markets eggs are essential to reduce the contamination of *salmonella*.

**Limitation**

The isolates were not molecularly characterized due to lack of resource.

**Abbreviations**

BGA Brilliant Green Agar

BUG Biolog Universal Growth

XLD Xylose Lysine Desoxycholate

**Declarations**

**Ethical Clearance and Consent to Participate**

Ethical clearance was obtained from Jimma University, College of Agriculture and Veterinary Medicine. All participants were informed about the aim of research. Additionally, written consent was obtained from all participants and Jimma town
administration office.

Consent to Publication

Not applicable

Availability of Data and Material

The data sets developed and analyzed during the current study are available from the first author or from the corresponding authors upon request.

Competing Interests

The authors declare that they have no competing interest.

Funding

Jimma University College of Agriculture and Veterinary Medicine was sponsored for the research to design the study and collection, analyzing, and interpretation of the data and writing of the manuscript.

Author’s Contribution

D.T, E.S, T.T and B.D were participated in the conception of the research idea, Methodology and, M.L and A.O carried out the laboratory work of OmniLog test and all Authors were read and approve the manuscript.

Acknowledgements

I would like to extend my gratitude for Jimma University College of Agriculture and Veterinary Medicines for giving me the opportunity to pursue this study. I would like to express my gratitude and appreciate to National Animal Health Diagnostic and Investigation Center (NAHDIC) for their plateful for phenotypic characterization of isolates. Finally, I would like to extend my heartfelt thanks to all of my friends for their support in providing me necessary information and constructive comments during implementation of this study.
References

1. Sharkawy, H., Tahoun, A., El-Gohary, A. E. G. A., El-Abasy, M., El-Khayat, F., Gillespie, T. & El-Adawy, H., Epidemiological, molecular characterization and antibiotic resistance of Salmonella entericaserovars isolated from chicken farms in Egypt, Gut.Pathogens, (2017) 9: p. 8.

2. Naik, V.K., Shakya, S., Patyal, A. and Gade, N. E., Isolation and molecular characterization of Salmonella spp. from chevon and chicken meat collected from different districts of Chhattisgarh, India. Vet. worl, (2015) 8: p. 702.

3. Feasey, N.A., Dougan, G., Kingsley, R., A., Heyderman, R. S. and Gordon, M. A, Invasive non-typhoidal Salmonella disease an emerging and neglected tropical disease in Africa (2012). 379: p. 2489-2499.

4. Kebede, A., Kemal, J., Alemayehu, H. and Habte Mariam, S., isolation, identification, and antibiotic susceptibility testing of Salmonella from slaughtered bovines and ovines in Addis Ababa Abattoir Enterprise Ethiopia, Inter.J.bacteriolog, (2016) 8: p. 421.

5. Moosavy, M.H., Esmaeili, S., Amiri, F. B., Mostafavi, E. and Salehi, T. Z, Detection of salmonella spp in commercial eggs in Iran. Iran. J microbiolog, (2015) 7.: p. 50.

6. Mohammed, H.I.a.I., A. E. A, Isolation and identification of salmonella from the environment of traditional poultry farms in Khartoum North, (2012) 7: p. 1239-1245.

7. Endrias, Z., prevalence, distribution and antimicrobial resistance profile of salmonella isolated from food items and personnel in Ethiopia, Addis Ababa University, (2004)

8. Bhunia, Arun K. Foodborne microbial pathogens: mechanisms and pathogenesis. Springer, 2018

9. De Knegt, L. V., Sara Monteiro Pires, and Tine Hald. "Attributing foodborne salmonellosis in humans to animal reservoirs in the European Union using a multi-country stochastic model." Epidemiology & Infection 143 (2015): p. 1175-1186.
10. Organization, W.H., Antimicrobial resistance: global report on surveillance: *World Health Organization*. (2014)

11. Bezerra, W.G.A., Silva, I.N.G., Vasconcelos, R.H., Machado, D.N., de Souza Lopes, E., Lima, S.V.G., de Castro Teixeira, R.S., Lima, J.B., Oliveira, F.R. and Maciel, W.C., Isolation and Antimicrobial Resistance of *Escherichia Coli* and *Salmonella Enterica* Subsp Enterica in Broiler Chickens, *Acta. Sci.Vet.*, (2016). 44: p. 1-7.

12. Kindu, A., Addis and Mekonnen, A survey on *Salmonella* infection among chicken flocks in Jimma town, Ethiopia, Africa. *j.microbiology. res*, (2013) 7: p. 1239-1245.

13. Bayu, Z., Asrade, B., Kebede, N., Sisay, Z., and Bayu, Y., identification and characterization of *salmonella* species in whole egg purchased from local markets in Addis Ababa, Ethiopia, *J. of Vet. Med and Anim. Heal*, (2013). 5: p. 133-137.

14. Duguma, Belay, Yisehak Kechero, and Geert PJ Janssens. "Survey of major diseases affecting dairy cattle in Jimma town, Oromia, Ethiopia." *Global veterinaria* 8 (2012): p. 62-66.

15. Thrusfield, M., Veterinary Epidemiology 3rd ed. *Black well Science Ltd London, England*, (2005) p. 228-245.

16. García, C., Soriano, J.M., Benítez, V. and Catalá-Gregori, P, Assessment of *Salmonella* spp. in feces, cloacal swabs, and eggs (eggshell and content separately) from a laying hen farm, *Poul.scie.*, (2011). 90: p. 1581-1585.

17. Standardization, I.O.f., Microbiology of food and animal feeding stuffs Horizontal method for the detection of *Salmonella* spp. ISO, (2002). 6579: p. 62.

18. Msallam, A.K., Occurrence of *Salmonella* spp. in Hens Eggs and their Environment in Selected Farms in Gaza Strip (Doctoral dissertation, *Islamic University-Gaza*. (2008).

19. International Organization for Standardization. ISO-6579. "Microbiology--General guidance on methods for the detection of Salmonella." (2002): 27
20. Özkalp, B., Isolation and identification of *salmonellas* from different samples Dange. *Foodborne Pathog*, (2012): p. 21:7-29.

21. Wallace H. Andrews, H.W., Andrew Jacobson, and Thomas Hammack, "Bacteriological Analytical Manual (BAM). Chapter 5 Salmonella" (2011).

22. Wragg, P., Randall, L., and What more, A. M, Comparison of Biolog GEN III MicroStation semi-automated bacterial identification system with matrix-assisted laser desorption ionization-time of flight mass spectrometry and 16S ribosomal RNA gene sequencing for the identification of bacteria of veterinary interest, *J.microbiolog.meth*, (2014). 105: p. 16-21.

23. Osielska, Maria Aleksandra, and Paweł Piotr Jagodziński. "Long non-coding RNA as potential biomarkers in non-small-cell lung cancer: What do we know so far?." *Biomedicine & Pharmacotherapy* 101 (2018): p. 322-333.

24. Matsumura, Paul M., Jones M. Hyman, Scott R. Jeffrey, Martin J. Maresch, Thurman C. Thorpe and William G. Barron, Device and method for microbial antibiotic susceptibility testing, (2000).

25. Lambey, H.S., Verma, A.K., Jain, U. and Bist, B, Bacteriological quality of chevon and pork in Mathura City, *J.of Vet. Pub.Heal*, (20090. 7(2): p. 141-143.

26. Dabassa, A.a.B., K., The Prevalence and Antibiogram of *Salmonella* and *Shigella* Isolated from Abattoir, Jimma Town, Southwestern Ethiopia. in *Conference of Jimma University*, 2011: p. 169.

27. Elson, R., Little, C.L. and Mitchell, R.T, *Salmonella* and raw shell eggs: results of a cross-sectional study of contamination rates and egg safety practices in the United Kingdom catering sector, *J. fo. Prote. ,* (2005). 68: p. 256-264.

28. Gantois, I., Ducatelle, R., Pasmans, F., Haesebrouck, F. and Gast, R Mechanisms of egg contamination by *Salmonella Enteritidis*, *Fems Microbiol. Rev*, (2009) 33: p. 718-738.
29. Foley, S.L., Lynne, A.M. and Nayak, R. S, *Salmonella* challenges: prevalence in swine and poultry and potential pathogenicity of such isolates, *J. animscie* (2008). 86: p. 149-162.

30. Velge, P., A. Cloeckaert and P. Barrow, Emergence of *Salmonella* epidemics: the problems related to *Salmonella enterica* serotype Enteritidis and multiple antibiotic resistances in other major serotypes. *Vet. Res*, (2005) 36: p. 267-288.

31. Tessema K, Bedu H, Ejo M, Hiko A Prevalence and Antibiotic Resistance of Salmonella Species Isolated from Chicken Eggs by Standard Bacteriological Method. *J Vet Sci Technol* 8: 421. doi: 10.4172/2157-7579.1000421.

32. Singh, S., Yadav, A.S., Singh, S.M. and Bharti, P., Prevalence of *Salmonella* in chicken eggs collected from poultry farms and marketing channels and their antimicrobial resistance. *Food. Res Inter*, (2010). 43: p. 2027-2030.

33. Humphrey TJ, B.A., Mawer S, Rowe B, Hooper S., *Salmonella* enteritidis phage type 4 from the contents of intact eggs: a study involving naturally infected hens, *Epi and Inf*, (1989) 103: p. 415-23.

34. Agulles, T.M., how egg quality impacts the health of day-one-chicks?, *Poult. Fish Wildl. Sci*, (2014).

35. Lopez, L., Roos, R., Cressey, P., ESR, B.H. & MPI, J.L, foodborne disease in new zealand, Ministry for Primary Industries, (2016).

36. Andrews, W. H. "Salmonella: Bacteriological Analytical Manual." *Food Drug Administration* (1993): p. 5-01.

37. Suresh, T., Hatha, A.A.M., Sreenivasan, D., Sangeetha, N. and Lashmanaperumalsamy, P prevalence and antimicrobial resistance of *salmonella* enteritidis and other *salmonellas* in the eggs and egg-storing trays from retails markets of coimbatore, South India, *Food microbiolog*, (2006) 23: p. 294-299.
38. Tassew, A., Isolation, identification, antimicrobial profile and molecular characterization of enterohaemorrhagic isolated from ruminants slaughtered at debre zeitelfora export abattoir and addis ababa abattoirs enterprise, (2015)

39. Garedew L., H.Z., Addis Z., Tesfaye R. and Zegeye B, Prevalence and antimicrobial butcher shops in Gondar town, Ethiopia. Antimicrob. Resis. and Infect. Cont, (2015) 4: p. 015-0062.

40. Reda, A.A., Seyoum, B., Yimam, J., Fiseha, S. and Jean-Michel, V, Antibiotic susceptibility patterns of Salmonella and Shigella isolates in Harar Eastern Ethiopia. J. Infec.t Dis. mmu, (2011) 3: p. 134-139.

41. Tsegaye, S., Beyene, W., Tesfaye, B., Tesfaye, S. and Feleke, A, Prevalence and antimicrobial susceptibility pattern of Salmonella species from exotic chicken eggs in Alage, Ziway and Shashemene, Ethiopia, Afric. J. Ba. sApp. Scie, (2016) 8: p. 180-4.

42. Mouttotou, N., Ahmad, S., Kamran, Z. and Koutoulis, K.C, Prevalence, Risks and Antibiotic Resistance of Salmonella in Poultry Production Chain, (2017)

43. Perron, G.G., Bell, G. and Quessy, S, Parallel evolution of multidrug-resistance in Salmonella enterica isolated. FEMS. Microbiology. letters, (2008) 281: p. 17-22.

44. Dominic, H., Barbara, R., Aniko, P., Michael, R., Peter, B., Scott, B., Mark, E., Barbara, T., Colin, M., Shawn, D. and Colin, H, Antibiotic Susceptibilities of Pseudomonas aeruginosa Isolates Derived from Patients with Cystic Fibrosis under aerobic, anaerobic and biofilm Conditions, (2005). 43: p. 5085-5090.

45. Brown, K., Li, W., & Kaur, P, Role of aromatic and negatively charged residues of DrrB in multisubstrate specificity conferred by the DrrAB system of Streptomyces peucetius. Biochemistry (2017), 56: p.1921-1931.

46. Musgrove, M.T.J., D. R., Northcutt, J. K. Cox, N. A. Harrison, M. A. Fedorka-Cray, P. J. and Ladely, S. R., Antimicrobial Resistance in Salmonella and Escherichia coli Isolated from
Commercial Shell Eggs, *Poult. Scie*, (2006) 85: p. 1665-1669.

47. Tessema, K., Bedu, H., Ejo, M. and Hiko, A, prevalence and antibiotic resistance of *salmonella* species isolated from chicken eggs *J.Vet.Sci.Technol*, (2017). 8.(421).

48. Bekele, B.a.A., M, Distribution of drug resistance among enterococci and *salmonella* from poultry and cattle in Ethiopia, *Trop. Anim. Heal. Prod*, (2010) 4: p. 857-64.

**Tables**

Due to technical limitations, tables 1 through 3 only available as downloads in the supplemental files section.

**Supplementary Files**

This is a list of supplementary files associated with the primary manuscript. Click to download.

Table 3.jpg
Table 2.jpg
Table 1.jpg