Isolation and Antibiotic Susceptibility of Campylobacter Species from Cattle Offals in Gwagwalada Abattoir, Abuja-FCT Nigeria

H.O.K. Olabode*, S. Mailafia, M.E. Ogbole, G.R. Okoh, C.I.C. Ifeanyi, H.O. Onigbanjo and I.B. Ugbaja

Department of Microbiology, Faculty of Veterinary Medicine, University of Abuja, Nigeria

*Corresponding author

A B S T R A C T

This study was conducted to establish the occurrence and antibiotic susceptibility testing on isolates of Campylobacter obtained in cattle offals slaughtered within Gwagwalada abattoir. A total of 75 samples were collected over a period of five weeks using sterile swab sticks for cultures on blood free selective Campylobacter agar (modified CCDA-Preston) enriched with selective supplement and incubated at 42°C for 48 hours microaerobically. The colonies were subjected to biochemical reactions of oxidase, catalase, citrate, indole reaction, hydrogen sulphide production and motility test. Antibiotic sensitivity test was also performed using an antibiotic impregnated multi-disk (Optudisc, UK) Gentamycin (10µg), Streptomycin (30µg), Rifampicin (20µg), Erythromycin (30µg), Ampiclox (20µg), Amoxicillin (20µg), Chloramphenicol (30µg), Levofloxacin (20µg) and Norfloxacin (10µg). Cultural and Gram staining characteristics showed 68% were positive for Campylobacter spp as gram negative curved rods. Biochemical reaction further revealed isolates were motile, oxidase, catalase and citrate utilization positive, as well as indole and hydrogen sulphide negative. Antibiotic sensitivity testing revealed that isolates were sensitive to Gentamycin and Amoxil and resistant to Norfloxacin, Rifampicin, Chloramphenicol, Streptomycin and Ampiclox but showed some effect to Ciprofloxacin, Levofloxacin and Erythromycin. These Campylobacter isolates within offals has a potential ability to contaminate meat obtained from the abattoir which may increase the risk of human infection. This finding indicates the presence of Campylobacter isolates in cattle offals showing resistance to commonly used antibiotics. Awareness campaign amongst both butchers and the general public on the occurrence and possible contamination of beef with Campylobacter is recommended with emphasis on safe and wholesome meat preparation and good hygienic slaughtering practices.

Keywords
Isolation, Antibiotic Susceptibility, Campylobacter species, Cattle offals, Gwagwalada abattoir

Introduction

Campylobacteriosis is a significant emerging bacterial foodborne zoonosis caused by the bacterial genus of Campylobacter, primarily associated with consumption of undercooked poultry, other meat products (Mazick et al., 2006) contaminated with faeces (Friedman et al., 2000) especially in several industrialized countries (Altekruse et al., 1999) and characterized by Campylobacter gastroenteritis (Kapperud et al., 2003). The genus Campylobacter comprises of about 16 species and 4 sub - species (Vandamme, 2002) which are Gram negative, micro-aerophilic, curved or spiral rods, with a single polar flagellum.
Campylobacter have been incriminated in a variety of animal diseases including abortion in sheep and goats (Andersen et al., 1983), infertility and abortion in cattle, diarrhea in sheep and cattle (Al-Mashat and Taylor, 1980), intestinal adenomitis in swine and gastroenteritis and abortion in dogs (Adak et al., 2005). Genital Campylobacteriosis in animals have occurred during coitus and artificial insemination (AI) in cows (Skirrow, 1977). However, Chicken and cattle are the principal sources of C. jejuni pathogenic to humans, whereas wild animal and environmental sources have been associated with about 3% of the disease (Wilson et al., 2008).

The routes of transmission of Campylobacter between food animals and humans are numerous and complex (Andersen et al., 2006). Foodborne transmission is the mode by which majority of the cases occur. Raw poultry meat has often been implicated as the major source of human Campylobacteriosis (Wingstrand et al., 2006).

Contamination of cattle carcasses during processing either directly or indirectly have also been reported (Sharon et al., 2013). However, person–to-person spread of infection was reported but is uncommon (Blaser et al., 1981) Human foodborne illness have been reported post consumption of Campylobacter contaminated bovine products like unpasteurized milk (Sato et al., 2004) and meat (Osano and Arimi, 1999) with serious public health consequences (Besser et al., 2005, Friedman et al., 2004). Contaminated surface water run-off from bovine reservoirs and cattle pastures and or direct cattle contact (Friedman et al., 2000) were also documented during disposal of abattoir effluents and slurries which contaminates water for human consumption (Tauxe, 1992).

Epidemiological studies have identified a significant association between Campylobacter infection in humans and consumption as well as handling of poultry (Wingstrand et al., 2006). However, other studies reported similar association with cattle (Garcia et al., 1985). This direct contact exposure to bovine faeces and consumption of unpasteurized cow milk are the leading causes of acute bacterial Campylobacteriosis outbreaks in cattle (Sato et al., 2004) and humans globally (Nachamkin, 1995) with enteric Campylobacteriosis been prevalent amongst HIV-infected patients (Sorvillo et al., 1991) and found to be resistant to antimicrobial therapy especially C. jejuni (Altekruse et al., 1999) alongside other observed complications of Neuropathies such as Guilliam-Barre syndrome (GBS) (Godschalk et al., 2006), myocarditis (Cunningham and Lee, 2003).

The increasing concern based on previous epidemiological studies on the potential role of non-poultry sources for human clinical infections has been underestimated (Ngulukun, 2009, 2011). The relative direct and indirect contributions of cattle and sheep to human infections are still poorly understood (Frost, 2001). This premised the study to investigate the occurrence and antibiotic susceptibility testing of Campylobacter isolates in slaughtered cattle offals from Gwagwalada abattoir for the purpose of designing a disease control plan.

**Materials and Methods**

**Study area**

Gwagwalada is one of the six Area Councils of the Federal Capital Territory of Nigeria, alongside Abaji, Kuje, Bwari, Kwali and Abuja municipal area council. University of Abuja is located in Gwagwalada, which has an area of 1,043 km² and population of 157,770 during the 2006 census. Gwagwalada
is on geographical coordinates of 8° 56’ 29” North, 7° 5’ 31” East as shown on satellite images (3D Google Earth) with an extremely hot and daily temperature of 31°C. The abattoir is located mid-way between the popular ‘kasuwandere’ and the Federal Radio Corporation of Nigeria (FRCN) along old Kutunku road. The abattoir has been the main source of wholesome meat for the culturally diverse inhabitants of Gwagwalada metropolis and its environs (Olabode, et al., 2011).

**Study design and sampling method**

The study was conducted between July and August 2016 in Gwagwalada metropolis abattoir, Gwagwalada Area Council of the Federal Capital Territory (FCT) Abuja. There were five (5) visits to the abattoir (forth nightly) during which samples were collected randomly from intestinal (offals) lumen of cattle immediately post slaughter. Fifteen (15) samples were collected weekly and stored 4°C and transported in cold boxes to the laboratory for analysis over a period of five weeks.

**Sample collection and processing**

A total of seventy five (75) samples were collected during the study period and location. Fifteen samples were collected on each visit to the abattoir over the five weeks period using sterile swab sticks. These intestinal swabs were appropriately labeled and designated as abattoir cattle using the abbreviation “AC”: AC1, AC2 ------- AC75 and transported in cold boxes to the laboratory for analysis over a period of five weeks.

**Media**

The media used for this study include *Campylobacter* blood-free selective agar (Modified CCDA- Preston) (Oxoid, Hampshire, England) and CCDA Selective supplement (SR155E) for Isolation, SIM [Sulphide-Indole-Motility] (Merck, Germany), Simmon Citrate Agar (Hi-Media, India), Kovacs reagent (Hi-Media, India) for biochemical reactions and Muller Hinton Agar (Hi Media, India) for Antibiotic susceptibility testing. All these media were prepared in accordance with manufacturer’s instructions and sterilized using an autoclave at 121°C for 15 minutes.

**Sample plating and inoculation**

Samples were innoculated unto solid agar plates by streaking out technique on modified CCDA-preston using swab sticks. Inoculated agar plates were then transferred into anaerobic gas jar with a control plate (not inoculated), and the lid closed, (this is to create a microaerobic environment for normal growth and metabolism of *Campylobacter*). The jar was then transferred into the incubator for a period of 48 hours at 42°C.

**Culture and identification**

Post incubation, the cultural growth were visually and macroscopically identified as described by Teufel, (2002) for Flat, smooth, glossy and grayish colonies with no confluent growth. The colonies were later Gram stained as described by Bergey et al., (1994) for Gram negative, curved or spiral rods, with single polar flagellum post microscopic examination.

**Biochemical reaction**

Suspicious colonies of *Campylobacter* species were used for biochemical characterization post sub culturing on *Campylobacter* blood-free selective agar (Modified CCDA- Preston) (Oxoid, Hampshire, England) and CCDA Selective supplement (SR155E). The isolates were subjected to biochemical tests (Catalase,
Oxidase, Motility, Indole, Hydrogen Sulphide test, and Citrate utilization) in accordance with standard methods.

**Antibiotic susceptibility testing**

The isolates were subjected to antibiotic susceptibility test using disc diffusion method as described by Taradon, *et al.*, (2007). Antibiotics impregnated disk (OPTUDISC, UK) used include; Ciprofloxacin (10µg), Norfloxacan (10µg), Gentamycin (10µg), Amoxicillin (20µg), Streptomycin (30µg), Erythromycin (30µg), Rifampicin (20µg), Chloramphenicol (30µg), Levofloxacin (20µg), Ampiclox (20µg). The isolates were uniformly and aseptically inoculated unto a set of dried sterile Mueller-Hinton agar plates and kept for 3-5 minutes post streaking to allow for drying off excess surface. Then, the antibiotic Multi-discs were aseptically placed on the agar using sterile forcep and incubated at 37°C for 24 h. The clear zones of inhibition were measured to the nearest millimeter using a transparent Millimeter ruler. The results were expressed as susceptible, intermediate, and resistant as indicated by the Clinical and Laboratory Standards Institute guidelines (CLSI, 2006).

**Statistical analysis**

The data generated from the research work was analyzed using descriptive statistics such as frequency, percentages and chart.

**Results and Discussion**

Out of the seventy five (75) samples collected from the intestinal tracts of sampled cattle in Gwagwalada abattoir during the study period. Fifty-one (51) [68%] samples were positive with typical morphological characteristics (gram negative curved rods) for *Campylobacter* as indicated in table 1 and figure 1.

For week one 8 (53%) were positive for *Campylobacter*, week two had 10 (67%) samples positive for *Campylobacter*, week three had 13 (86%) samples positive for *Campylobacter*, week four had 12 (80%) samples positive for *Campylobacter*, week five had 8 (53%) samples positive for *Campylobacter* as indicated in table 2.

Biochemical characterization showed that the isolates were motile, oxidase positive, indole negative, catalase positive, citrate utilization positive, and Hydrogen sulphide negative as indicated in table 3.

Antibiotic sensitivity testing further revealed that the isolates were sensitive to Ciprofloxacin, Gentamycin, Amoxil, Erythromycin and Levofloxacin and were resistant to Norfloxacin, Rifampicin, Chloramphenicol, Streptomycin and Ampiclox as shown in table 4.

In this study the overall prevalence of *Campylobacter* isolates in cattle slaughtered in Gwagwalada abattoir was 68%. This prevalence is as high as the 66.7% (Ngulukun, *et al.*, 2011) reported in Plateau state. The increased rate of isolation in the study could be associated with the specific agar and enrichment medium employed. The increased occurrence could also be attributed to the management type (free ranged), and sources (markets/herds) where the cattle were transited from, before slaughter in the study area.

The observed colonies of *Campylobacter* showed grey, butyrous, moist, flat and spreading topography, the isolates were gram negative curved rods in shaped as described (Quinn *et al.*, 1994). Biochemically, isolates were oxidase, catalase and citrate positive, isolates were motile, indole negative and did not produce Hydrogen Sulphide.
### Table 1: Weekly distribution of *Campylobacter* isolates obtained from cattle offals in Gwagwalada abattoir

| Weeks | Sources | Sample Collected | Number +ve | Number -ve |
|-------|---------|------------------|------------|------------|
| 1     | Cattle  | 15               | 8          | 7          |
| 2     | Cattle  | 15               | 10         | 5          |
| 3     | Cattle  | 15               | 13         | 2          |
| 4     | Cattle  | 15               | 12         | 3          |
| 5     | Cattle  | 15               | 8          | 7          |
| Total |         | 75               | 51 (68%)   | 24         |

**Keys:** +ve: Positive, -ve: Negative

### Table 2: Occurrence of *Campylobacter* isolates in cattle offals slaughtered in Gwagwalada

| Weeks | Sample Collected | Number +ve | Number -ve |
|-------|------------------|------------|------------|
| 1     | 15               | 8 (16%)    | 7          |
| 2     | 15               | 10 (20%)   | 5          |
| 3     | 15               | 13 (25%)   | 2          |
| 4     | 15               | 12 (24%)   | 3          |
| 5     | 15               | 8 (16%)    | 7          |
| Total | 75               | 51 (68%)   | 24 (32%)   |

**Keys:** +ve: Positive, -ve: Negative

### Table 3: Biochemical characterization of *Campylobacter* isolates from intestinal content

| No. of +ve | Motility | Oxidase | Indole | Catalase | Citrate | Gram staining | H2S Production |
|------------|----------|---------|--------|----------|---------|---------------|----------------|
| AC 5       | +        | +       | -      | +        | +       | -             | -              |
| AC 6       | +        | +       | -      | +        | +       | -             | -              |
| AC 7       | +        | +       | -      | +        | +       | -             | -              |
| AC 8       | +        | +       | -      | +        | +       | -             | -              |
| AC 16      | +        | +       | -      | +        | +       | -             | -              |
| AC 19      | +        | +       | -      | +        | +       | -             | -              |
| AC 21      | +        | +       | -      | +        | +       | -             | -              |
| AC 24      | +        | +       | -      | +        | +       | -             | -              |
| AC 33      | +        | +       | -      | +        | +       | -             | -              |
| AC 36      | +        | +       | -      | +        | +       | -             | -              |
| AC 42      | +        | +       | -      | +        | +       | -             | -              |
| AC 47      | +        | +       | -      | +        | +       | -             | -              |
| AC 50      | +        | +       | -      | +        | +       | -             | -              |
| AC 54      | +        | +       | -      | +        | +       | -             | -              |
| AC 55      | +        | +       | -      | +        | +       | -             | -              |
| AC 60      | +        | +       | -      | +        | +       | -             | -              |
| AC 64      | +        | +       | -      | +        | +       | -             | -              |
| AC 67      | +        | +       | -      | +        | +       | -             | -              |
| AC 71      | +        | +       | -      | +        | +       | -             | -              |

**Keys:** +ve Positive reaction, -ve Negative reaction  AC: Abattoir cattle
Table 4 Antibiotic sensitivity pattern of Bovine *Campylobacter* isolates

| Antibiotics     | Samples tested | Sensitive | Resistant | Zone of inhibition (mm) |
|-----------------|----------------|-----------|-----------|-------------------------|
| Ciprofloxacin   | 10             | I         | -         | 18                      |
| Norfloxacin     | 10             | -         | R         | Nil                     |
| Gentamycin      | 10             | S         | -         | 21                      |
| Amoxil          | 10             | S         | -         | 22                      |
| Streptomycin    | 10             | -         | R         | Nil                     |
| Rifampicin      | 10             | -         | R         | Nil                     |
| Erythromycin    | 10             | I         | -         | 19                      |
| Chloramphenicol | 10             | -         | R         | Nil                     |
| Ampiclox        | 10             | -         | R         | Nil                     |
| Levofloxacin    | 10             | I         | -         | 17                      |

**Keys:** S- Susceptible, I- Intermediate, R- Resistant  
S +++: 20-30mm Zone of Inhibition  
I ++: 10-20mm Zone of Inhibition  
R: 0 < 10mm Zone of Inhibition

Fig. 1 Pie chart showing the weekly distribution of *Campylobacter* isolates in Gwagwalada abattoir

However, hippurate hydrolysis that has capacity to differentiate *Campylobacter jejuni* from *Campylobacter coli* was not conducted as *C. coli* usually indicates a negative reaction to hippurate test and *C. jejuni* have been associated more with pathogenic infection.
(Salihu et al., 2009). Although, previous reports of Campylobacter species isolation have been documented (Ngulukun et al., 2009) in apparently healthy cattle.

The Campylobacter species isolates tested were sensitive to gentamycin and amoxicillin in this study. Amoxicillin susceptibility contrast previous report Tajada et al., (1996) that organisms are resistant to a large number of betalactams particularly ampicillin and amoxicillin. The isolates were moderately susceptible to erythromycin, ciprofloxacin, and levofloxacin. The erythromycin zone of inhibition is similar to previous findings (Gaudreau et al., 2007; Okunlade, et al., 2015) and ciprofloxacin susceptibility is in line with Okunlade, et al., (2015) but contrast Gaudreau et al., (2007) this in consistency indicates increasing resistance of Campylobacter to antibiotics particularly macrolides and fluoroquinolones as reported (Asrestrup and Enberg, 2001). The high resistance to most of the antimicrobial agents tested in this study may be the consequence of indiscriminate use and abuse of these drugs in livestock herds and farms.

The high occurrence of Campylobacter spp in offals of slaughtered cattle suggests the possible contamination of commercially obtained meat and butchers handling meat and offals during slaughter operations as well as environment especially the surface water during disposal of abattoir effluent and animal slurry to land (Inglis et al., 2004).

The observed post mortem and sanitary operating standards during this study is poor, characterized by weak veterinary supervision. Intestinal gut contents are dump either in the drainages (gutter) constructed beside the slaughter slabs or spilled on the floor where carcasses are kept before transportation to the market. Thus, there exists the possibility of contamination and hence the occurrence of Campylobacter spp in the study area.

Therefore, this study provides a preliminary report on the existence of Campylobacter species in Gwagwalada as a potential zoonotic problem associated with the supply of unwholesome meat and offals from the abattoir for human consumption especially amongst vulnerable groups. In addition, Campylobacter species isolates were susceptible to Gentamycin and showed increased resistance to fluoroquinolones and macrolides antibiotics most commonly used antibiotic for the treatment of human diarrhea. Hence, the needs to further conduct molecular biotyping studies to identify the specific Campylobacter species involved and educate the public especially the abattoir workers and women on the need to conduct proper hygienic practices during meat and meat products handling is thus suggested.

References
Aarestrup, F.M., and Engberg, J. 2001. Antimicrobial resistance of thermophilic Campylobacter. Vet. Res. 32: 311-321.

Adak, G.K., S.M Meakins, H. Yip, B.A. Lopman, and O’Brien, S. J. 2005. Disease risks from foods, England and Wales, 1996-2000. Emerg. Infect. Dis. 11:365-372.

Altekruse, S. F., N. J. Stern, P.I. Fields, and Swerdlow, D. L. 1999. Campylobacter jejuni an emerging food borne pathogen. Emerg. Infect. Dis. 5 (1): 28-35.

Al-Mashat, R.R., and Taylor, D. J. 1980. Campylobacter species in enteric lesions in cattle. Vet. Rec. 107: 32-34.

Anderson, K. L., M. M. Hamoud, J.W Urbance, M.S. Rhoades, and Bryner, J. H. 1983. Isolation of Campylobacter jejuni from an aborted caprine foetus. J. American Vet. Med. Assoc. 63: 90 –
92.
Andersen, S. R., P. Saadby, N. M. Shukri, H. Rosenquist, N. L. Nielson, and Boel, J. 2006. Antimicrobial resistance among \textit{Campylobacter jejuni} isolated from raw poultry meat at retail level in Denmark. Int. J. Food Microbiol. 107: 250 - 255.

Besser, T. E., J. T. Lejeune, D. H. Rice, J. Berg, R. P. Stilborn, K. Kaya, W. Bae, and Hancock, D. D. 2005. Increasing prevalence of \textit{Campylobacter jejuni} in feedlot cattle through the feeding period. Appl. Environ. Microbiol. 71: 5752-5758.

Bergey, D., J. G. Holt, N R. Krieg, and Sneath, P. H.A. 1994. In: Bergey’s Manual of Determinative Bacteriology, Ninth ed. Lippincott Williams & Wilkins.

Blaser, M. J., D. N. Taylor, and Feldman, R. A. 1984. Epidemiology of \textit{Campylobacter} infections In: \textit{Campylobacter} infection in Man and Animals, ed., Butzler, J. P. Boca Raton, FL: CRC Press. pp. 143-161.

Clinical and Laboratory Standards Institute [CLSI] 2006. Performance standards for antimicrobial disk susceptibility tests, approved standard, 9th ed. Clinical and Laboratory Standards document M2-A9. Clinical and Laboratory Standards Institute, Wayne, PA.

Cunningham, C., and Lee, C. H. 2003. ‘Myocarditis related to \textit{Campylobacter jejuni} infection: a case report’. BMC Infect. Dis. 3:16.

Friedman, C. R., Neimann, J., Wegener, H. C and Tauxe, R. V. (2000). Epidemiology of \textit{Campylobacter jejuni} infection in the United States and other Industrialized Nations. In: I. Nachamkin and M. J. Blaser (ed), \textit{Campylobacter}, Second edition. ASM Press, Washington D.C. pp. 121-138.

Friedman, C. R., R. M. Hoekstra, M. Samuel, R. Marcus, J. Bender, B. Shiferaw, S. Reddy, S. D. Ahuja, D. L. Helfrick, F. Hardnett, M. Carter, B. Anderson, R. V. Tauxe, and Emerging Infections Program Food Net Working Group 2004. Risk factors for sporadic \textit{Campylobacter} infection in the United States: a case-control study in FoodNet sites. Clin. Infect. Dis. 38 (3): 285-296.

Frost, J. A., 2001. Current epidemiological issues in human Campylobacteriosis. Symp. Ser. Soc. Appl. Microbiol. 85-95.

Garcia, M. M., H. Lior, R. B. Stewart, G. M. Ruckebauer, J. R. Trudel, and Skljarevski, A. 1985. Isolation, characterization, and serotyping of \textit{Campylobacter jejuni} and \textit{Campylobacter} coli from slaughter cattle. Appl. Environ. Microbiol. 49: 667-72.

Godschalk, P. C., M. P. Bergman, R. F. Gorkink, G. Simons, N. van den Braak, A. J. Lastovica, H. P. Endtz, H. A. Verbrugh, and van Belkum, A. (2006). Identification of DNA sequence variation in \textit{Campylobacter jejuni} strains associated with the Guillain-Barre syndrome by high-throughput AFLP analysis. BMC Microbiol. 6:32.

Gaudreau C., Y. Girouard, L. Ringuette, and Tsimiklis, C. 2007. Comparison of disk diffusion and agar dilution method for erythromycin and ciprofloxacin susceptibility testing of \textit{Campylobacter coli} and for tetracycline susceptibility testing of \textit{Campylobacter jejuni} subsp \textit{jejuni}. Antimicrob. Agents Chemother. 51: 1524-1526.

Inglis, G. D., L.D. Kalischuk., and Busz, H.W. 2004. Chronic shedding of \textit{Campylobacter} species in beef cattle. Journal of Applied Microbiology. 97:
Kapperud, G., G. Espeland, E. Wahl, A. Walde, H. Herikstad, S. Gustavsen, I. Tveit, O. Natås, L. Bevanger, and Digranes, A. 2003. Factors associated with increased and decreased risk of Campylobacter infection: a prospective case-control study in Norway. American J. Epidemiol. 158: 234-242.

Mazick, A., S. Ethelberg, E.M.K. Nielsen, K. Molbak, and M. Lisby. 2006. An outbreak of Campylobacter Jejuni associated with consumption of chicken Copenhagen, Eurosurveillance. 11: 137-139.

Nachamkin, I., 1995. Campylobacter and Arcobacter. In: Manual of Clinical Microbiology. ASM Press, Washington, D.C. pp. 483–491.

Ngulukun, S. S., S.I. Oboegbulem, P.A. Okewole, M. J. Muhammed, O. O. Chukwu, W. J. Bertu, M. Sugun,G.D. Moses, and Gusi, A. M. 2009. Occurrence of Thermophilic Campylobacter species in apparently healthy cattle in Vom, Nigeria.Vom J. Vet. Sci. 6: 74-77.

Ngulukun, S. S., S. I. Oboegbulem,I.O. Fagbamilla,W. J. Bertu, and Odugbo, M.O. 2011. Prevalence and Molecular Characterization of Thermophilic Campylobacter species isolated from cattle in Plateau State, Nigeria. Nig. Vet. J. 32(4):349-356.

Okunlade, A. O., A.O. Ogunleye, F.O. Jeminlehin, and Ajuwape, A. T. P. 2015.Occurrence of Campylobacter species in beef cattle and local chickens and their antibiotic profiling in Ibadan, Oyo State, Nigeria. Afri. J. Microbiol. Res. 9(22): 1473-1479

Olabode, H.O.K., S. Mailafia, B. M. J. Adah, P. Nyambee, and Bello. R.H. 2011. Antibiogram of bacterial isolates associated reproductive abnormalities in sheep in Gwagwalada–FCT, Nigeria. J. Agric. Vet. Sci. 3: 20-27

Osano, O., and Arimi, S. M. (1999). Retail poultry and beef as sources of Campylobacter jejuni. East Afri. Med. J. 76: 141-143.

Quinn, P. J., M. E. Carter, G.R. Carter,. and Markey, P. 1994. Campylobacter species. In: Veterinary Clinical Microbiology, First edition. Mosby, London. Pp. 268-275.

Sato, K., P.C. Bartlett, J.B. Kaneene, and Downes, F. P. 2004. Comparison of prevalence and antimicrobial susceptibilities of Campylobacter species isolates from organic and conventional dairy herds in Wisconsin. Appl. Environ. Microbiol.70: 1442-1447.

Salihu, M.D., U. A. Junaidu, S.I. Oboegbuleum, G.O. Egwu, A. A. Magaji, M. Lawal, and Hassan, Y. 2009. Isolation and prevalence of Campylobacter from Sokoto State, Nigeria. Veter.Hal. Ser.45 (4): 501-505.

Sharon V. R, B. Roger, E. Michael, D. P. Timothy, C.A. Robin, and David, J. N. 2013. Foodborne Campylobacter: Infections, Metabolism, Pathogenesis and reservoir. Int. J Environ. Res. Pub. hltth. 10: 6292-6304.

Sorvillo, F. J., L. E. Lieb, and Waterman, S. H. 1991. Incidence of Campylobacteriosis among patients with AIDS in Los Angeles County. JAIDS. 4:598-602

Skirrow, M. B (1994). Diseases due to Campylobacter, Helicobacter and Related Bacteria. J. Comp. Path. 111: 113 - 214.

Taradon, L., Y.M. Teresa, B.E. Amma, J. I. Aaron, and Qijing, Z. 2007. Comparison of Antimicrobial Susceptibility Testing of Campylobacter spp. by Agar Dilution
and Agar Disk Diffusion Methods. J. Clin. Microbiol. 45(2):590-594
Tauxe, R. V. 1992. Epidemiology of Campylobacter jejuni infections in the United States and other industrialized Nations. In: I. Nachamkin, M. J. Blaser, and L. S. Tompkins (ed.), Campylobacter jejuni: Current status and Future trends. American Society for Microbiology, Washington, DC pp. 9–16.
Tajada, P., J. L. Gomez-Garces, J. I. Alos, D. Balas, and Cogollos, S. (1996). Antimicrobial susceptibilities of C. jejuni and C. coli to 12 B-lactam agents and combinations with B-lactamase inhibitors. Antimicrob. Agents Chemothera. 40: 1924 -1925.
Teufel, P., 2002. Campylobacter coli and Campylobacter jejuni. Elsevier science. pp 237-243.
Wilson, I.G., 2003. Antibiotic resistance in raw retail chickens and imported chicken portions. Epidemiol. Infect. 131: 1181-1186.
Vandamme, P., 2002. Taxonomy of the family Campylobacterriaceae, eds, I. Nachamkin and M. J. Blaser, ASM Press, Washington, D.C. pp.3-26.
Wingstrand, A., J. Neimann, J. Engbreg, N.E. Moller, P. Gerner–Smidt, and Wegener, H. C. 2006. Fresh chicken as main risk factor for Campylobacteriosis, Denmark. Emerg. Infect. Dis. 12: 280-285.