

Original Article

Microbiological Analysis of Poultry Feeds Along with the Demonstration of the Antibiotic Susceptibility of the Isolates and the Antibacterial Activity of the Feeds

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Poultry farms and poultry product processing industries are increasing worldwide to fill up the expanding demand for protein of the escalating population. To get good growth and more eggs from the domestic birds in the poultry farms, nutritious food supplements are commonly known as the poultry feed provided. These feeds also serve as sources of bacterial, fungal and viral contamination which in turn can cause diseases in the birds and ultimately can infect the consumers if the poultry is not processed and cooked properly. In this study, in order to determine the pathogenic bacterial load five different poultry feed samples sold in local markets of Dhaka city were analyzed. All samples harbored total viable bacteria up to 5.0×10^6 cfu/gm and total fungal count up to 4.5×10^5 cfu/gm. While *Escherichia coli* was absent in all samples; *Klebsiella* spp. and *Aeromonas* spp. were found to be present in only one sample (1.4×10^6 cfu/gm in sample 4 and 2.9×10^5 cfu/gm in sample 5 respectively). *Staphylococcus aureus* and *Shigella* spp. were found to be predominant in all the samples. *Pseudomonas* spp. and *Vibrio* spp. were present in 3 and 4 samples, respectively. *Aeromonas* spp., *Vibrio* spp., *Salmonella* spp. and *Staphylococcus aureus* showed 100% drug resistance towards ER, NA, NVB, KAN antibiotics. The finding of the study emphasis on the prevention of contamination through a sound maintenance of quality during poultry feeds preparation, storage and maintenance. Diseased birds and their excreta must be destroyed during poultry farming. Usage of excess antibiotics must be regulated as suggested from the data of the current study that shows high resistance of the bacterial isolates from the food. Finally, the consumers should process and cook the poultry items properly to save themselves from further food hazards.

Key words: Poultry feed, contamination, pathogenic bacteria, resistance, health hazards.

Introduction

Poultry products are very popular among the people worldwide providing a source of high protein containing food. Any type of avian species used for consumption as protein source by providing meat and eggs is called poultry. The birds may be chicken, duck, turkey, pigeons, quail etc^{1,2}. Poultry feeds are nutritious elements given to these domestic birds to make them grow properly and provide more meat and eggs^{3,4,5}. Poultry feeds are prepared using bone meal, cassava waste, grains, cereals, soya beans and vegetables like tridax, water leaf, amaranthus spp. etc^{1,6}. The feeds which are given to the domestic birds can be a source of microorganisms to them which includes bacteria, fungi as well as their secreted toxins. *Escherichia* spp., *Enterobacter* spp., *Salmonella* spp., *Listeria* spp., *Streptococcus* spp., *Clostridia* spp., etc have been isolated so far from poultry feeds and many of them showed multi-drug resistance⁷⁻¹⁹. The growth of molds deteriorates the quality of the feed and production of toxins make the feed toxic, carcinogenic and often teratogenic resulting in different types of diseases in the domestic birds²⁰⁻²⁹. Diseases like cholera, colibacillosis, listeriosis, staphylococcosis, amoebic

dysentery, bacillary dysentery, salmonellosis, avian influenza, newcastle disease, infectious coryza are most common among those diseases which can transmit to the consumers as well^{9-11,30,31}. Human diseases like *Salmonella* paratyphoid fever, traveller's diarrhea etc. can occur due to the consumption of poultry birds which contracted infections from poultry feeds⁵. The poultry feeds can be contaminated during preparation, by using contaminated raw materials, by improper handling, from poor storage conditions, due to high humidity, by exposure to environmental microorganisms and so on³². Contamination can be reduced by applying organic acids, organic salts, exposure to heat (>80°C) etc.

Poultry farming is quite popular in Bangladesh because of its ease of handling as well as lower investment cost which is manageable for the middle class societies. However, the microbiological concerns for feeds are not properly addressed in Bangladesh which may impose several disease complications. Such a concern for public health drove the current study to (1) isolate and enumerate bacteria from the poultry feeds along with the further determination of the antibiotic susceptibility of the

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bacterial isolates and (2) to detect the antibacterial activity of the feeds if present.

Materials and methods

Study area and sampling

Five types of poultry feed samples were collected from different areas of Dhaka city between the time frame of January, 2017 to April, 2017. Samples were collected in sterile glass bottles following the aseptic technique³³. After collection of the samples, they were transported to the laboratory and kept at room temperature until the laboratory procedures started.

Sample collection and sample preparation:

Samples were collected early in the morning and transported and stored. Then it was subjected to microbiological analysis. ten gm of each sample was transferred to 90 ml normal saline for homogenization and then serial dilution was done up to 10^{-5} . For isolation of VBNC bacteria for example *Vibrio* spp., *Salmonella* spp. & *Shigella* spp., 1 ml homogenized sample was inoculated into 9 ml APW (alkaline peptone water) and 9 ml SCB (selenite cysteine broth) respectively for all the samples. The inoculated APW and SCB tubes were vortex mixed properly and incubated at 37°C for 4 to 6 hours for enrichment. After enrichment the tubes were subjected to serial dilution³⁴.

Total Viable Bacterial Count (TVBC) and Total Fungal Count (TFC)

0.1 ml diluted sample from 10^{-3} and 10^{-5} dilution of the homogenized samples of poultry feed were spread onto the nutrient agar (NA) plates and sabouraud dextrose agar (SDA) plates for TVBC and total fungal load respectively. NA plates were kept in the 37°C incubator for 24 hours and SDA plates were kept in the 25°C incubator for 48 hours³⁴.

Determination of *Pseudomonas* spp., *Staphylococcus* spp., *Escherichia coli* & *Klebsiella* spp.

0.1ml sample from 10^{-3} and 10^{-5} dilution was spread over *Pseudomonas* Agar, MSA (Mannitol Salt Agar), MAC (MacConkey Agar) plates and incubated overnight at 37°C to isolate *Pseudomonas* spp., *Staphylococcus* spp., *Klebsiella* spp. and *Escherichia coli* respectively³⁴.

Determination of VBNC bacteria

The enriched SCB and APW tubes were subjected to serial dilution up to 10^{-3} in normal saline. 0.1 ml of sample from 10^{-2} and 10^{-3} dilutions were inoculated onto Thiosulfate Citrate Bile Salt Sucrose (TCBS) agar plates and *Salmonella-Shigella* (SS) agar plates for the detection of *Vibrio* spp., *Aeromonas* spp., *Salmonella* spp., and *Shigella* spp.^{35,36}. All plates were incubated at 37°C for 24 hours^{37,38}.

Antibiotic susceptibility of the isolates found in poultry feeds

Bacterial susceptibility to antibiotics was determined by using the standardized agar disc-diffusion method known as the Kirby Bauer method³³. Antibiotics used in this study included

Gentamycin (10¼g), Erythromycin(15¼g), Ceftriaxone (30¼g), Rifampin (5¼g), Kanamycin (30¼g), Novobiocin (30¼g), Nalidixic Acid (30¼g), Amoxicillin (30¼g), Ciprofloxacin (5¼g). A suspension of the *Salmonella* spp., *Enterobacter* spp., *Pseudomonas* spp., *Klebsiella* spp., *Escherichia coli*, *Proteus* spp., *Vibrio* spp., *Staphylococcus aureus* were prepared. A sterile cotton swab was dipped into the prepared bacterial suspension and used to make lawn of the bacterial suspension evenly over the entire surface of a Mueller-Hinton agar plate. Antibiotic disc were placed aseptically over the surface of the inoculated plates using sterile forceps. The plates were then incubated at 37°C for 8 hours. After incubation the plates were examined & the diameters of the zones of inhibition were measured in mm³⁴.

Antibacterial activity of the poultry feeds against clinical isolates

The antimicrobial activity of the homogenized poultry feed samples were determined by agar well diffusion method⁴⁰. Suspensions of clinical isolates (*Staphylococcus* spp., *Pseudomonas* spp., *Klebsiella* spp., *Vibrio* spp., *Escherichia coli*) were used to make lawn directly on the Muller-Hinton agar (MHA) media separately. Each of the five samples were then introduced (volume of 100¼l) separately in the specified hole made in the MHA agar plates with sterile cork borer. After incubation period of 24 hours, the presence of clear zone around the sample solution indicated the presence of antibacterial activity. This indirectly indicated the presence of antibiotics in poultry feeds tested.

Results and discussion

In Bangladesh, poultry farms are very common which are responsible for commercially providing poultry feeds in the retail and super shops. Both small scale domestic poultry farms and commercial large poultry farms are available in our country. The proper growth and health status of the poultry birds depends on the quality of the supplied poultry feed. Very often low quality, locally produced feeds are provided to the birds of small farms. Such low quality feeds not only provide poor nutrition but also can harbor different types of pathogenic bacteria which can infect the birds and cause disease²⁸. Such poultry products can cause diseases in human if not processed and cooked properly. The pathogenic bacteria from the poultry products can infect human body causing various acute and chronic diseases^{39-44,35}. *Salmonella* spp. can undergo chronic stage in human patients who might become carrier of salmonellosis towards other susceptible individual. Till now, 82 serotypes of *Salmonella* spp. have been reported of which 45 isolates were isolated from poultry feeds^{45,46}. Enterobacteriaceae group is one of the major contaminants of poultry feed²⁶. Poultry droppings from infected birds must be cleaned and disposed properly to reduce the transmission from droppings to other feeds, to human during handling, to fishes when they are used as fish feed⁴⁷.

During the current investigation, five different types of poultry feed samples were selected for microbiological analysis. Total

viable bacterial count was within the range of 5.0×10^4 cfu/gm to 5.0×10^6 cfu/gm. Highest total fungal count (4.5×10^5 cfu/gm) was observed in sample 04 and the lowest count (2.0×10^3 cfu/gm) was found in sample 05. *Escherichia coli* was absent in all the samples. *Aeromonas* spp. and *Klebsiella* spp. were found in only one sample (sample 5 and sample 4 respectively). *Staphylococcus aureus* (2.7×10^5 cfu/gm to 5.0×10^3 cfu/gm) and *Shigella* spp. (3.2×10^4 cfu/gm to 1.1×10^6 cfu/gm) were the most abundant pathogenic bacteria found to be present in all the samples. *Pseudomonas* spp. was present in sample 01, 03 and 04. *Vibrio* spp. was the second most abundant pathogen in the poultry feeds. Four samples out of five harbored *Vibrio* spp. within the range of 1.8×10^5 cfu/gm in sample 5 to 2.4×10^5 cfu/gm in sample 4.

In case of locally made feeds, the quality must be maintained by physical and chemical treatments to lessen the bacterial load. Storage conditions, packaging, handling should also be maintained properly. Cross contaminations must be prevented. The consumption of uncooked eggs and undercooked meat of poultry should be discouraged strongly. If not maintained properly the food products can not only be contaminated but also the contamination level will increase and finally find its way into the consumers causing illness. In a data provided by CDC it had been found that 29444 illnesses cases were confirmed among which 1184 patients were hospitalized resulting in 23 deaths only in the time period of 2009-2010. The main causative agents were *Salmonella* spp., *Clostridium* spp. and *Listeria* spp.^{48,49}. Studies in different countries also showed the presence of different groups of microorganisms in poultry feed which can cause food borne infections^{50,51}. Bacterial limit for animal feed products has been documented by EU Commission Regulation act in 2011 which stated the acceptable count of specific microbes in the feed. For example *Enterobacteriaceae* spp. 300 cfu/gm, *Salmonella* spp. nil, moulds and yeast 10^6 cfu/ml⁵².

Drug resistance has become a dreadful clinical obstacle these days. Such resistances are increasing due to mutation, gene

transfer, growth with antibiotic stress, inadequate dosage of antibiotics, failure in completion of antibiotic therapy course etc⁵³. Drug resistant bacteria can transfer the resistance gene containing plasmid to the susceptible isolates rendering them resistant too. This makes the treatment procedures more difficult because the disease caused by the resistant microorganisms fails to resolve as the microbes are no longer sensitive towards antibiotic⁵⁴. Poultry feeds can be contaminated with such drug resistant bacteria which cause diseases in the domestic birds and human afterwards which are difficult to treat. Addition of antibiotics in the feeds for preventing diseases in the birds is another cause to raise resistance in the sensitive bacterial isolates.

In this study, Rifampin and Erythromycin are 90% resistant against *Klebsiella* spp. whereas Ciprofloxacin and Ceftriaxone were the most sensitive. *Pseudomonas* spp. was 100% susceptible to Ceftriaxone. *Staphylococcus aureus* was completely resistant towards Kanamycin, Novobiocin and Erythromycin. *Salmonella* spp. and *Shigella* spp. both showed resistance towards Ceftriaxone. Novobiocin was susceptible for maximum isolates except *Vibrio* spp. which showed 100% resistance. And finally *Aeromonas* spp. was completely resistant towards Erythromycin. The resistant isolates which will cause disease in the domestic birds, could be transferred into the human body if consumed undercooked. Then the infection which might arise could not be treated using the antibiotics towards which they have become resistant. Choice of susceptible drugs is decreasing very fast. This may result in the death from simple diseases which will fail to resume for unavailability of appropriate susceptible drugs.

Homogenized poultry feed samples were subjected to detect antibacterial activity towards clinical bacterial isolates. The isolates included *Pseudomonas* spp., *Staphylococcus* spp., *Vibrio* spp., *Escherichia* spp. and *Klebsiella* spp. Antibacterial activity against these bacteria have been found to be negative.

Table 1: Number of different bacteria isolated from poultry feed.

Sample	TVBC	Total Fungal count	E. coli	Klebsiella spp.	Pseudomonas spp.	Staphylococcus aureus	Vibrio spp.	Salmonella spp.	Shigella spp.	Aeromonas spp.
S1	5.0×10^6	2.0×10^4	0	0	2.0×10^4	1.0×10^4	0	0	5.0×10^4	0
S2	2.5×10^6	1.2×10^4	0	0	0	2.7×10^5	2.0×10^4	0	8.8×10^4	0
S3	5.0×10^4	1.3×10^4	0	0	1.6×10^4	1.8×10^5	2.1×10^5	0	1.1×10^6	0
S4	2.1×10^6	4.5×10^5	0	1.4×10^6	2.5×10^6	8.8×10^4	2.4×10^5	7.0×10^3	3.2×10^4	0
S5	4.0×10^5	2.0×10^3	0	0	0	5.0×10^3	1.8×10^5	0	2.3×10^5	2.9×10^5

Table 2: Antibiotic susceptibility of the isolates

Isolates Antibiotics	<i>Klebsiella</i> spp. N=8		<i>Pseudomonas</i> spp. N=6		<i>Staphylococcus</i> <i>aureus</i> N=5		<i>Salmonella</i> spp. N=3		<i>Shigella</i> spp. N=5		<i>Vibrio</i> spp. N=4		<i>Aeromonas</i> spp. N=4	
	R	S	R	S	R	S	R	S	R	S	R	S	R	S
RFM (5µg)	90%	10%	70%	30%	60%	40%	60%	40%	70%	30%	40%	60%	30%	70%
CFT (30µg)	10%	90%	0%	100%	10%	90%	0%	100%	0%	100%	20%	80%	10%	90%
KAN (30µg)	60%	40%	10%	90%	100%	0%	80%	20%	10%	90%	30%	70%	10%	90%
NVB (30µg)	40%	60%	30%	70%	80%	20%	100%	0%	40%	60%	80%	20%	40%	60%
NA (30µg)	30%	70%	80%	20%	100%	0%	60%	40%	10%	90%	100%	0%	10%	90%
GEN (10µg)	20%	80%	40%	60%	20%	80%	20%	80%	40%	60%	10%	90%	40%	60%
AMO (30µg)	20%	80%	20%	80%	0%	100%	40%	60%	30%	70%	45%	55%	30%	70%
ER (15µg)	90%	10%	70%	30%	100%	0%	50%	50%	75%	25%	20%	80%	100%	0%
CIP (5µg)	10%	90%	10%	90%	0%	100%	30%	70%	45%	55%	40%	60%	45%	55%

N.B. R= Resistant, S= Sensitive

RFM= Rifampin (5¼g), GEN= Gentamycin (10¼g), ER= Erythromycin(15¼g), CFT= Ceftriaxone (30¼g), KAN= Kanamycin (30¼g), NVB= Novobiocin (30¼g), NA= Nalidixic Acid (30¼g), AMO= Amoxicillin (30¼g), CIP= Ciprofloxacin (5¼g).

Conclusion

Poultry products are good sources of proteins. This sector is expanding in Bangladesh to meet the protein demand of the growing population. But this protein source can be responsible for public health hazards if it harbors adequate amount of pathogenic bacteria. Pathogenic bacteria can be introduced from the ingredients, storage conditions, environmental facilities. Commercially available good quality feeds should be provided to the domestic birds to avoid diseases of domestic birds as well as their transmission to consumers.

Conflict of interest: None

References:

- Barakat R. 2004. Monitoring Feeds for *Salmonella* in Canada. Animal Feeds Workshop 2004, Atlanta, Georgia, USA. <http://bsm.org.bd/images/head.jpg>
- Raffoff EM. 2003. "Salmonella Reservoirs in Animals and Feeds", *Journal of Poultry Science*. **46**(22): 7-9.
- Smith WT. 2005. Feed chickens properly Co-operative extension. Extension service of Mississippi State University Service. pp 58-60.
- Microlovestock. 1991. A little known small animals with a promising economic future. National Academic Press Washington, pp 79-160.
- Obi CN and Ozugbo IJ. 2007. Microbiological analysis of poultry feeds sold in Umuahia main market, Abia State, Nigeria. *Research Journal of Applied Sciences*. **2**(1): 22-25.
- Ogbulie JN and Okpokwasili GC. 1998. Efficacy of chemotherapeutic agents in controlling bacterial diseases of cultured fish. *Journal of Aquaculture in the Tropics*. **13**: 61 – 72.
- Gill C and Best R. 1998. Antibiotic resistance in U.S.A: Scientists to look more closely. *Feed International*. **19**(8): 16 – 17.
- Ruff MD. 1992. New Methods of Disease control. *Feed Mix*. **1**: 15 – 18.
- Hesseltine CW. 1984. Toxigenic Fungi – their toxins and health hazard. Koclarisha Press. Peoria, Illinois, 61604.
- Betina, V. (Ed). 1989. Mycotoxins – Chemical, Biological and Environmental Aspects. Amsterdam.12. Barnes M, Vallancourt J P and Gross W B. 2003. *Diseases of poultry*, 11 th Edition Iowa State University Press, Amesia USA, pp 200-240.
- Gilbert J. 1995. Analysis of Mycotoxins in Food and feed. Certification of DIN in wheat and Maize. *American Pathology*. **3**(4): 263 – 268.
- White DG and Torman J. 1995. Post harvest application of low rates of DMX – 7 mold inhibitor on storage fungi of corn during ambient air drying and storage. *Applied Engineering in Agriculture*. **11**(4): 573 – 576.

14. Creppy EE. Review article. 2002. Update of survey, regulation and toxic effects of mycotoxins in Europe. *Toxicol Lett.* **127**:19-28.
15. MAFF. 1993. *Salmonella* in Animal Feeding stuffs and Ingredients. January-September 1993. Technical Report 3 of the Ministry of Agriculture fisheries and Foods. Animal Health (Zoonoses Division, London).
16. Morris MF, Pastorek JD, Yarg DE and Martin, DH. 1999. Epidemiology and outcomes associated with moderate to Heavy *Escherichia* Colonization. *A.M. Intern Med.* **149**(78): 33-5.
17. Tabib Z, Jones FT, and Hamilton PB. 1981. Microbiological Quality of Poultry Feed and Ingredients. *Poultry Science.* **60**:1392-1397.
18. Anderson KE and Richardson KE. 1999. Effects of Terpin-8 and compound on the Microbiological and Physical Quality of Shell Eggs from Commercial Eggs laying chickens. *Poultry Science.* **70**(1): 70.
19. Derouchey DP and Tyadal SP. 2004. Comparison of Methods for diagnosing Bacterial Fungi among poultry feeds. *J.C. Clinical Micro.* **27**(13); 23-5.
20. Krstanovi V, Klavec T, Veli N and Milakovi Z. 2005. Contamination of malt barley and wheat by *Fusarium graminearum* and *Fusarium culmorum* from the crop years 2001-2003 in eastern Croatia. *Microbiol Res.* **160**: 353-359.
21. D'Mello J, Placinta C and Macdonald A. 1999. *Fusarium* mycotoxins: a review of global implications for animal health, welfare and productivity. *Anim Feed Sci Technol.* **80**:183-205.
22. Egal S, Hounsa A, Gong Y, Turner P, Wild C, Hall A, Hell K and Cardwell K. 2005. Dietary exposure to aflatoxin from maize and groundnut in young children from Benin and Togo, West Africa. *Int J Food Microbiol.* **104**: 215-224.
23. Kan C and Meijer G. 2007. The risk of contamination of food with toxic substances present in animal food. *Anim Feed Sci Technol.* **133**: 84-108.
24. Krysińska-Traczyk E, Perkowski J and Dutkiewicz J. 2007. Levels of fungi and mycotoxins in the samples of grain and grain dust collected from various cereal crops in eastern Poland. *Ann Agric Environ Med.* **14**: 159-167.
25. Morgavi DP and Riley RT. 2007. A historical overview of fild disease outbreaks known or suspected to be caused by consumption of feed contaminated with *Fusarium* toxins. *Anim Feed Sci Technol.* **137**: 201-212.
26. Anon. 2001. *Salmonella*: Coordinating Chemical and Thermal Control. Feed International December. pp 27-30.
27. Veldman A, Vahl HA and Borggreve GJ *et al.* 1995. A survey of the incidence of *Salmonella* species and enterobacteriaceae in poultry feed and feed components. *Vet. Rec.* **135**:169-172.
28. Maciorowski KG, Jones FT, Plliai SD and Ricke SC. 2004. Incidence, Sources and Control of Food Borne *Salmonella* Spp. in Poultry Feed. *Worlds Poultry Science Journal.* **60**: 446-457.
29. Okogun GRA, Jemikalajah DJ and Ebhohimen EV. 2016. Bacteriological evolution of poultry feeds in Ekpoma, Nigeria. *African Journal of Cellular Pathology.* **6**: 6-9.
30. CheBkowski J. 2008. Mycotoxins and toxin-forming fungi, as a significant indicator of food and feed quality. *Pol Poultry.* **10**: 22-27 (in Polish).
31. Hussein H and Brasel J. 2001. Toxicity, metabolism and impact of mycotoxins on humans and animals. *Toxicology.* **167**: 101-134.
32. Onyeze Rosemary C, Onah Gloria T and Eluke Obinne C. 2013. Bacterial contaminants associated with commercial poultry feeds in Enugu, Nigeria. *Int. J. LifeSc. Bt & Pharm. Res.* **2**(3): 432-437.
33. American Public Health Association. 1998. Standard methods for the examination of water and waste water. American Public Health Association: Washington DC.
34. Cappuccino JG and Sherman N. 1996. Microbiology - A Laboratory Manual. The Benjamin/Cummings Publishing Co., Inc., Menlo Park, California.
35. Marjan S, Das KK, Munshi SK and Noor R. 2014. Drug-resistant bacterial pathogens in milk and some milk products. *Nutrition & Food Science.* **44**(3): 241-248.
36. Rahman F and Noor R. 2012. Prevalence of pathogenic bacteria in common salad vegetables of Dhaka Metropolis. *Bangladesh Journal of Botany.* **41**(2), 159-162.
37. Sriram N and Reetha D. 2015. Isolation and characterization of dye degrading bacteria from textile dye effluents. *Central European Journal of Experimental Biology.* **4**(2):5-10.
38. Singh RP, Singh PK, and Singh RL. 2014. Bacterial Decolorization of Textile Azo Dye Acid Orange by *Staphylococcus hominis* RMLRT03. *Toxicol Int.* **21**(2): 160-166. doi: 10.4103/0971-6580.139797.
39. Noor R, Uddin MA, Haq MA, Munshi SK, Acharjee M and Rahman MM. 2013. Microbiological study of vendor and packed fruit juices locally available in Dhaka city, Bangladesh. *Int Food Res J.* **20**(2):1011-1015.
40. Yasmin S, Parveen S, Munna MS and Noor R. 2015. Detection of *Salmonella* spp. and Microbiological Analysis of Milk and Milk Based Products Available within Dhaka Metropolis, Bangladesh. *British Microbiology Research Journal.* **5**(6): 474-480.
41. Ahmed T, Baidya S, Sharma BC, Malek M, Das KK, Acharjee M, Munshi SK and Noor R. 2003. Identification of drug-resistant bacteria among export quality shrimp samples in Bangladesh. *Asian J Microbiol Biotech Env Sci.* **15**(4): 31-36.
42. Sultana S, Tarafder GH, Siddiqui TA, Shaha BC, Walliullah M, Ahmed T, Munna MS, Noor AF, Popy SK, Das KK, Acharjee M, Urmi NJ, Rahman T and Noor R. 2014. Microbiological quality analysis of shrimps collected from local market around Dhaka city. *Int Food Res J.* **21**(1): 33-38.
43. Fatema N, Acharjee M and Noor R. 2013. Microbiological profiling of imported apples and demonstration of bacterial survival capacity through in vitro challenge test. *Am J Microbiol Res.* **1**(4): 98- 04.
44. Uddin MA, Haque HMM and Noor R, 2011. Isolation and Identification of Pathogenic *Escherichia coli*, *Klebsiella* spp. And *Staphylococcus* spp. in Raw Milk Samples Collected from Different Areas of Dhaka City, Bangladesh. *Stamford J Microbiol.* **1**(1): 19-23.
45. Hald T, Wingstrand A, Bronsted T and Wong DM. 2006. Human Health Impact of *Salmonella* Contamination in Imported Soybean Products: a Semi Quantitative Risk Assessment. *Food Borne Pathogens and Diseases.* **34**: 422-431.
46. Crump JA, Griffen PM and Angulo FJ. 2002. Bacterial Contamination of Animal Feed and its Relationship to Food Borne Illness. *Infect. Dis.* **35**: 859-865.
47. Jawetz E, Melnick J L and Adelberg E . 1995. Medical Microbiology. Appleton and Lange, Norwalk, pp 656.
48. Centers for Disease Control and Prevention (CDC). Tracking and Reporting Foodborne Disease Outbreaks; 2015. Available at: <http://www.cdc.gov/features/dsfoodborneoutbreaks/> [Accessed October 31, 2015].
49. European Food Safety Authority (EFSA) and European Centre for Disease Prevention and Control (ECDC). 2015. The European Union Summary Report on Trends and Sources of Zoonoses, Zoonotic Agents and Food-borne Outbreaks in 2013. *EFSA Journal.* **13**(1): 3991, pp 162, DOI: 10.2903/j.efsa.2015.3991.
50. Kidd RS, Rossignol AM and Grmroth MJ. 2002. *Salmonella* and other Enterobacteriaceae in animal feed ingredients and antimicrobial resistance in western Oregon. *J. Environ. Health.* **64**: 9-16.
51. Boyer CL, Burner DW and Brown JA. 1985. *Salmonella* organisms isolated from poultry feed. *Avian Dis.* **2**: 396-401.
52. Commission Regulation (EU) 142/2011, annex XIII, chapter 2.
53. Dutta S, Hassan MR, Rahman F, Jilani MFA and Noor R. 2013. Study of antimicrobial susceptibility of clinically significant microorganisms isolated from selected areas of Dhaka, Bangladesh. *Bang J Med Sci.* **12**(1): 34-42.
54. Duin DV and Paterson D. 2016. Multidrug Resistant Bacteria in the Community: Trends and Lessons Learned. *Infect Dis Clin North Am.* **30**(2): 377-390.