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ORIGINAL PAPER

Antimicrobial resistance pattern of *Salmonella serotypes* isolated from food items and personnel in Addis Ababa, Ethiopia

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Abstract Antimicrobial susceptibility test of 98 isolates of *Salmonella* was assayed from September 2003 to February 2004 using the guidelines of the National Committee for Clinical Laboratory Standards (NCCLS).The result revealed that 32.7% of *Salmonella* isolates were resistant to one or more of the 24 antimicrobials tested. Generally resistance for 13 different antimicrobial drugs was recognized. The most common resistance was to streptomycin (24/32, 75%), ampicillin (19/32, 59.4%), tetracycline (15/32, 46.9%), spectinomycin (13/32, 40.6%) and sulfisoxazole (13/32, 40.6%). All the three *Salmonella* Kentucky isolates showed resistance to at least 8 antimicrobials. Out of the 12 *Salmonella* Braenderup isolates, 10 (83.3%) showed multidrug resistance to ampicillin, spectinomycin, streptomycin, sulfisoxazole, sulfamethoxazole/trimethoprim, amoxicillin/clavulanic acid and trimethoprim. Among the 8 *S.* Hadar isolates 7 (86.5%) showed antimicrobial resistance. All the 6 *S.* Dublin isolates were resistant to carbadox (100%). All the 6 *S.* Haifa isolates were resistant for at least ampicillin, streptomycin and tetracycline. Up to ten different antimicrobial resistances pattern was observed. Multiple antimicrobial drug resistance was observed in 23 *Salmonella* isolates (23.5%). The level of antimicrobial resistance was significantly higher for isolates from chicken carcass (18/29, 62.1%) and pork isolates (5/22, 22.7%) (p=0.003). The findings of the present study ascertain that significant proportion *Salmonella* isolates have developed resistance for routinely prescribed antimicrobial drugs and poses considerable health hazards to the consumers unless prudent control measures are instituted.

Keywords Antimicrobials · Resistance · Isolates · *Salmonella* · Multidrug resistance · NCCLS

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Introduction

Antimicrobial-resistant salmonellae are increasing due to the use of antimicrobial agents in food animals, which are subsequently transmitted to humans usually through the food supply (White et al. 2001; Angulo et al. 2000; Fey et al. 2000; Mølback et al. 1999; Tollefson et al. 1998; D'Aoust 1989). Routine assessment of patterns of emerging antibiotic resistant *Salmonella* strains is of paramount importance because such information channeled to physicians and veterinarians help to timely redirect drug use so as to diminish the development and spread of resistance (Tellefson et al. 1998).

As serovars and phage types and, with them, antibiotic sensitivity patterns can vary annually (Van Duijkeren et al. 1994b); the choice of the drug for treatment of salmonellosis should always be based on sensitivity testing of the causative strain. However, since it takes two or three days before the result is available, blind therapy has to be started in severely ill animals. Therefore, susceptibility testing combined with knowledge of the pharmacokinetic and toxicologic data of the drug are essential in choosing an effective drug for antimicrobial therapy (Prescott and Baggot 1993).

The strains of S. Typhimurium known as definitive phage type 104 (DT 104) have become a worldwide health problem causing illness in humans and animals. It is usually resistant to five drugs: ampicillin, chloramphinicol, streptomycin, sulfonamides, and tetracyclines (White et al. 2001; Hohmann 2001; Lesser and Miller 2001; Cloeckaert et al. 2000; Mølback et al. 1999; Tellefson et al. 1998; Glynn et al. 1998). A report from the United Kingdom suggests that infections caused by this five-drug-resistant *S.* Typhimurium might be associated with greater morbidity and mortality than other *Salmonella* infections (Lesser and Miller 2001; Wall et al. 1994).

The emerging resistance in *Salmonella* is largely a consequence of the use of antimicrobial agents in animals (Acha and Szyfres 2001; Hohmann 2001; Olsen et al. 2001; Gorbach 2001) as well as the indiscriminate prescription-drug treatment of people and animals (Acha and Szyfres 2001). Resistance in *Salmonella* raise health care costs (Gorbach 2001) and limits the therapeutic options available to veterinarians and physicians in the treatment of certain cases of salmonellosis (Witte 1998).

In recent years, testing of *Salmonella* isolates has shown that an increasing proportion of isolates are resistant to several antimicrobial agents both in developing and developed countries. The issue of antimicrobial resistance is more complex in developing countries (Leegaard et al. 1996) like Ethiopia where *Salmonella* is not routinely isolated and resistance to commonly used antimicrobial drugs in veterinary and public health sector not regularly assessed. Therefore, the present study, which was a part of cross-sectional study of *Salmonella* from supermarket food items and personnel, was undertaken to investigate the susceptibility of *Salmonella* isolates to commonly used antimicrobial agents in Ethiopia for the treatment of bacterial diseases including salmonellosis.

Materials and methods

Isolation of salmonellae

A total of 1200 food samples i.e. chicken meat (208), pork (194), minced beef (142), mutton (212), cottage cheese (190), fish (128) and ice cream (126) and 68 stool samples collected from retail supermarkets, open markets and shops in Addis Ababa were examined for detection of *Salmonella* using the technique recommended by the International Organization for Standardization (ISO 1998) during the period from September 2003 to February 2004. *Salmonella* isolation was successful from all samples except ice cream. Ninety-eight *Salmonella* isolates identified into fourteen different serotypes were employed for the purpose of this study.

Antimicrobial susceptibility testing

The antimicrobial susceptibility test of all isolates of *Salmonella* was assayed in the Food Microbiology Laboratory, Laboratory Service Division, Animal Health Laboratory, University of Guelph, Guelph, Ontario; Canada. The National Committee for Clinical Laboratory Standards (NCCLS) (1999) guidelines was followed throughout the agar dilution testing procedure and interpretation of results as susceptible and resistant. Briefly, the isolates were grown to 0.5 – 1.0 McFarland density in Muller Hilton (MH) broth (Difco, Detroit, USA) and replica plated using a Cathra Replicator (Brown and Washington 1978) on to MH agar plates (Difco, Detroit, USA). The list of panel of antimicrobials utilized, their symbols and concentrations to classify an isolate as susceptible or resistant were shown on Table 1. An isolate was defined as resistant if it was resistant to one or more of the antimicrobial drugs tested whereas multiple resistance was defined as resistance to two or more antimicrobial drugs. Standard and reference strains were used following the recommendations of NCCLS (1999).

Table 1 Antimicrobials and concentrations used to test susceptibility of *Salmonella* isolates

Antimicrobial	Abbreviations[a]	Break points and Concentrations[b]	
		Susceptible at ≤μg/ml	Resistant at ≥μg/ml
Amikacin	AMK	16	ND[c]
Ampicillin	AMP	ND	32
Amoxicillin/clavulanic acid	AMC	ND	64/16[d]
Apramycin	APR[e,f]	ND	32[g]
Carbadox	CRB[e,f]	ND	30[h]
Cephalothin	CEF	ND	32
Ceftriaxone	CRO	8	ND
Ceftiofur	CTF[e]	ND	8
Cefoxitin	FOX	ND	32
Chloramphinicol	CHL	ND	32
Ciprofloxacin	CIP	0.125[i]	ND
Florfenicol	FLO[e,f]	ND	16[j]
Gentamycin	GEN	ND	16
Kanamycin	KAN	ND	64
Nalidixic acid	NAL	ND	32
Neomycin	NEO[e,f]	ND	16[g]
Nitrofurantoin	NIT	ND	64[k]
Spectinomycin	SPT[f]	ND	64[g]
Streptomycin	STR[f]	ND	32[g]
Sulfisoxazole	SUL[e]	ND	512
Sulfamethoxazole/trimethoprim	SXT	ND	76/4
Tetracycline	TET	ND	16
Tobramycin	TOB	ND	8
Trimethoprim	TMP	ND	16

[a] Abbreviations - the abbreviations are those described previously (Antim Agents Chemother 2004; **48**: xviii)

[b] The breakpoint concentrations to determine susceptible and resistance were those specified by the NCCLS standards M31-A and M100-S12.

[c] ND - not done.

[d] The strains were considered resistant when growing on agar plates with amoxicillin/clavulanic acid at 64/16 μg/ml.

[e] The abbreviations APR, CRB, CTF, FLO, NEO and SUL were self-chosen.

[f] There are no interpretive standards specified by the NCCLS standards M31-A or M100-S12 for apramycin, carbadox, florfenicol, neomycin, spectinomycin and streptomycin.

[g] Strains were considered to be resistant to apramycin, neomycin, spectinomycin and streptomycin at 32, 16, 64, and 32 μg/ml, respectively.

[h] The strains were considered to be resistant to carbadox, a veterinary growth promoter for pigs, at 30 μg/ml

[i] A 0.125 μg/ml of ciprofloxacin concentration determines reduced sensitivity to ciprofloxacin.

[j] Strains were considered to be resistant to florfenicol at the level of 16 μg/ml.

[k] Strains were considered to be resistant to nitrofurantoin at 64 μg/ml; human urinary tract isolates are considered to be resistant to nitrofurantoin at 128 μg/ml (NCCLS, M100-S12).

Fisher's exact test was used to see the significance of antimicrobial resistance between food items. A difference will be statistically significant if the P-value is less than 0.05. Statistical analysis was performed using Intercooled Stata 6.0 soft ware package.

Results

Of the 98 *Salmonella* serotypes subjected to antimicrobial susceptibility test, using a panel of 24 different antimicrobials (Table 1), 32 serotypes (32.7%) were found resistant to one or more of the antimicrobials used. A total of 66 (67.3%) *Salmonella* isolates belonging to *S.* Newport, *S.* Typhimurium, *S.* Infantis, *S.* Bovismorbificans, *S.* Anatum, *S.* Zanzibar, *S.* Kottbus, *S.* Saintpaul and *S.* I: 9, 12:- were found to be susceptible to all antimicrobials tested. However, 32 *Salmonella* isolates (32.7%) belonging to *S.* Braenderup, *S.* Hadar, *S.* Dublin, *S.* Haifa and *S.* Kentucky were resistant to one or more of the 24 antimicrobials tested (Tables 2 and 3). All *Salmonella* isolates belonging to *S.* Dublin (isolated from pork, mutton and minced beef) were resistant to carbadox and *S.* Haifa (isolated from pork and cottage cheese) were resistant to ampicillin, streptomycin and tetracycline. About 83% of *S.* Braenderup isolated from chicken carcass and 87.5% of *S.* Hadar isolated from chicken carcass and mutton were also resistant to one or more of the antimicrobials tested. In relation to the total *Salmonella* isolates tested, 24.5% were found resistant to streptomycin, while 19.4%, 15.3%, 13.3% and 13.3% were resistant to ampicillin, tetracycline, spectinomycin and sulfisoxazole, respectively.

With regards to source of the 32 resistant *Salmonella* isolates, chicken carcass accounted for 56.3% (18/32) while pork, mutton, minced beef and cottage cheese accounted for 21.9% (7/32), 9.4% (3/32), 9.4% (3/32) and 3.1% (1/32), respectively. Among *Salmonella* isolates from chicken carcass and pork samples 62.1% and 31.8% were resistant for one or more antimicrobials tested (Table 6). All *Salmonella*

Table 2 Distribution of antimicrobial resistant *Salmonella* from food items and personnel in Addis Ababa

Sample type	No. of samples		*Salmonella* Serotypes (No.)	No. of resistant isolates
	Examined	Positive (%)		
Chicken carcass	208	29 (13.9)	*S.* Braenderup (12)	10
			S. Hadar (6)	6
			S. Newport(4)	
			S. Typhimurium (3)	
			S. Kentucky (2)	2
			S. Bovismorbificans (1)	
			S. Anatum (1)	
Pork	194	22 (11.3)	*S.* Newport (12)	
			S. Haifa (5)	5
			S. Dublin (2)	2
			S. Infantis (2)	
			S. Kottbus (1)	
Mutton	212	23 (10.8)	*S.* Newport (12)	
			S. Typhimurium (3)	
			S. Hadar (2)	1
			S. Dublin (2)	2
			S. Bovismorbificans (2)	
			S. Infantis (1)	
			S. Zanzibar (1)	
Minced beef	142	12 (8.5)	*S.* Newport (3)	
			S. Dublin (2)	2
			S. Anatum (2)	
			S. Typhimurium (1)	
			S. Infantis (1)	
			S. Kentucky (1)	1
			*S.*Saintpaul (1)	
			S. 1:9,12:-(1)	
Cottage cheese	190	4 (2.1)	*S.* Newport (3)	
			S. Haifa (1)	1
Fish	128	3 (2.3)	*S.* Newport (2)	
			S. Zanzibar (1)	
Stool	68	5 (7.4)	*S.* Newport (5)	

Table 3 Multiple antimicrobial resistance of *Salmonella* isolates by serotype

Serotype	No. of strains			Resistance Pattern
	Tested	R (%)	MR (%)	
S. Newport	41	–	–	
S. Braenderup	12	10 (83.3)	10 (83.3)	Amp Spt Str Sul Sxt Tmp (9)
				Amp Amc Spt Str Sul Sxt Tmp (1)
S. Hadar	8	7 (87.5)	3 (37.5)	Str Tet (3)
				Str (2)
				Tet (2)
S. Typhimurium	7	–	–	
S. Dublin	6	6 (100)	1 (16.7)	Crb Tet (1)
				Crb (5)
S. Haifa	6	6 (100)	6 (100)	Amp Amc Str Tet (4)
				Amp Str Tet (2)
S. Infantis	4	–	–	
S. Kentucky	3	3 (100)	3 (100)	Amp Amc Cef Cip Gen Nal Spt Str SulTet (1)
				Amp Amc Cef Cip Nal Spt Str Sul Tet (1)
				Amp Amc Cip Nal Spt Str Sul Tet (1)
S. Bovismorbificans	3			
S. Anatum	3			
S. Zanzibar	2			
S. Kottbus	1			
S. Saintpaul	1			
S.:1:9,12:-	1			
Total	98	32 (32.7)	23 (23.5)	

( ) = Number of strains

R = Resistant, MR = Multiple Resistance

isolates from personnel and fish were susceptible to all antimicrobials tested (Tables 2 and 6).

None of the *Salmonella* isolates showed resistance for the following antimicrobials: amikacin, apramycin, ceftriaxone, ceftiofur, cefoxitin, chloramphinicol, florfenicol, kanamycin, neomycin, nitrofurantoin and tobramycin.

Out of the 32 resistant *Salmonella* isolates, 23 (23.5%) were multidrug resistant (MDR) (Table 3). The proportion of MDR *Salmonella* isolates varied

Table 4 Multiple antimicrobial resistances of *Salmonella* serotypes isolated from food items of Addis Ababa markets

Number of antimicrobial resistance	Antimicrobial resistance pattern (No.)	No. of isolates (%)
Zero	none	66 (67.3)
One	Str (2)	9 (9.2)
	Tet (2)	
	Crb (5)	
Two	Str Tet (3)	4 (4.1)
	Crb Tet (1)	
Three	Amp Str Tet (2)	2 (2)
Four	Amp Amc Str Tet (4)	4 (4.1)
Six	Amp Spt Str Sul Sxt Tmp (9)	9 (9.2)
Seven	Amp Amc Spt Str Sul Sxt Tmp (1)	1 (1)
Eight	Amp Amc Cip Nal Spt Str Sul Tet (1)	1 (1)
Nine	Amp Amc Cef Cip Nal Spt Str Sul Tet (1)	1 (1)
Ten	Amp Amc Cef Cip Gen Nal Spt Str Sul Tet (1)	1 (1)

between sample types being highest in chicken carcass (65.2%, 15/23), cottage cheese (25%, 1/4) and pork 21.7%, 5/23). It is lowest in minced beef (8.3%, 1/12) and mutton (4.3%, 1/23) samples. Among MDR isolates resistance to streptomycin, spectinomycin, sulfisoxazole, ampicillin and tetracycline was most often observed (Table 5).

Serotypes isolated from chicken carcass (*S.* Braederup and *S.* Kentucky) showed resistance pattern for up to ten antimicrobials, while those isolates from pork (*S.* Haifa) showed resistance pattern for up to four antimicrobials. None of the mutton and cottage cheese isolates showed resistance for more than three antimicrobials and only one serotype from minced beef showed resistance for 8 antimicrobials. The most frequent combination of resistance was seen in *S.* Braenderup for the following antimicrobials: ampicillin, spectinomycin, streptomycin, sulfisoxazole, sulfamethoxazole/trimethoprim and trimethoprim. The three *S.* Kentucky serotypes isolated from exotic chicken carcass (one), local chicken carcass (one) and minced beef (one) samples were found to have MDR pattern for 10, 9 and 8 antimicrobials, respectively. Although 12 different antimicrobial resistance patterns were seen in this study, the two most common resistance patterns were Amp Spt Str Sul Sxt Tmp (9 isolates from chicken) and Amp Amc Str Tet (4 isolates from pork). Resistance to trimethoprim and sulfamethoxazole/trimethoprim was seen only in *S.* Braenderup and *S.* Kentucky isolated from chicken carcass while to carbadox was seen only among *S.* Dublin isolates from pork, mutton and minced beef (Tables 3 and 4).

Looking at individual antimicrobial drug, resistance to streptomycin was most frequently observed, followed by ampicillin, tetracycline, spectinomycin, and sulfisoxazole (Table 5). Isolates resistant to these antimicrobials were detected predominantly from chicken carcass and pork.

Discussion

Antimicrobial resistance recognizes no geographical boundaries and increasing rate of resistance of *Salmonella* isolates have been reported from developing and developed countries. Some of the antimicrobial drugs for which *Salmonella* serotypes/serogroups were resistant in our study have been reported earlier from Ethiopia (Molla et al. 2003; Alemayehu et al. 2004; Tibaijuka et al. 2003; Mache 2002; Molla et al. 1999b; Mache et al. 1997; Ashenafi and Gedebou 1985; Gedebou and Tassew 1981), other African countries (Leegaard et al. 1996; Adesiyun and Oni 1989; Hadfield and Monson 1985; Hummel 1979) and elsewhere (White et al. 2001; Gebreyes et al. 2000; Tellefson et al. 1998; Lee et al. 1993; D'Aoust et al. 1992).

The finding of 32.7% antimicrobial resistant *Salmonella* isolates from food samples examined was remarkable. It represents public health hazards due to the fact that food poisoning outbreaks would

Table 5 *Salmonella* isolates resistance by antimicrobial type

Antimicrobial drug	Total No. (%) of isolates resistant					
	Total resistant isolates (n=32)	Chicken carcass (n=18)	Pork (n=7)	Mutton (n=3)	Minced beef (n=3)	Cottage cheese (n=1)
AMP	19 (59.4)	12 (66.7)	5 (71.4)	0 (0.0)	1 (33.3)	1 (100)
SPT	13 (40.6)	12 (66.7)	0 (0.0)	0 (0.0)	1 (33.3)	0 (0.0)
STR	24 (75)	17 (94.4)	5 (71.4)	0 (0.0)	1 (33.3)	1 (100)
SUL	13 (40.6)	12 (66.7)	0 (0.0)	0 (0.0)	1 (33.3)	0 (0.0)
SXT	10 (31.3)	10 (55.6)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
TMP	10 (31.3)	10 (55.6)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
TET	15 (46.9)	6 (33.3)	5 (71.4)	2 (66.7)	1 (33.3)	1 (100)
CEF	2 (6.3)	2 (11.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
AMC	8 (25)	3 (16.7)	4 (57.1)	0 (0.0)	1 (33.3)	0 (0.0)
CIP	3 (9.4)	2 (11.1)	0 (0.0)	0 (0.0)	1 (33.3)	0 (0.0)
GEN	1 (3.1)	1 (5.6)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
NAL	3 (9.4)	2 (11.1)	0 (0.0)	0 (0.0)	1 (33.3)	0 (0.0)
CRB	6 (18.8)	0 (0.0)	2 (28.6)	2 (66.7)	2 (66.7)	0 (0.0)

Table 6 Percentage of samples with antimicrobial resistant salmonellae

Type of Sample	Number Tested	Number Resistant	Percent Antimicrobial Resistant
Chicken Carcass	29	18	62.1
Pork	22	7	31.8
Mutton	23	3	13.0
Minced beef	12	3	25.0
Cottage cheese	4	1	25.0
Fish	3	0	0.0
Stool	5	0	0.0
Total	98	32	32.65

be difficult to treat and this pool of multi-drug resistant *Salmonella* in food supply represents a reservoir for transferable resistant genes (Diaz De Aguayo et al. 1992).

Among the important findings of the antimicrobial resistance testing was that 62.1% (18/29) of chicken carcass, 31.8% (7/22) of pork, 25% (1/4) of cottage cheese, 13% (3/23) of mutton and none of the fish and human isolates were antimicrobial resistant (Table 2). The level of resistance was significantly higher for chicken carcass and pork isolates (p=0.003) (Table 6). Tibaijuka et al. (2003) also reported 60% antimicrobial drug resistance from chicken meat, which was similar to our findings. D'Aoust et al. (1992) also indicated a high antimicrobial resistance among poultry isolates as compared to *Salmonella* isolated from other sources. Out of the 32 resistant isolates 24 (75%), 19 (59.4%) and 15 (46.9%) were resistant for streptomycin, ampicillin and tetracycline, respectively (Table 5). The significantly high frequency of resistant salmonellae for these antimicrobials was probably an indication of their frequent usage both in livestock and public health sectors. The high prevalence of *Salmonella* isolates resistant to some of these relatively cheaper and commonly available antimicrobials is disturbing because of the limited access and high cost of newer cephalosporins and quinolone drugs (D'Aoust 1989) for poor citizens of developing countries like Ethiopia. Furthermore, systemic spread of such resistant isolates in human host could lead to serious complications or to a fatal outcome (D'Aoust 1991).

Our antimicrobial drug resistance result indicated that resistance to some extended spectrum cephalosporins (ceftriaxone, ceftiofur), aminoglycosides and newer quinolones was absent, perhaps due to their limited usage in veterinary and public health sectors of Ethiopia. On the other hand the occurrence of resistance to the quinolone (nalidic acid) and fluoroquinolone (ciprofloxacin) in 9.4% of resistant isolates from chicken carcass and minced beef or 3.1% of the total *Salmonella* isolates (*S.* Kentucky) was striking because development of resistance undermines the value of this first line drug (ciprofloxacin) for human systemic salmonellosis. Reasons for the emergence of resistance against these drugs were unknown and deserve investigation. However, introduction of resistant *Salmonella* with importation of food items and travelers was suspected (D'Aoust 1994). MDR was higher in *Salmonella* isolates from chicken carcass and pork. Thus, 65.2% of MDR isolates were S. Braenderup, *S.* Hadar and *S.* Kentucky from chicken carcass and 21.7% of MDR isolates from pork were *S.* Haifa. These all show that antimicrobial resistant *Salmonella* serotypes are widespread and more common particularly from chicken carcass, cottage cheese and pork samples as compared to mutton and minced beef. The isolation of susceptible *S.* Newport among supermarket butchery workers and food items examined indicate that the source of contamination could be either from reservoir animals or personnel. The reasons for the recovery of antimicrobial resistant *Salmonella* serotypes was most likely due to the indiscriminate use of antimicrobials (Guthrie 1992; WHO 1988), self-medication due to easy access to antibiotics without prescription (Acha and Szyfres 2001) in public health sector and the administration of sub-therapeutic dose of antimicrobials to livestock for prophylactic or nutritional purpose. Such agricultural practices introduce selective pressures that potentiate the emergence and distribution of resistant salmonellae in meats and other products (D'Aoust 1989). Therefore, attempts should be made to reduce the magnitude of the problem at various levels through prudent use of antimicrobials. The tendency of salmonellae for intra- and inter-generic exchange of cytoplasmic DNA (R plasmid) that encodes for single or multiple antimicrobial resistances is another contributing factor (D'Aoust et al. 1992; D'Aoust 1989, 1991; WHO 1988). Nonetheless, there is a need to relate the type and amount of antimicrobial drugs used in intensive farms with data from systematic survey of resistant *Salmonella* infection to monitor changing resistance and to determine if change in the frequency and pattern of resistance are related to specific pattern of antimicrobial usage (Lee et al. 1993).

None of the *S.* Typhimurium isolates were found resistant to any of the antimicrobial drugs used. In contrast, Alemayehu et al. (2004) detected MDR strain of *S.* Typhimurium phage type 2 and Molla et al. (1999b) reported 60% of *S.* Typhimurium isolates from chicken and minced beef to be MDR. Leegaard et al. (1996) also reported MDR *S.* Typhimurium. The absence of antimicrobial resistant *Salmonella* isolates from minced beef in Nyeleti et al. (2000) and 25% (3/12) resistant isolates in the present investigation was contrasting and suggests that antimicrobial resistant salmonellae from minced beef are emerging through time.

The present study demonstrated that supermarket meat samples particularly dressed chicken carcass and pork, were important sources of antimicrobial resistant *Salmonella* serotypes for consumers and stressed the need to regulate the ethical usage of antimicrobials and regular monitoring of antimicrobial resistance.

Conclusion

Antimicrobial susceptibility testing of *Salmonella* isolates from food items and food handling personnel is of considerable importance in attempt of supplying sound and safe food for community people. Antimicrobial resistance of *Salmonella* isolates from food items may suggest the possible existence of antimicrobial resistance at farm level among food animals. Significant proportions of *Salmonella* isolates were resistant for antimicrobials (32.7%), of which 23.5% were MDR. This could make treatment of humans' clinical salmonellosis and other bacterial diseases difficult should food poisoning by similar resistant *Salmonella* serotype ensue. Among MDR serotypes, *Salmonella* Kentucky was resistant to up to ten antimicrobials. The findings also suggest the need for developing educational program to address issues related to the consumption of raw animal products that might contain antimicrobial resistant *Salmonella*.

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