Salmonella serotyping conducted at the Bogor research institute for veterinary science during April 1989 – March 1996

S8-3

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Abstrak

Sebagai laboratorium rujukan untuk Salmonella, *Balai Penelitian Veteriner/Balitvet secara rutin telah menerima spesimen atau biakan untuk penentuan serotipe* Salmonella. *Sejak 1989 hingga 1996, Balitvet telah melakukan pemeriksaan serotipe dari 2196 isolat* Salmonella *dari Jawa Barat, Jawa Timur, Lampung, Kalimantan Selatan dan Bogor. Isolat tersebut berasal dari manusia (51), ayam (828), itik (233), telur (219), babi (95), sapi (59), makanan ternak (66),bahan tinja binatang (169), air (209), bulu (56) dan dari berbagai sumber lain (211). Sepuluh jenis serotipe* Salmonella *yang paling sering ditemukan adalah:* S. hadar *299 (13,61%);* S. typhimurium *227 (10,01%);* S. ouakam *168 (7,65%);* S. blockley *144 (6,55%);* S. amsterdam *108 (4,91%);* S. virchow *90 (4,09%);* S. enteritidis *87 (3,96%);* S. senftenberg *77 (3,50%);* S. livingstone *75 (3,41%);* S. derby *73 (3,32%); dan 536 (24,40%) berbagai jenis serotipe yang lain. Maksud dari laporan ini adalah memberikan informasi tentang berbagai jenis serovars* Salmonella *yang ditemukan di berbagai wilayah Indonesia selama periode April 1989 - Maret 1996.*

Abstract

As a reference laboratory for Salmonella, *specimens or cultures are routinely received by Research Institute for Veterinary Science (RIVS), Bogor for* Salmonella *serotyping. Between 1989 - 1996, 2,196* Salmonella *isolates from West Java, East Java, Lampung, South Kalimantan and Bogor were serotyped. These isolates originated from human (51), chickens (828), ducks (233), eggs (219), pigs (95), cattle (59), animal feed (66), litter (169), water (209), fluff (56) and other sources (211). The ten serotypes most commonly typed were* S. hadar *299 (13.61 %);* S. typhimurium *227 (10.01 %);* S. ouakam *168 (7.65 %);* S. blockley *144 (6.55 %);* S. amsterdam *108 (4.91 %);* S. virchow *90 (4.09 %);* S. enteritidis *87 (3.96 %);* S. senftenberg *77 (3.50 %);* S. livingstone *75 (3.41 %);* S. derby *73 (3.32 %) and other serotypes 536 (24.40%). This report aims to share information on* Salmonella *serotypes found in different parts of Indonesia between April 1989 - March 1996.*

INTRODUCTION

Salmonellosis is one of the most important food-borne and zoonotic diseases caused by bacteria[1,2]. Many types of *Salmonella* have been isolated from domestic animals, poultry and egg products, animal feeds, manure and fertilizers, sewage and surface water[3,4]. Poultry and pigs may become the main source of infection for the animal species and for man[5]. Food poisoning due to *Salmonella* is the most prevalent food-borne disease in Germany, United Kingdom, Sweden, United States of America, Canada[6], and Thailand[7]. In Indonesia the occurrence of salmonellosis in human was estimated at approximately 54,000 to 1,210,000 cases per anum[8]. However, salmonellosis in domestic animals in Indonesia is rarely reported [9,10]. There is no accurate data for salmonellosis in animals in Indonesia. Since 1984, the Research Institute for Veterinary Science has routinely received specimens from several areas for salmonella serotyping and reports the findings annually. The most common *Salmonella* serotypes in Indonesia during 1971 - 1989 were *S. typhimurium*, *S. lexington*, *S. weltevreden* and *S. blockley* . This paper, aims to report salmonella serotypes isolated in Indonesia between 1989 - 1996.

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Table 1. Number of specimens examined during April 1989 - March 1996.

Specimens source/animals		Year							Sub total
		89/90	90/91	91/92	92/93	93/94	94/95	95/96	
Cattle	- Carcass	100							
	- ML	100	*	*	*	*	*	*	300
	- Faeces	100							
Pig	- Carcass	100							
	- ML	100	*	*	*	*	*	*	300
	- Faeces	100							
Sheep/Goat	- Carcass	50							
	- ML	50	*	*	*	*	*	*	150
	- Faeces	50							
Chickens	- Carcass/dressed	226	95	*	*	*	210	194	1,480
	- Intestine	28	85	124	49	76	200	194	
Feed/fish/bone meal		15	34	199	367	61	9		685
Processing	- Floor/Table	52	26	*	*	*	12	8	
plant	- Knife	27	–	*	*	*	*	*	269
	- Effluent	82	42	*	*	*	11	9	
Fluff/duck feather		*	22	39	63	121	75	94	414
Water		*	37	183	306	75	42	118	761
Litter		*	20	228	198	29	*	*	475
Egg/duck/chicken		*	*	7	50	*	*	*	57
Miscellaneous of sick animals		265	235	711	931	99	270	135	2,646
Cultures		78	154	113	428	475	457	397	2,102
Sub total		1,523	750	1,604	2,392	936	1,286	1,149	
Total									9,639

ML = Mesenteric gland. ** = No specimen received/examined.*

MATERIALS AND METHODS

During the period of April 1989 – March 1996 a total of 9,639 specimens was received and examined by the Research Institute for Veterinary Science, Bogor (Table 1). They consisted of 2,102 bacteria cultures sent by various veterinary laboratories in West Java, Central Java, East Java, Lampung and South Kalimantan, 2,646 miscellaneous specimens from sick animals, and other specimens collected from abattoir, poultry processing plants and poultry farms. Isolation and identification of *Salmonella* were performed according to Cowan[12] and Hitchner *et al*[13]. The production of *Salmonella* specific antisera and serotyping was performed following the standard method[14,15].

RESULTS AND DISCUSSION

In 7 years period (April 1989 – March 1996), 2,196 isolates of *Salmonella* were found from 9,639 specimens (Table 1) The number of specimens examined each year was inconsistent since RIVS did not actively collect the specimens from the field. Sometimes the cultures sent by laboratories outside RIVS,

Table 2. The 10 most common *Salmonella* serotypes isolated from human and non human sources during April 1989 – March 1996

No.	*Salmonella* serotypes	No. of isolates	Persentage
1	*S. hadar*	299	13.61
2	*S. typhimurium*	227	10.33
3	*S. ouakam*	168	7.65
4	*S. blockley*	144	6.55
5	*S. amsterdam*	108	4.91
6	*S. virchow*	90	4.09
7	*S. enteritidis*	87	3.96
8	*S. senftenberg*	77	3.50
9	*S. livingstone*	75	3.41
10	*S. derby*	73	3.32
Total of 10 serotypes		1,660 (75.66 %)	
Total of other serotypes		536 (24.40 %)	
Grand total		2,196 (100 %)	

Table 3. Distribution of *Salmonella* Serotyped at RIVS during April 1989 – March 1996

No.	Serotype	Group	Year							Total
			89/90	90/91	91/92	92/93	93/94	94/95	95/96	
1	*S. hadar*	C_2	1	23	43	99	17	73	43	299
2	*S. typhimurium*	B	5	7	31	63	41	30	50	227
3	*S. ouakam*	D_2	4	9	4	7	35	74	35	168
4	*S. blockley*	C_2	3	-	9	33	34	38	27	144
5	*S. amsterdam*	E_1	5	12	11	37	9	21	13	108
6	*S. virchow*	C_1	2	10	2	12	30	20	14	90
7	*S. enteritidis* *	D_1	-	1	-	1	2	39	44	87
8	*S. senftenberg*	E_4	4	9	1	21	31	4	7	77
9	*S. livingstone*	C_1	15	2	-	20	27	22	9	75
10	*S. derby*	B	52	-	-	1	3	15	2	73
11	*S. thompson*	C_1	23	12	24	6	-	4	3	72
12	*S. emek*	C_3	-	4	4	5	6	42	7	68
13	*S. weltevreden*	E_1	8	11	10	19	7	6	6	67
14	*S. agona*	B	21	5	1	7	6	8	14	62
15	*S. kentucky*	C_3	9	7	5	15	11	3	7	57
16	*S. heidelberg*	B	1	19	4	10	10	-	5	49
17	*S. sofia* II *	B	20	-	6	18	5	-	-	49
18	*S. anatum*	E_1	27	-	-	2	2	8	7	46
19	*S. infantis*	C_1	17	4	1	9	-	5	4	40
20	*S. javiana*	D_1	7	-	3	5	2	10	8	35
21	*S. typhi* *	D_1	-	-	-	-	34	1	-	35
22	*S. lexington*	E_1	2	4	1	14	5	1	7	34
23	*S. paratyphi* b	B	-	1	4	5	-	3	14	27
24	*S. paratyphi* b.v. java	B	8	1	7	4	-	-	-	20
25	*S. potsdam*	C_1	-	-	-	5	4	7	3	19
26	*S. newport*	C_2	1	-	4	7	1	1	4	18
27	*S. schwarzengrund*	B	1	1	5	-	4	2	4	17
28	*S. montevideo*	C_1	1	1	1	1	-	9	2	15
29	**Not typeable**	-	-	2	7	1	1	2	-	13
30	*S. mbandaka*	C_1	-	-	-	8	1	3	-	12
31	*S. london*	E_1	-	-	-	6	-	3	2	11
32	*S. hvittingfoss* *	I	6	-	-	-	2	-	-	8
33	*S. oslo* *	C_1	-	-	-	2	-	2	3	7
34	*S. panama*	D_1	-	-	-	-	-	-	6	6
35	*S. alachua* *	35	-	-	1	-	-	4	-	5
36	*S. alagbon* *	C_3	-	-	-	-	-	-	5	5
37	*S. arizona* *	-	-	3	-	-	2	-	-	5
38	*S. tennessee*	C_1	3	-	1	-	-	-	1	5
39	*S. wandsworth* *	Q(39)	-	-	-	-	-	-	5	5
40	*S. glasgow* *	I(16)	-	-	-	-	-	-	4	4
41	*S. havana*	C_2	1	1	-	-	-	1	1	4
42	*S. krefeld*	E_4	-	1	3	-	-	-	-	4
43	*S. chester* *	B	-	1	-	-	2	-	-	3
44	*S. widemarsh* *	O(35)	-	-	-	-	-	3	-	3
45	*S. brunei* *	C_3	-	-	1	1	-	-	-	2
46	*S. bardo* *	C_3	-	1	-	-	-	-	-	1
47	*S. bonn* *	C_1	-	-	-	-	-	1	-	1
48	*S. breukelen* *	C_2	-	1	-	-	-	-	-	1
49	*S. california* *	B	-	-	-	-	-	-	1	1
50	*S. galiema*	C_1	-	-	1	-	-	-	-	1
51	*S. gaminara* *	I(16)	-	-	-	-	-	1	-	1
52	*S. kottbus*	C_2	-	-	-	-	-	-	1	1
53	*S. kua* *	V(44)	-	1	-	-	-	-	-	1
54	*S. maiduguri* *	E_4	-	-	-	-	-	1	-	1
55	*S. napoli* *	D_1	-	-	-	-	-	-	1	1
56	*S. nyeko* *	I(16)	-	-	-	-	-	1	-	1
57	*S. oranienberg*	C_1	-	-	-	-	-	-	1	1
58	*S. orientalis* *	I(16)	-	-	-	-	-	1	-	1
59	*S. saintpaul*	B	-	1	-	-	-	-	-	1
60	S. 40:Z_4 Z_{23}	R(40)	1	-	-	-	-	-	-	1
61	S_{11}.48:d:1,2/Z_6	Y(48)	-	-	-	-	-	1	-	1
62	S.67:Z:-	67	-	1	-	-	-	-	-	1
	Grand Total		248	156	194	444	334	450	370	2196

* = *Not found before 1989*

Table 4. *Salmonella* Serotypes isolated from human during April 1989 – March 1996

No.	Serotype	Group	Year							Total
			89/90	90/91	91/92	92/93	93/94	94/95	95/96	
1	*S. typhi*	D_1	-	-	-	-	34	-	-	34
2	*S. blockley*	C_2	-	-	-	-	3	-	1	4
3	*S. agona*	B	-	-	-	3	-	-	-	3
4	*S. lexington*	E_1	-	-	-	3	-	-	-	3
5	*S. newport*	C_2	-	-	-	3	-	-	-	3
6	*S. typhimurium*	B	-	-	-	1	1	-	-	2
7	*S. kentucky*	C_3	-	-	-	1	-	-	-	1
8	*S. sofia* II	B	-	-	-	-	1	-	-	1
	Total					11	39	-	1	
	Grand Total									51

Table 5. *Salmonella* Serotypes isolated from chickens during April 1989 – March 1996

No.	Serotype	Group	Year							Total
			89/90	90/91	91/92	92/93	93/94	94/95	95/96	
1	*S. hadar*	C_2	-	14	6	12	2	34	35	103
2	*S. blockley*	C_2	2	-	8	30	24	21	17	102
3	*S. ouakam*	D_2	2	-	1	3	16	44	16	82
4	*S. enteritidis*	D_1	-	1	-	1	2	35	37	76
5	*S. typhimurium*	B	4	7	17	27	1	8	4	68
6	*S. livingstone*	C_1	12	-	-	14	-	1	9	36
7	*S. heidelberg*	B	1	12	4	7	5	-	5	34
8	*S. amsterdam*	E_1	-	2	-	-	1	13	10	26
9	*S. kentucky*	C_3	3	3	3	5	3	2	7	26
10	*S. emek*	C_3	-	-	1	1	-	20	3	25
11	*S. sofia* II	B	5	-	6	11	3	-	-	25
12	*S. thompson*	C_1	-	5	6	3	-	4	3	21
13	*S. weltevreden*	E_1	-	3	4	6	3	3	2	21
14	*S. agona*	B	4	3	1	2	-	5	5	20
15	*S. virchow*	C_1	2	1	1	1	5	2	8	20
16	*S. infantis*	C_1	6	1	1	1	-	3	4	16
17	*S. schwarzengrund*	B	1	-	5	-	-	5	4	15
18	*S. javiana*	D_1	1	-	3	-	-	9	1	14
19	*S. paratyphi* b	B	-	-	1	-	-	2	11	14
20	*S. senftenberg*	E_4	-	2	-	2	-	3	6	13
21	*S. anatum*	E_1	-	-	-	2	-	5	2	9
22	*S. derby*	B	-	-	-	-	-	4	2	6
23	*S. hvittingfoss*	I	6	-	-	-	-	-	-	6
24	*S. lexington*	E_1	-	-	-	-	4	1	-	5
25	*S. mbandaka*	C_1	-	-	-	3	-	2	-	5
26	*S. newport*	C_2	-	-	-	-	1	1	3	5
27	*S. london*	E_1	-	-	-	-	-	2	2	4
28	*S. paratyphi* b.v. java	B	-	-	4	-	-	-	-	4
29	*S. alachua*	35	-	-	1	-	-	2	-	3
30	*S. alagbon*	C_3	-	-	-	-	-	-	3	3
31	*S. glasgow*	I(16)	-	-	-	-	-	-	3	3
32	*S. potsdam*	C_1	-	-	-	-	2	-	1	3
33	*S. chester*	B	-	-	-	-	2	-	-	2
34	*S. oslo*	C_1	-	-	-	-	-	1	1	2
35	*S. widemarsh*	O(35)	-	-	-	-	-	2	-	2
36	*S. bonn*	C_1	-	-	-	-	-	1	-	1
37	*S. gaminara*	I(16)	-	-	-	-	-	1	-	1
38	*S. havana*	C_2	-	1	-	-	-	-	-	1
39	*S. maiduguri*	E_4	-	-	-	-	-	1	-	1
40	*S. montevideo*	C_1	-	1	-	-	-	-	-	1
41	*S. napoli*	D_1	-	-	-	-	-	-	1	1
42	*S. nyeko*	I(16)	-	-	-	-	-	1	-	1
43	*S. oranienberg*	C_1	-	-	-	-	-	-	1	1
44	*S. orientalis*	I(16)	-	-	-	-	-	1	-	1
	Grand Total		49	56	73	131	75	239	205	828

consisted of 4 to 5 isolates from the same specimen code, and some were not *Salmonella*. Table 3 shows the distribution of *Salmonella* serotypes during this period. The 2,196 isolates consisting of 62 different serotypes, including 23 serotypes which had never been isolated before the year 1989, included *S. enteritidis*. Of the 62 serotypes, there were 10 most common serotypes, i.e. *S. hadar* 299 (13.61 %), *S. typhimurium* 227 (10.01 %), *S. ouakam* 168 (7.65 %), *S. blockley* 144 (6.55%), *S. amsterdam* 108 (4.91 %), *S. virchow* 90 (4.09 %), *S. enteritidis* 87 (3.96 %), *S. senftenberg* 77 (3.50 %), *S. livingstone* 75 (3.41 %), *S. derby* 73 (3.32 %), and other serotypes 536 (24.40 %) as shown in Table 2. The most common serotypes reported between 1971 - 1989 were *S. typhimurium* 107 (16.85 %), *S. lexington* 76 (11.96 %), *S. agona* 72 (11.34 %), *S. weltevreden* 46 (7.24 %), *S. blockley* 43 (6.77 %) and other serotypes 291 (45.84 %)[11]. *S. hadar* the most frequent isolate was rarely found in the previous report[11]. This may be due to the import of chickens from other countries. The result (Table 3) also showed that serogroups C_{23}, B_{10}, E_8 and E_6 were predominant out of the 62 serotypes found. Of the fifty one isolates, 2.32 % were from humans, they belonged to 8 serotypes (Table 4). 1,505 isolates (68.52 %) were from poultry (chickens, ducks, eggs, litters and fluffs) consisting of 50 serotypes (Table 5-9). 95 isolates (4.32 %) were from pigs and of 12 serotypes (Table 10). 59 isolates (2.60 %) were from cattle and of 11 serotypes (Table 11). 66 isolates (3.00 %) were from feedstuff and of 20 serotypes (Table 12), 209 (9.50%) were from water and of 41 serotypes (Table 13), 211 (9,60 %) were from miscellaneous sources.

Salmonella isolated from human

Salmonellosis in human such as typhoid fever has a high incidence rate in the developing countries[8,16-8], whereas non-typhoidal salmonellosis especially caused by *S. enteritidis*[20-2]. is a problem for both developed and developing countries[6,19]. In Indonesia, the incidence of non-typhoidal salmonellosis is rarely reported. This may be due to the fact that perhaps there are other diseases which get higher priorities or non typhoidal salmonellosis is not considered important to Indonesia. The 51 isolates from human sources belonged to 8 serotypes and 5 groups (Table 4) in which *Salmonella typhi* of group D_1 was the most frequently found (34 isolates). This is similar to the finding of typhoid fever reported in humans in other developing countries[8,16-8]. However, this figure does not represent the whole typhoid fever in Indonesia since the samples were received only from the University of Indonesia, Jakarta.

Salmonella isolated from poultry

A total of 1,505 isolates (Table 5-9) were found in poultry and consisted of 50 serotypes. The most common serotypes among others were *S. hadar* 103 from chickens; 102 from ducks, 40 from eggs, 12 from litters, 22 from fluff; *S. typhimurium* 68 from chickens, 38 from ducks, 79 from eggs, 8 from litter; *S. ouakam* 82 from chickens, 22 from ducks, 3 from eggs; *S. blockley* 102 from chickens, 8 from litters; *S. enteritidis,* 76 from chickens and 4 from litter. *Sixteen serotypes found in ducks were also found in chickens except S. wandsworth* (Table 6); 14 serotypes found

Table 6. *Salmonella* Serotypes isolated from ducks during April 1989 – March 1996

No.	Serotype	Group	Year							Total
			89/90	90/91	91/92	92/93	93/94	94/95	95/96	
1	*S. hadar*	E_1	-	-	33	27	11	19	12	102
2	*S. typhimurium*	B	-	-	4	-	8	9	17	38
3	*S. virchow*	C_1	-	-	-	6	10	9	-	25
4	*S. ouakam*	D_2	-	-	-	-	-	11	11	22
5	*Salmonella*	B	-	-	2	-	-	2	4	8
6	*S. thompson*	C_1	-	-	4	3	-	-	-	7
7	*S. javiana*	D_1	-	-	-	-	-	-	6	6
8	*S. senftenberg*	E_4	-	-	-	2	4	-	-	6
9	*S. wandsworth*	Q(39)	-	-	-	-	-	-	5	5
10	*S. lexington* b	E_1	-	-	-	3	-	-	-	3
11	*S. paratyphi* var java	B	-	-	1	2	-	-	-	3
12	*S. oslo*	C_1	-	-	-	2	-	-	-	2
13	*S. postdam*	C_1	-	-	-	2	-	-	-	2
14	*S. weltevrede*	E_1	-	-	1	1	-	-	-	2
15	*S. amsterdam*	E_1	-	-	1	-	-	-	-	1
16	*S. sofia* II	B	-	-	-	1	-	-	-	1
	Grand Total		-	-	46	49	33	50	55	233

Table 7. *Salmonella* Serotypes isolated from eggs during April 1989 – March 1996

No.	Serotype	Group	Year						Total
			89/90	90/91	91/92	92/93	93/94	94/95	95/96	
1	*S. typhimurium*	B	-	-	5	31	30	-	13	79
2	*S. senftenberg*	E_4	-	5	-	13	26	-	-	44
3	*S. hadar*	C_2	-	7	1	32	-	-	-	40
4	*S. virchow*	C_1	-	8	14	-	12	-	-	24
5	*S. thompson*	C_1	-	5	10	-	-	-	-	15
6	*S. mbandaka*	C_1	-	5	-	1	-	-	-	6
7	*S. ouakam*	D_2	-	-	-	1	2	-	-	3
8	*S. postdam*	C_1	-	-	-	2	-	-	-	2
9	*S. agona*	B	-	-	-	1	-	-	-	1
10	*S. javiana*	D_1	-	-	-	1	-	-	-	1
11	*S. kentucky*	C_3	-	-	-	1	-	-	-	1
12	*S. paratyphi* b var Java	B	-	-	-	1	-	-	-	1
13	*S. sofia* II	B	-	-	-	1	-	-	-	1
14	*S. weltevreden*	E_1	1	-	-	-	-	-	-	1
	Grand Total		1	30	20	85	70	-	13	219

Table 8. *Salmonella* Serotypes isolated from litter during April 1989 – March 1996

No.	Serotype	Group	Year						Total
			89/90	90/91	91/92	92/93	93/94	94/95	95/96	
1	*S. amsterdam*	E_1	-	5	10	10	8	2	-	35
2	*S. livingstone*	C_1	-	-	-	-	27	-	-	27
3	*S. ouakam*	D_2	-	4	1	1	14	1	2	23
4	*S. hadar*	C_2	-	1	2	3	-	3	3	12
5	*S. blockley*	C_2	-	-	1	3	-	4	-	8
6	*S. typhimurium*	B	1	-	4	3	-	-	-	8
7	*S. heidelberg*	B	-	-	-	1	5	-	-	6
8	*S. thompson*	C_1	2	2	2	-	-	-	-	6
9	*S. enteritidis*	D_1	-	-	-	-	-	3	1	4
10	*S. london*	E_1	-	-	-	3	-	1	-	4
11	*S. derby*	B	1	-	-	-	2	-	-	3
12	*S. kentucky*	C_3	-	-	2	-	-	1	-	3
13	*S. mbandaka*	C_1	-	-	-	2	1	-	-	3
14	*S. virchow*	C_1	-	1	-	-	1	1	-	3
15	*S. weltevreden*	E_1	-	-	1	1	-	1	-	3
16	*S. emek*	C_3	-	-	-	-	-	2	-	2
17	*S. hvittingfoss*	I	-	-	-	-	2	-	-	2
18	*S. infantis*	C_1	1	1	-	-	-	-	-	2
19	*S. krefelt*	E_4	-	1	1	-	-	-	-	2
20	*S. lexington*	E_1	-	1	-	-	1	-	-	2
21	*S. oslo*	C_1	-	-	-	-	-	1	1	2
22	*S. agona*	B	1	-	-	-	-	-	-	1
23	*S. alagbon*	C_3	-	-	-	-	-	-	1	1
24	*S. anatum*	E_1	-	-	-	-	1	-	-	1
25	*S. galiema*	C_1	-	-	1	-	-	-	-	1
26	*S. javiana*	D_1	-	-	-	-	-	1	-	1
27	*S. montevideo*	C_1	-	-	-	-	-	-	1	1
28	*S. paratyphi* B	B	-	-	-	-	-	-	1	1
29	*S. potsdam*	C_1	-	-	-	1	-	-	-	1
30	$S_{11}.48:d:1,2/Z_6$	Y(48)	-	-	-	-	-	1	-	1
	Grand Total		6	16	25	28	62	22	10	169

in eggs (Table 7) were all found in chickens; serotypes in litter were also found in chickens except *S. galiema, S. krefeld* and S_{II} 48:1,2/Z_6 (Table 8); 14 serotypes in fluff were also found in chickens except *S. bardo,* and *S. saintpaul* (Table 9). *S. pullorum* which was found in the previous period was not found in this period. This may be caused by regular pullorum test performed and prevention program conducted by the breeding farms. An interesting fact is that there is a high frequency of *S. enteritidis* isolated from chickens which was not found during 1971-1989. In many countries, the incidence of *S. enteritidis* has also in-

Table 9. *Salmonella* Serotypes isolated from fluff during April 1989 – March 1996

No.	Serotype	Group	Year							Total
			89/90	90/91	91/92	92/93	93/94	94/95	95/96	
1	*S. hadar*	C_2	1	-	21	-	-	-	-	22
2	*S. emek*	C_3	-	4	3	-	-	-	3	10
3	*S. agona*	B	-	2	-	-	2	-	-	4
4	*S. weltevreden*	E_1	-	1	-	1	-	2	-	4
5	*S. paratyphi* b.v. java	B	1	2	-	-	-	-	-	3
6	*S. virchow*	C_1	1	1	-	-	-	-	1	3
7	*Salmonella*	B	2	-	-	1	-	-	-	3
8	*S. amsterdam*	E_1	-	1	-	-	-	-	-	1
9	*S. bardo*	C_3	-	1	-	-	-	-	-	1
10	*S. montevideo*	C_1	1	-	-	-	-	-	-	1
11	*S. saintpaul*	B	1	-	-	-	-	-	-	1
12	*S. senftenberg*	E_4	-	1	-	-	-	-	-	1
13	*S. sofia* II	B	-	-	-	1	-	-	-	1
14	*S. thompson*	C_1	-	1	-	-	-	-	-	1
	Grand Total		7	14	24	3	2	2	4	56

Table 10. *Salmonella* Serotypes isolated from pigs during April 1989 – March 1996

No.	Serotype	Group	Year							Total
			89/90	90/91	91/92	92/93	93/94	94/95	95/96	
1	*S. derby*	B	31	-	-	-	-	-	-	31
2	*S. anatum*	E_1	14	-	-	-	-	-	2	16
3	*S. agona*	B	5	-	-	-	-	-	8	13
4	*S. typhimurium*	B	-	-	-	-	-	-	13	13
5	*S. kentucky*	C_3	5	-	-	-	-	-	-	5
6	*S. weltevreden*	E_1	3	-	-	-	-	-	2	5
7	*S. amsterdam*	E_1	4	-	-	-	-	-	-	4
8	*S. livingstone*	C_1	3	-	-	-	-	-	-	3
9	*S. lexington*	E_1	2	-	-	-	-	-	-	2
10	*S. javiana*	D_1	1	-	-	-	-	-	-	1
11	*S. paratyphi* b var Java	B	1	-	-	-	-	-	-	1
12	*S. virchow*	C_1	-	-	-	-	-	-	1	1
	Grand Total		69	-	-	-	-	-	26	95

Table 11. *Salmonella* Serotypes isolated from cattle during April 1989 – March 1996

No.	Serotype	Group	Year							Total
			89/90	90/91	91/92	92/93	93/94	94/95	95/96	
1	*S. infantis*	C_1	7	-	-	8	-	-	-	15
2	*S. typhimurium*	B	8	-	-	-	1	-	-	9
3	*S. newport*	C_2	-	-	4	4	-	-	-	8
4	*S. lexington*	E_1	-	-	-	6	-	-	-	6
5	*S. paratyphi* b var java	B	6	-	-	-	-	-	-	6
6	*S. virchow*	C_1	-	-	-	-	5	-	-	5
7	*S. heidelberg*	B	-	-	-	3	-	-	-	3
8	*S. thompson*	C_1	3	-	-	-	-	-	-	3
9	*S. agona*	B	2	-	-	-	-	-	-	2
10	*S. blockley*	C_2	1	-	-	-	-	-	-	1
11	*S. javiana*	D_1	1	-	-	-	-	-	-	1
	Grand Total		28	-	4	21	6	-	-	59

creased dramatically[6,19]. *S. enteritidis* in chickens may have entered into Indonesia together with breeding stock imported from other countries, as it was found in 7 days old sick parent stock chickens[23].

Salmonella isolated from pigs

From 95 isolates of *Salmonella* (Table 10) found in pigs, 69 isolates were isolated in 1989/1990 were from healthy looking pigs slaughtered in abattoirs. The

Table 12. *Salmonella* Serotypes isolated from feed stuff during April 1989 – March 1996

No.	Serotype	Group	Year							Total
			89/90	90/91	91/92	92/93	93/94	94/95	95/96	
1	*S. amsterdam*	E_1	1	2	-	4	-	-	-	7
2	*S. lexington*	E_1	-	-	1	-	-	-	5	6
3	*S. senftenberg*	E_4	3	-	1	1	1	-	-	6
4	*S. hadar*	B	-	-	-	-	2	3	-	5
5	*S. kentucky*	C_3	1	-	-	4	-	-	-	5
6	*S. livingstone*	C_1	-	2	-	2	-	-	-	4
7	*S. ouakam*	D_2	1	1	1	1	-	-	-	4
8	*S. tennessee*	C_1	3	-	1	-	-	-	-	4
9	*S. weltevreden*	E_1	-	-	1	3	-	-	-	4
10	*S. agona*	B	2	-	-	-	-	1	-	3
11	*S. sofia* II	B	-	-	-	3	-	-	-	3
12	*S. typhimurium*	B	-	-	-	-	-	3	-	3
13	*S. krefeld*	E_4	-	-	2	-	-	-	-	2
14	*S. mbandaka*	C_1	-	-	-	1	-	1	-	2
15	*S. montevideo*	C_1	1	-	-	1	-	-	-	2
16	*S. virchow*	C_1	-	-	-	-	2	-	-	2
17	*S. blockley*	C_2	1	-	-	-	-	-	-	1
18	*S. california*	B	-	-	-	-	-	-	1	1
19	*S. havana*	C_2	1	-	-	-	-	-	-	1
20	S_{67}:Z_{29} :-	67	-	1	-	-	-	-	-	1
	Grand Total		14	6	7	20	5	8	6	66

other 26 isolates found in 1995/1996 from sick animals consisted of *S. agona*[8], *S. anatum*[2], *S. typhimurium*[13], *S. virchow*[1] and *S. weltevreden*[2].

Salmonella isolated from cattle

The 59 isolates of *Salmonella* (Table 11) consisted of *S. infantis*[15], *S. typhimurium*[9], *S. newport*[8], *S. lexington*[6], *S. paratyphi* B. var java[6], *S. virchow*[5], *S. heidelberg*[3], *S. thompson*[3], *S. agona*[2] , *S. blockley*[1], and *S. javiana*[1].

Salmonella isolated from feedstuff

Table 12 showed that 66 isolates of *Salmonella* were coming from chicken feed and consisting of 20 serotypes. They were *S. amsterdam*[7], *S. lexington*[6], *S. senftenberg*[6], *S.hadar*[5], *S. kentucky*[5], *S. weltevreden* [4], S. agona[3], *S. sofia II*[3], *S. typhimurium*[3], *S. krefeld*[2], *S. virchow*[2], *S. blockley*[1], *S. california*[1], *S. havana*[1], and S_{67} : Z_{29} : - (1). The feed consisted of chicken feed where its ingredients were mainly bone meal and fish meal.

Salmonella isolated from water

Out of 209 isolates of *Salmonella* from water (Table 13) 60 isolates were from abattoirs and poultry processing plant effluents. They consisted of *S. agona*[7], *S. anatum*[6], *S. derby*[9], *S. hadar*[1], *S. infantis*[5], *S. lexington* [4], *S. newport*[1], *S. ouakam*[2], *S. weltevreden*[10]. The isolates from river water were *S. sofia* II[1], from well were *S. brunei*[1], *S. virchow*[1], *S. typhi*[1], and from pond were *S. enteritidis*[2]. The other 143 isolates came from drinking water of chicken farms, and they consisted of 31 serotypes such as *S. enteritidis*, *S. typhimurium, S. blockley*, *S. hadar, S. agona*, *S. amsterdam*, *S. ouakam*, and *S. paratyphi* B. Water plays an important role in the distribution of *Salmonella* which comes from contamination by wild animals, domestic animals, birds and humans[3].

Salmonella isolated from miscellaneous sources

From chicken carcasses the *Salmonella* serotypes found were: *S. agona, S. anatum, S. blockley, S. hadar, S. heidelberg, S. kentucky, S. ouakam, S. potsdam, S. schwarzengrund, S. sofia* II, *S. thompson, S. typhimurium, S. virchow,* and *S. weltevreden*; from horses: *S. typhimurium*; from shrimps: *S.kentucky*; from fish: *S. typhimurium*; from pigeons: *S. typhimurium*; from monkeys: *S. weltevreden*; from frogs: *S. typhimurium*; from worms: *S. typhimurium;* from soils: *S. typhimurium*; from dust: *S. typhimurium*; from bonesaw: *S. anatum*; from ostrich: *S. paratyphi B, S. javiana; Crocodile; S. arizona, S. breukelen, S. chester, S. kua, S. paratyphi B*; goat/sheep: *S. anatum, S. thompson, S. kentucky.*

Although the same serotype had been isolated from different sources of specimens and places of origin, it is difficult to see any correlation among the origin of the specimens, since the sources of the specimens

were not well recorded. It is then important to conduct an epidemiological study to see the correlation among salmonella infection in animals, humans and environment in Indonesia. This will enable us to trace exactly the source of each salmonellosis and promote the preventive procedure. Besides, it may be necessary to conduct more active surveillance on *Salmonella* in human and animals, in order to learn the distribution of bacteria. Apart from importing agricultural related raw materials, Indonesia also plans to become an exporting country for livestock products. However, this requires the status of being free from any contaminant hazardous to human being such as salmonella in this products, That will become a major issue for food safety.

Table 13. *Salmonella* Serotypes isolated from water during April 1989 – March 1996

No.	Serotype	Group	Year							Total
			89/90	90/91	91/92	92/93	93/94	94/95	95/96	
1	*S. amsterdam*	E_1	-	1	-	20	-	6	3	30
2	*S. weltevreden*	E_1	2	-	3	7	2	-	1	15
3	*S. hadar*	C_2	-	-	1	4	-	6	3	14
4	*S. ouakam*	D_2	1	1	1	1	2	5	1	12
5	*S. derby*	B	9	-	-	-	-	1	-	10
6	*S. agona*	B	7	-	-	1	-	-	1	9
7	*S. paratyphi* b	B	-	-	3	3	-	1	2	9
8	*S. anatum*	E_1	3	-	-	-	-	1	3	7
9	*S. enteritidis*	D_1	-	-	-	-	-	1	6	7
10	*S. infantis*	C_1	3	2	-	-	-	2	-	7
11	*S. montevideo*	C_1	-	-	-	-	-	6	1	7
12	*S. virchow*	C_1	-	-	-	1	-	2	4	7
13	*S. lexington*	E_1	-	2	-	2	-	-	2	6
14	*S. panama*	D_1	-	-	-	-	-	-	6	6
15	*S. blockley*	C_2	-	-	-	-	2	3	-	5
16	*S. emek*	C_3	-	-	-	-	-	4	1	5
17	*S. senftenberg*	E_4	1	-	-	2	-	1	1	5
18	*S. kentucky*	C_3	-	-	-	4	-	-	-	4
19	*S. livingstone*	E_1	-	-	-	3	-	1	-	4
20	*S. potsdam*	C_1	-	-	-	-	2	1	1	4
21	*S. sofia* II	B	1	-	-	2	1	-	-	4
22	*S. javiana*	D_1	-	-	-	-	2	-	1	3
23	*S. oslo*	C_1	-	-	-	-	-	-	3	3
24	*S. alachua*	35	-	-	-	-	-	2	-	2
25	*S. arizona*	-	-	-	-	-	2	-	-	2
26	*S. brunei*	C_3	-	-	1	1	-	-	-	2
27	*S. havana*	C_2	-	-	-	-	-	1	1	2
28	*S. newport*	C_2	1	-	-	-	-	-	1	2
29	*S. schwarzengrund*	B	-	-	-	-	-	2	-	2
30	*S. thompson*	C_1	-	-	2	-	-	-	-	2
31	*S. typhimurium*	B	-	-	1	-	-	1	-	2
32	*S. alagbon*	C_3	-	-	-	-	-	-	1	1
33	*S. glasgow*	I(16)	-	-	-	-	-	-	1	1
34	*S. kottbus*	C_2	-	-	-	-	-	-	1	1
35	*S. london*	E_1	-	-	-	1	-	-	-	1
36	*S. mbandaka*	C_1	-	-	-	1	-	-	-	1
37	*S. paratyphi* b.v. java	B	-	-	-	1	-	-	-	1
38	*S. tennessee*	C_1	-	-	-	-	-	-	1	1
39	*S. typhi*	D_1	-	-	-	-	-	1	-	1
40	*S. widemarsh*	O(35)	-	-	-	-	-	1	-	1
41	*Salmonella*	B	-	-	1	-	-	-	-	1
	Grand Total		28	6	13	54	13	49	46	209

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