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Study of *Campylobacter* spp. Carriage in Poultry Farms in Kindia Prefecture (Republic of Guinea)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Introduction: In the field of food safety, *Campylobacter* is an emerging hazard whose importance is increasing over the years.
Objective: The aim of this study was to investigate the prevalence of *Campylobacter* spp. in poultry farms in the Kindia prefecture in order to protect the health of the population.
Methods: This is a prospective and descriptive study on the carriage of *Campylobacter*s spp. which lasted 7 months, from 25 June 2016 to 24 January 2017.
Results: Of 120 samples of droppings taken from modern farms, 33.3% were found to contain *Campylobacter*s. Carriage was high in all farms: 100 in the Cheick Taliby farm, 90% in the Kinyéya

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farm, 60% in the Samorya farm, 70% in Bamban and 80% in Monastère Saint Croix. In Kindia's main market, the rate of *Campylobacter* spp. carriage in droppings was 73.3%. Carriage of *Campylobacter* spp. in eggs at the two modern farms was 38.3%, with 50% at the Couvoir de Kahéré and 26.7% at the Avi Leydi farm. *Campylobacter* spp. carriage was 80% on the Cheick Taliby and Claudine farms, compared with 40% on the Monastère Saint Croix farm. *Campylobacter*s spp. were carried in eggs at the Kindia market (58.3%). *Campylobacter*s pp. were carried in 17.9% of droppings from modern farms, 42.6% from semi-modern farms and 39.5% from traditional farming. Contamination of water supplies and drinking troughs by *Campylobacter*s spp. was 16.67% for water. The rate of contamination of drinking troughs was high on the Couvoir de Kahéré farm, at 33.33% compared with 0% on the Avi Leydi farm. However, the borehole water after analysis did not contain *Campylobacter* spp. Carriage of feed stocks by *Campylobacter*s spp. on the two modern farms (Couvoir de Kahéré and Avi Leydi) was 0.0%. However, it was 83% in the feed troughs at the Couvoir de Kahéré and 50% at the Avi Leydi farm. *Campylobacter* spp. contamination of water taken from troughs on semi-modern farms was 70.83%. All samples taken from troughs on the Cheick Taliby farm and those on the Kinyéya farm were contaminated, representing a 100% *Campylobacter* spp. carriage rate, compared with 75% on the Claudine farm and 50% on the Bamban, Monastère Saint Croix and Samorya farms. In the food stocks of the semi-modern farms, all the samples were positive for *Campylobacter* spp. in particular in the Cheick Taliby farm, i.e. 100%, the Kinyéya and Claudine farms had a carriage rate of 83.83%, followed by the Monastère Saint Croix farm with 66.66% and the Samorya farm with 33.33%. The overall carry rate for food stocks was 69.44%. On the other hand, 91.66% of feed was carried in the troughs. In the water troughs of traditional chickens sold at the Kindia market, *Campylobacter* spp. contamination was around 75%, whereas the number of water bottles contaminated by *Campylobacter* spp. was 33.3%. In the food stocks of traditional chickens sold at the Kindia market, the rate of *Campylobacter* spp. contamination was 33.3%. On the other hand, 62.5% of traditional chicken feeders contained *Campylobacter* spp.

Conclusion: Our results show that *Campylobacter* spp. is widely circulated on poultry farms in the Kindia prefecture through eggs, feed, droppings and drinking water.

Keywords: Campylobacter spp.; poultry farms; droppings; eggs; water; feed; Kindia.

1. INTRODUCTION

In the field of food safety, *Campylobacter* is an emerging hazard whose importance is increasing over the years. The increase in cases of *campylobacter*iosis, the existence of rare but serious complications such as GUILLAIN-BARRÉ syndrome, and the worrying rise in *Campylobacter* resistance to antibiotics explain the renewed interest in this bacterial genus. These bacteria are currently considered to be the leading cause of food-borne infectious disease in humans worldwide (Friedman et al., 2000; World Health Organization, 2000) and the annual incidence in the general population is estimated at 90 per 100,000 inhabitants (Berndtson et al., 1996). In some developed countries where a surveillance system exists, an increase in cases of *Campylobacter* has been reported in recent years. In the USA, the number of *Campylobacter* infections is estimated at between 2.1 and 2.4 million, giving an annual incidence of 880. per 100,000 population (almost double the estimated incidence of salmonellosis) (Friedman et al., 2000). In the United Kingdom in 2000, out of 2 million reported cases of bacterial food poisoning, 77.3% were due to *Campylobacter* jejuni, compared with 20.9% of salmonella infections (Friedman et al., 2000). In France, a study carried out by the Institut de Veille Sanitaire estimated the incidence of *Campylobacter* infections at between 1,667 and 2,733 per 100,000 inhabitants, based on surveillance data (Gallay, 2006). In Africa, children under the age of 5 are most at risk (Coker's Cloth, 1994; Lindblom et al., 1995). Generally speaking, the annual incidence of *campylobacter*iosis in these children in developing countries is estimated at between 40,000 and 60,000 per 100,000 population (Oberhelman & Taylor, 2000; Lastovica & Skirrow, 2000; Rao et al., 2001), compared with 300 per 100,000 in developed countries (Tauxe, 1992). According to the World Health Organisation (WHO), these figures are increasing in most of these countries (World Health Organization, 2000). Four species belonging to the *Campylobacter* genus have been described as being responsible for the health problems observed in humans: C. jejuni,

C. coli, respectively implicated in around 80-90% and 5-10% of cases, and to a lesser extent C. lari and C. upsaliensis. Various authors have reported the presence of *campylobacter*s in the intestinal tract of numerous species of wild and domestic animals, including poultry (Berndtson et al., 1996). Consumption of contaminated foods such as unpasteurised milk, meat, poultry, shellfish, fruit and vegetables can cause *Campylobacter* toxi-infection in humans (Evans & Sayers, 2000). Efforts within the abattoir to improve hygiene to reduce *Campylobacter* contamination have limited effect and are likely to have little impact on the risk to consumers. Therefore, in the absence of cost-effective and acceptable methods of carcass decontamination, the aim must be to produce infection-free chickens at slaughter and thereby reduce the potential for human infection from this source. Identifying the risk factors for infection could enable the development of interventions on farms to achieve this objective (Stern et al., 2001. In the Republic of Guinea, poultry, in particular broiler chicken, has become one of the main sources of protein for the population. However, we were unable to find any studies on *campylobacter* carriage in chickens, the main source of infection in humans. The difficulties associated with isolating and identifying the bacteria could be at the root of this lack of information on *Campylobacter* in the poultry industry. The aim of this study was to investigate the prevalence of *Campylobacter spp*. in poultry farms in the Kindia prefecture in order to protect the health of the population.

2. MATERIALS AND WORKING METHODS

2.1 Study Environment

Our study was carried out in the prefecture of Kindia. It covers an area of 9,115 km^2. It is bordered to the east by the prefecture of Coyah, to the north by the prefecture of Télimélé, to the south by Sierra Leone and to the west by the prefecture of Mamou. The population is estimated at 438 315 inhabitants (2014 Census) for an average density of 48 inhabitants per Km2, with an estimated growth rate of 34%.

2.2 Study Setting

The Guineo-Russian laboratory of the Institut de Recherche en Biologie Appliquée de Guinée (IRBAG) provided the setting for this work.

2.3 Working Method

This is a prospective and descriptive study of the analytical type, which lasted 7 months, from 25 June 2016 to 24 January 2017. The work focused on 24 farms in the urban commune and in three sub-prefectures (ultramodern farms, modern farms, semi-modern farms and traditional livestock farms). Sampling was systematic and included 360 samples of droppings, 180 eggs, 88 water sources and 102 feed samples during the course of our survey. Our study included layers reared on the various farms, their droppings, eggs, feed, spring water and water used on the farms.

2.4 Work Equipment

2.4.1 Laboratory equipment

We used the basic material of the IRBAG Bacteriology laboratory:

Equipment, reagents and other consumables.

2.4.1.1 Equipment

Gene 6000 rotor; Transport medium (Cary-Blair); Disinfectant; 1.5 ml Eppendorf tubes; Icebox with cold accumulator; Automatic pasteur pipettes; Filter tips; Micropipettes; Microcentrifuge; Vortex mixer; Refrigerator; Freezers: -20°C,-80°C; Thermostat; Sterile swabs; Petri dishes, 50-60 mm; Table container for used materials and instruments; Sterile vials; Nitrile gloves.

2.4.1.2 Protective equipment

Overalls, shoes, overshoes, N95 mask, safety goggles; tweezers; vacuum pump; cellulose membrane filters with pore sizes ranging from 0.45-0.65µm; marker; alcohol lamp and scales.

2.4.2 Reagents

All the reagents we used came from Russia and were produced by "Amplisens". The composition of "DNA-Sorb-B FEP/FRT" is shown in the List 2.

2.4.3 Other consumables

- 70% ethanol ;
- Acetone ;
- Physiological water.

List 1. Table of poultry farms in Kindia prefecture

Location	Number of farms	Number of laying hens
Town centre	3	4 100
Sub-prefecture of Damakania	2	3000
Sub-prefecture of Friguiagbé	12	89 038
Sub-prefecture of Mambia	7	20 705
Total	24	116 843

List 2. The composition of "DNA-Sorb-B FEP/FRT

Reagents	Colour	Volume in ml	Quantity
Lysis solution (Guanidine thio cyanate)	Colourless transparent liquid	15	1 bottle
Internal Control (IC) Clear,	Colourless liquid	1,0	3 bottles
Adsorbent solution	Colourless transparent liquid	1,25	2 bottles
Solution de lavage1	Colourless transparent liquid	15	1 bottle
Wash solution2 (70% ethanol)	Colourless transparent liquid	50	1 bottle
Washing solution3 (acetone)	Colourless transparent liquid	50	1 bottle
DNA-elution	Colourless transparent liquid	5	1 bottle

List 3. Reagents for the PCR reaction mixture: Composition of the "*Campylobacter* FEP/FRT" kit

Reagents	Colour	Volume in ml	Quantity
Amorces PCR (*Campylobacter* spp./adenovirus)	Colourless transparent liquid	0,6	1 bottle
Polymerase (TaqF)	Colourless transparent liquid	0,3	4 bottles
Tampon D'NTP / ADN	Colourless transparent liquid	0,5	1 bottle
Campylobacter jejuni /adenovirus positive control	Colourless transparent liquid	0,12	5 bottles
Negative Control	Colourless transparent liquid	1,6	1 bottle

List 4. This consists of droppings, eggs, water sources and feed used on the farms

Farms	Water				Food	
	Drinking	Troughs	Wells	Taps	Stores	Feed troughs
Modern farms	24	2	NU	NU	12	12
Semi-modern farms	24	4	1	1	36	12
Traditional farming (chickens sold at market)	24	NU	6	NU	6	24
Total	72	6	7	1	54	48

Legend: NU= sources not used

2.4.4 Biological material

2.4.4.1 Transport

Campylobacters are particularly sensitive to environmental conditions, especially dehydration, atmospheric oxygen, sunlight and high temperatures. Transport to the laboratory was possible rapidly. Transport tubes containing Cary-Blair medium and swabs were used.

3. RESULTS

The application of the research methodology led to the following results in the form of tables, which were interpreted, commented on and discussed according to the available literature data.

In Table 1, out of 120 samples of droppings taken from the modern farms, 40 were found to contain *Campylobacters*, i.e. 33.3%. The percentage of infection remains high on both farms: 41.7% on the Couvoir de Kahéré farm compared with 25% on the Avi Leydi farm. Despite this percentage difference, it was not statistically significant (p-value >0.05).

Table 1. Results of manure analyses on modern farms

Farms	Samples			95% CI	p-value
	Number	positive	Percentage		
Kahéré hatchery	60	25	41,7	[29,1-55,1]	0,08
Avi leydi	60	15	25,0	[14,7-37,9]	
Total	120	40	33,3	[25,0-42,5]	

In Table 2, the percentages of *Campylobacter* positivity are higher than on modern farms. In the Cheick Taliby farm, 100%, 90% in the Kinyéya farm and 60% to 80% respectively in the Bamban, Samorya and Monastère Saint Croix farms. This could be explained by the higher number of samples on the semi-modern farms, on the one hand, and insufficient application of hygiene measures relating to feeding, on the other. The difference between the semi-modern farms was statistically significant (p-value = 0.03).

Table 3 shows that chicken droppings from the large market in Kindia are highly contaminated with *Campylobacters* spp. with a carriage rate of 73.3%. Contamination of manure samples from chickens of various origins is also high, which would justify the poor feeding, hygiene and sanitary conditions that characterise traditional extensive farming.

Samples of eggs from the two modern farms showed that 23/60, or 38.3%, carried *Campylobacter* spp. DNA. The difference between the two farms was not significant (p-value >0.05), although Couvoir de Kahéré carried 15/30, or 50%, while Avi Leydi carried 8/30, or 26.7%.

The results in Table 5 also show a high carriage of *Campylobacters* spp. eggs in the semi-modern farms. The Cheick Taliby and Claudine farms each had an egg carriage rate of 08 out of 10, i.e. 80%, compared with 40% on the Monastère Saint Croix farm. These high percentages for eggs could be linked to overcrowding (very high number of chickens compared to the capacity) and the lack of hygiene on these farms. However, the differences in *Campylobacter* spp. carriage observed on eggs from semi-modern farms were not significant.

In Table 6, the studies carried out at the Kindia market show that eggs from traditional chickens carry *Campylobacters* spp. with 35/60, i.e. a carriage rate of 58.3%. The high carriage rates of egg samples from chickens of various origins could also be linked to the poor feeding, hygiene and sanitary conditions of the facilities that characterise extensive farming.

Table 2. Results of manure analyses on semi-modern farms

Farms	Samples			[95% CI]	P-value
	Number	Positive	Percentage		
Bamban	20	12	60	[36,1 - 80,9]	0,03
Claudine	20	16	80	[56,3 - 94,3]	
Monastère Saint Croix	20	15	75	[50, 9 - 91,3]	
Kinyéya	20	18	90	[68,3 - 98,8]	
Cheick Taliby	20	20	100	[76,2 - 100]	
Samorya	20	14	70	[45,7 - 88,1]	
Total	120	95	79,2	[70,8 - 86,0]	

Table 3. Results of analyses of chicken droppings sold at the Kindia market

Operation	Samples			[95% CI]
	Number	positive	Percentage	
Market	120	88	73,3	[64,5-81,0]

Table 4. Test results for eggs from hens on modern farms

Farms	Samples			[95% CI]	p-value
	Number	positive	Percentage		
Couvoir de Kahéré	30	15	50	[32,31- 67,63]	
Avi Leydi	30	08	26 ,7	[12,3 - 45,9]	0,11
Total	60	23	38,3	[26,1 - 51,8]	

Table 5. Egg analysis results for semi-modern farms

Farms	Samples			[95% CI]	p-value
	Number	positive	%		
Bamban	10	06	60,0	[26,2 - 87,8]	0,4
Chez Cheick Taliby	10	08	80,0	[44,4 - 97,5]	
Monastère Saint Croix	10	04	40,0	[12,2 - 73,8]	
Kinyéya	10	06	60,0	[26,2 - 87,8]	
Samorya	10	05	50,0	[18,7 - 81,3]	
Claudine	10	08	80,0	[44,4 - 97,5]	
Total	60	37	61,7	[48,2 - 73,9]	

In Table 7, of the 223 samples of droppings and 95 samples of eggs, the carriage of *Campylobacters* spp. was as follows: 40/223, or 17.9% for droppings from modern farms, 95/223, or 42.6% for semi-modern farms and 88/223, or 39.5% for traditional chicken farming. As for the eggs, 24% came from modern farms, 39% from semi-modern farms and 36.8% from traditional farming. The difference in sample sizes is explained by the availability of poultry farms and the nature of the farm.

Table 8 shows that of the 24 water samples taken from the troughs of the poultry farms, 4 were found to contain *Campylobacter* spp., i.e. a carriage rate of 16.67%. The carriage rate in drinking troughs was high at the Kahéré hatchery (33.33%), compared with 0% at the Avi Leydi farm. However, after analysis, the borehole water did not contain the DNA of *Campylobacter* spp.

Table 9 shows that of the 12 samples taken from the food stocks, no *Campylobacters* pp. DNA was found in the two modern farms (Couvoir de Kahéré and Avi Leydi). On the other hand, of the 12 samples taken from the feed troughs, 5 out of 6 were found to carry *Campylobacters* pp., i.e. 83% in the Couvoir de Kahéré and 3 out of 6 samples were positive in the Avi Leydi farm, i.e. 50%. This carrier situation could be explained by the fact that it is already infected chickens that contaminate the food served in the feed troughs. This could lead to the contamination of all the chickens on both farms.

Table 6. Results of analyses of chicken eggs sold at the Kindia market

Operation	Samples			[95% CI]
	Number	positive	Percentage	
Market	60	35	58,3	[44,9-70,9]

Table 7. Overall carriage of *Campylobacters* pp. according to bio-material and type of farm

Samples	Farming			Total
	Number per modern farm and %.	Number per semi-modern and % of	Traditional (chickens sold at the market) and %.	
Droppings	40 (17,9)	95 (42,6)	88 (39,5)	223 (100)
Eggs	23 (24,2)	37 (39)	35 (36,8)	95 (100)

Table 8. Results of analyses of water sources on modern poultry farms

Withdrawals / Farms	Water				
	Drinking troughs		Drilling (%)	Wells	Taps
	Number of samples	Positive cases (%)			
Couvoir de Kahéré	12	4 (33,33)	- (0,0)	NU	NU
Avi Leydi	12	- (0,0)	- (0,0)	NU	NU
Total	24	4 (33,33)	- (0,0)	NU	NU

Legend : - = absence of Campylobacter
NU = Sources not used by the farm

Table 9. Feed analysis results for modern farms

Farms	Foods			
	Withdrawals from stocks		Samples taken from feeders	
	Number of samples	Positive cases (%)	Number of samples	Positive cases (%)
Couvoir de Kahéré	6	- (0,0)	6	5 (83,33)
Avi Leydi	6	- (0,0)	6	3 (50,00)
Total	12	- (0,0)	12	9 (75)

Table 10. Results of source water analyses for semi-modern farms

Withdrawals / Farms	Sources of water							
	Drinking troughs		Drilling		Wells		Taps	
	Number	Positive (%)	Number	Positive (%)	Number	Positive (%)	Number	Positive (%)
Bamban	4	2 (50)	NU		1	-(0,0)	NU	
Cheick Taliby	4	4 (100)	1	-(0,0)	NU		NU	
Monastère Saint Croix	4	2 (50)	1	-(0,0)	NU		NU	
Kinyéya	4	4 (100)	1	-(0,0)	NU		NU	
Claudine	4	3 (75)	1	-(0,0)	NU		NU	
Samorya	4	2 (50)	NU		NU		1	00
Total	24	17 (70,83)	4	-(0,0)	1	-(0,0)	1	-(0,0)

Table 11. Feed analysis results for semi-modern farms

Farms	Foods			
	Withdrawals from stocks		Samples taken from feeders	
	Number	Positive (%)	Number	Positive (%)
Bamban	6	3(50)	2	1(50)
Cheick Taliby	6	6(100)	2	2(100)
Monastère Saint Croix	6	4(66,66)	2	2(100)
Kinyéya	6	5(83,83)	2	2(100)
Claudine	6	5(83,83)	2	2(100)
Samorya	6	2(33,33)	2	2(100)
Total	36	25 (69,44)	12	11 (91,66)

Table 12. Results of analyses of water sources from traditional farming (chickens sold at the market)

Withdrawals / Operating	Water					
	Drinking troughs		Drilling	Bottled water		Taps
				Number	Positive (%)	
Market	24	18(75)	NU	6	2 (33,33)	NU

Table 13. Feed analysis results for traditional farming (market chickens)

Operating	Foods			
	Withdrawals from stocks		Sampling at feeders	
	Number	Positive (%)	Number	Positive (%)
Market	6	2 (33,33)	24	15 (62,5)

Table 10 shows that of the 24 water samples taken from the troughs of the semi-modern farms, 17/24 were found to contain *Campylobacter* spp., i.e. 70.83% contamination. All the samples taken from the troughs on the Cheick Taliby farm and those on the Kinyéya farm were 100% (4/4) positive for *Campylobacter* spp. DNA, compared with ¾ (75%) on the Claudine farm and 2/4 (50%) on the Bamban, Monastère Saint Croix and Samorya farms. This can be explained by the fact that drinking troughs are sometimes poorly maintained. On the other hand, water from boreholes, wells and taps was free from any contamination by *Campylobacter* spp.

Table 11 shows that of the 36 samples taken from the food stocks of the semi-modern farms, all the samples (6/6) were found to contain *Campylobacter* spp on the Cheick Taliby farm, i.e. 100%, the Kinyéya and Claudine farms had 5 samples out of 6, i.e. 83.83%, followed by the Monastère Saint Croix farm with 4/6, i.e. 66.66% and the Samorya farm with 2/6, i.e. 33.33%. The percentage remains high on the Cheick Taliby farm at 100%, compared with 33.33% on the Samorya farm. The overall carrying capacity of food stocks on the 36 semi-modern farms was 69.44%. On the other hand, the 12 samples taken from the feed troughs were almost all positive (91.66%). The high rate of *Campylobacter* spp. carriage in the Cheick Taliby, Kinyéya, Monastère Saint Croix and Claudine farms is the result of a lack of hygiene in the chicken feed stocks and feed troughs.

Table 12 shows that of the 24 samples of water taken from the troughs of traditional chickens sold at the Kindia market, 18/24 samples were found to contain *Campylobacter* spp. i.e. 75%. On the other hand, of the 6/24 samples of bottled water, 2/6 samples contained *Campylobacter* spp. i.e. 33.3%.

Table 13 shows that of the 6 samples taken from the food stocks of traditional chickens sold at the Kindia market, 2/6 samples contained *Campylobacter* spp. or 33.3%. On the other hand, of the 24 samples taken from the feed troughs of traditional chickens, 15/24 samples contained *Campylobacter* spp. i.e. 62.5% carriage. This could be due to the lack of food and environmental hygiene on the premises.

4. DISCUSSION

The results of our research into the carriage of *Campylobacter* spp. on modern and semi-modern poultry farms and on traditional livestock farms in the prefecture of Kindia. We worked on chicken droppings, eggs, feed, water sources and drinking troughs.

Of 120 samples of droppings taken from modern farms, 33.3% were found to contain *Campylobacters*. The carriage rate remained high on the Couvoir de Kahéré farm, at 41.7%, compared with 25% on the Avi Leydi farm (Table 1).

Carriage was high on all farms: 100 on the Cheick Taliby farm, 90% on the Kinyéya farm, 60% on the Samorya farm, 70% on the Bamban farm and 80% on the Monastère Saint Croix farm (Table 2).

In the large market in Kindia, the rate of *Campylobacter* spp. carriage in droppings was 73.3% (Table 3).

Carriage of *Campylobacter* spp. in eggs at the two modern farms was 38.3%, with 50% at the Couvoir de Kahéré and 26.7% at the Avi Leydi farm (Table 4).

Carriage of *Campylobacters* spp. in eggs is high on the semi-modern farms. It was 80% on the Cheick Taliby and Claudine farms, compared with 40% on the Monastère Saint Croix farm (Table 5).

The *Campylobacters* spp. carriage rate for eggs at the Kindia market is 58.3% (Table 6).

Campylobacters pp. were carried in 17.9% of droppings from modern farms, 42.6% from semi-modern farms and 39.5% from traditional farming. As for eggs, 24% came from modern farms, 39% from semi-modern farms and 36.8% from traditional farming (Table 7).

Contamination of water supplies and drinking troughs by *Campylobacters* spp. was 16.67% for water. The rate of contamination of drinking troughs was high at the Couvoir de Kahéré farm (33.33%) compared with 0% at the Avi Leydi farm. However, after analysis, the borehole water did not contain *Campylobacter* spp. (Table 8).

Carriage of food stocks by *Campylobacter* spp. in the two modern farms (Couvoir de Kahéré and Avi Leydi) was 0.0%. However, it was 83% in the feed troughs at the Couvoir de Kahéré and 50% at the Avi Leydi farm (Table 9).

Campylobacter spp. contamination of water taken from troughs on semi-modern farms was 70.83%. All the samples taken from the troughs on the Cheick Taliby farm and those on the Kinyéya farm were contaminated, representing a 100% *Campylobacter* spp. carriage rate, compared with 75% on the Claudine farm and 50% on the Bamban, Monastère Saint Croix and Samorya farms (Table 10).

In the food stocks of the semi-modern farms, all the samples were positive for *Campylobacter* spp. in particular in the Cheick Taliby farm, i.e. 100%, the Kinyéya and Claudine farms had a carriage rate of 83.83%, followed by the Monastère Saint Croix farm with 66.66% and the Samorya farm with 33.33%. The overall carry rate for food stocks was 69.44%. In the feed troughs, on the other hand, the carry rate was 91.66% (Table 11).

In the water troughs of traditional chickens sold at the large market in Kindia, contamination by *Campylobacter* spp. was around 75%, whereas the number of water bottles contaminated by *Campylobacter* spp. was around 33.3% (Table 12).

In the food stocks of traditional chickens sold at the large market in Kindia, the rate of *Campylobacter* spp. contamination was 33.3%. In contrast, 62.5% of traditional chicken feeders contained *Campylobacter* spp. (Table 13).

In our study, the high rate of contamination of eggs on all these semi-modern farms shows the precariousness of the care given to the poultry. Our results are comparable to those found by some authors. Studies carried out by Yoon Y.D. et al in 1889 isolated strains of *Campylobacter* spp. from drinking water in poultry farms, and *Campylobacter jejuni* from drinking troughs (Yoon et al., 1989). In fact, out of 72 water samples taken from troughs, *Campylobacter* spp. was isolated in 70.83% of the semi-modern farms in our study.

The detection of *Campylobacter* spp. in the feed troughs of 75% and 92% of modern and semi-modern farms respectively attests to faecal contamination inside the farm, which is in line with the results of Gregory E. et al. in 1987, when all the excrement taken from 20 birds in hen houses 2 and 3 was positive (Gregory et al., 1987).

Work by Ellerbroek et al. in 2010 showed the presence of *Campylobacter* spp. on carcasses and in finished products (Ellerbroek et al., 2010). The prevalence of *Campylobacter* on farms may depend on the area where the animals are reared (European Food Safety Agency, 2011. In Canada, few data are available on the prevalence of *Campylobacters* in poultry farms (Canadian Food Inspection Agency, 2010. Our results are closer to those obtained in Europe on fresh droppings, showing a prevalence of 43% (European Food Safety Agency, 2011; Refregier-Petton & Rose, 2001). Our results on droppings (58.8%) are higher than those obtained in France (2001) by Refregier-Petton et al. (43%). The study carried out in 2011 (European Food Safety Agency, 2011; Refregier-Petton & Rose, 2001) shows a wide variation ranging from 2% in Estonia to 100% in Luxembourg; our results are within this variation.

In Niger, *Campylobacter* spp. was found in the droppings of cattle, sheep, goats and dogs at 15, 6.3, 1.8 and 20% respectively (Kazwala et al., 1993). And in poultry droppings, 20.5 and 13.6% of *Campylobacter* spp. were detected in Niger and Nigeria (Kazwala et al., 1993; Olubunmi & Adeniran, 1986). *Campylobacter* spp. were detected in 19%, 14.5% and 23.5% of ducks, turkeys and chickens respectively at the slaughterhouse in Egypt (Linton et al., 1997). In DR Congo, 44% of pigs examined carried *Campylobacters* (Kazwala et al., 1993). In Senegal, Cardinale et al. reported in 2004 a prevalence of 63% of fresh droppings positive for *C. jejuni* (Cardinale et al., 2004), which is comparable to our results.

Goualie et al. reported in 2010 in Côte d'Ivoire a high prevalence of 63.8% of *Campylobacter* in chickens (Gouali et al., 2005), which is also higher than our results. In Cameroon, Nzouankeu A. et al. found in 2010 that 90% of chickens were contaminated with *Campylobacter*, including 68.9% with *C. coli* and 31.1% with *C. jejuni* (Nzouankeu et al., 2010). In the Reunion Islands in 2011, Henry et al. showed that 54% of chicken farms were positive for *Campylobacter* spp. including 30% *C. coli*, 17% *C. jejuni* and 7% *C. coli* + *C. jejuni* (Henry et al., 2011).

5. CONCLUSION

In this study, we used the molecular method (real-time PCR) to detect *Campylobacter* spp. in samples of droppings, eggs, feed and water. The present work reports the results of the study of *Campylobacter* spp. Carriage on farms in Kindia prefecture. The detection rates were as follows:

- The *Campylobacter* spp. DNA detection rate for all samples taken in Kindia was 57.82%;
- The rate of *Campylobacter* spp. DNA carriage in chicken droppings and eggs was 58.88%, i.e. 61.94% in droppings and 52.77% in eggs.
- The rate of detection of *Campylobacter* spp. DNA in the immediate environment of

the chickens (feed and feed water) was 54.78%, i.e. 60.78% contaminated feed samples and 47.67% contaminated water sources.

Our results show a high circulation of *Campylobacter* spp. in poultry farms in the prefecture of Kindia (urban commune and sub-prefectures) and prove that these sources could play a major role in the aetiology of animal and human diseases in this prefecture.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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