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Full Length Research Paper

Farmer perceptions and pathological constraints in helmeted guinea fowl farming in the Borgou department in North-East Benin

C. K. Boko[1]*, M. T. Kpodekon[1], S. Farougou[1], M. Dahouda[2], A. K. I. Youssao[1], G. L. Aplogan[3], J. Zanou[3] and J. G. Mainil[4]

[1]Université d'Abomey-Calavi, Ecole Polytechnique d'Abomey Calavi/ Département de Production et Santé Animales, Republic of Benin.
[2]Université d'Abomey-Calavi, Faculté des Sciences Agronomiques/ Département de Production Animale, Republic of Benin.
[3]Laboratoire de Diagnostic Vétérinaire et de séro-surveillance, Parakou, Republic of Bénin.
[4]Université de Liège, Faculté de Médecine Vétérinaire, Département des Maladies Infectieuses et parasitaires/Bactériologie, Belgium.

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Though the raising of helmeted guinea fowl (*Numida meleagris*) is an important part of rural farming in West-Africa, the death rate of keets within the first two months of life reaches values higher than 50%. The aim of this study conducted in North East Benin (Borgou department) was (i) to correlate the farming systems to keet morbidity and mortality rates; and (ii) to identify non-biological and biological factors responsible for keet deaths. The scavenging farming system is the basis of guinea-fowl breeding with overnight housing in overcrowded coops and "natural" feeding/watering conditions. This farming system is therefore understandably predisposed to the onset and spread of microbial and parasitic diseases, but the mortality rate (ca. 70%) was also influenced by the monthly rainfall and the circadian rhythm of temperature. None of the clinical signs or organ lesions at necropsy was specific to any microbial or parasitic disease. Accordingly, with the exception of salmonellae, the isolated bacteria represented post-mortem invaders and/or secondary pathogens and the helminth species identified were of low pathogenicity. In conclusion, the practice of guinea fowl breeding within the scavenging system will only be successful after improvement of hygienic parameters, such as housing, crowding, feeding, and watering conditions.

Key words: Guinea fowl, scavenging system, morbidity, mortality, bacteria, parasites, Benin.

INTRODUCTION

Today, agriculture represents the most important income source for developing countries. Within agriculture, poultry farming plays a very important role in the struggle against poverty by producing a cheap source of protein, and local poultry represents the majority of animals raised by farming populations for their own consumption, sale, and cultural and social uses (Branckaert, and Gueye, 1999). In Africa, Asia and Latin America, 80% of farmers raise poultry via the scavenging system (FAO, 2004). This system of raising in which young poultry walk freely around the coops mixing with adult poultry of different species and mostly feeding upon local flora and fauna, inevitably comes up against numerous sanitary constraints.

In the Borgou department of North-East Benin, the raising of helmeted guinea fowl (*Numida meleagris*) is an important part of rural farming (Belco, 1985). According to Galor (1990), 75% of pathologies in guinea fowl occur before six-week-old. In Benin, the death rate of keets within the first two months of life varies between 68 and 87% (Belco, 1985; Boko, 2004). Similar observations have been made in Burkina Faso (Bessin et al., 1998)

*Corresponding author. E-mail: cyrilleboko@yahoo.fr.

with a death rate of 73 to 80% during the first three months of life.

Infestation by parasites, mainly helminths, is very high and probably responsible for a high proportion of keet deaths. Indeed, several surveys have indicated a high prevalence of parasites in different African countries: 85 to 89% in Burkina Faso (Vercruysse et al., 1985; Bessin et al., 1998); 40 to 92% in Niger (Idi, 1998); and 87 to 97% in Benin (Chrystophe et al., 1997; Salifou et al., 2003). In the Borgou department of Benin, anthelmintic (levamisol chlorhydrate 20%) treatment and prophylaxis have been shown to cause a two-fold reduction in the number of ascaridia and syngamus eggs per gram of faeces (Boko, 2004).

On the other hand, very few studies have been published on infection rates in guinea fowl by bacteria and viruses. In a study in Benin, the sero-prevalence of *Salmonella* serovar Pullorum was shown to be 1.1% (Chrysostome et al., 1997), but no bacterial isolation was performed. In a study in Burkina Faso, the most frequent bacteria isolated from dead keets (0-3 months) were *Escherichia coli* (24%), *Salmonella* sp. (23%), and *Proteus* sp. (10%) (Bessin et al., 1998). In Nigeria, Okaeme (1981) suspected a 10% prevalence of salmonellosis on the basis of clinical signs and lesions observed in local guinea fowl, but no laboratory analysis was performed.

Furthermore, most of the few existing viral studies have concerned the Newcastle virus infection with a sero-prevalence between 5 and 13% in Benin (Chrysostome, 1997; Boko, 2004) and of 20% in Burkina Faso (Bessin et al., 1998).

The aim of this study was (i) to perform a wide-scale questionnaire-based field survey to record precisely the conditions and constraints of the local guinea-fowl farming systems in the department of Borgou, Benin; (ii) to record the keet morbidity and mortality rate during the 2006 raising season in farms chosen on the basis of the answers to the questionnaire; and (iii) to identify putative non-biological and biological (focusing on bacteria and helminths) parameters responsible for the clinical signs, organ lesions and death of keets on those farms.

MATERIALS AND METHODS

Study area

The farms involved in the study are located in North-East Benin (Borgou Department), a territory covering 52093 square kms, that is, 46% of Benin's surface area, and situated between latitude 8°45' and 12°30', North; longitude 2° and 3°15' East. This region is characterised by a soudano-guinean climate with a rainy relatively cold season from April to October and a dry, very hot season from November to March. Annual rainfall varies from 900 to 1200 mm and extreme average temperatures are 30.8°C in February (dry season) and 24.4°C in August (rainy season). The economy is essentially based on the agricultural sector with up to 80% of the population earning their resources from crop production, animal breeding and/or fishing. But rural populations maintain a traditional type of farming characterised by a low output (Annual report, 2000).

First field survey

A wide scale-questionnaire-based field survey was carried out from January to March 2006 in seven townships in Borgou (Figure 1): Banikoara (37 breeders), Bembèrèkè (27 breeders), Gogounou (27 breeders), Kandi (26 breeders), N'dali (31 breeders), Parakou (34 breeders), and Tchaourou (28 breeders). The 210 guinea fowl breeders received a questionnaire regarding their whole management system: the general level of outdoor and indoor hygiene, sanitary constraints, and materials used for feeding and watering and their maintenance, and the heating system. The breeders were also asked to report all information relating to diseases, death rates and treatments carried out during the previous (2005) laying season. Since morbidity rates, disease conditions and mortality rates vary according to age (Okaeme, 1983), two groups were studied: from hatching to 2 months (hereafter named keets) and from 2 to 18 months (hereafter named adults).

Second field survey

A second field survey was carried out during the 2006 laying season, which corresponds to the rainy season (from April to November), with guinea fowl farmers chosen on the basis of their behaviour and answers given to the questionnaire during the first field survey. Each breeder was choosen according to his ability to work in a team, his past - experience in raising guinea fowl, the presence of a minimum of three laying guinea fowls in his flock and the ease of access to his farm. These farms were visited three times a week on Monday, Wednesday and Friday by a technician specialised in animal husbandry in each township. During these visits, information was gathered on the general management of the flock, as in the questionnaire distributed in the first survey. In addition, the report on each visit included the result of a clinical examination of the animals, with information on the type of clinical signs observed in individuals, their time of onset, and their evolution in the following days, on the duration of the illness in the flock, on the morbidity and mortality rates, and on the treatment applied, if any. The mortality rates of the 2006 laying season were calculated according to the two age groups described earlier.

Laboratory analysis

The dead and some diseased guinea fowls (following euthanisation) were placed in sealed bags, and transported in an icebox to the Bacteriological Department of the Veterinary Diagnostic and Serological Monitoring Laboratory of Parakou (Benin) in order to perform necropsy and complementary bacteriological and parasitological analyses. Lesions in internal organs (spleen, kidney, vitellin, liver, intestine, caecum, lungs and/or heart) were recorded and sampled for complementary bacteriological analysis.

Samples for bacterial growth were inoculated onto sheep blood agar. After overnight incubation at 37°C, the different colony types were transferred onto sheep blood, McConkey's and/or Chapman agar plates and incubated further for 18 h. Colonies growing on McConkey's agar were further transferred onto SS (*Salmonella-Shigella*) agar plates for presumptive identification of Salmonellae. All agar plates were prepared at the Laboratory of Production and Animal Health Department of the Polytechnic School of Abomey-Calavi (Benin) according to the instructions of the manufacturer (Becton Dickinson, Belgium). Identification of the colonies was performed according to classical procedures (Barrow and Feltham,

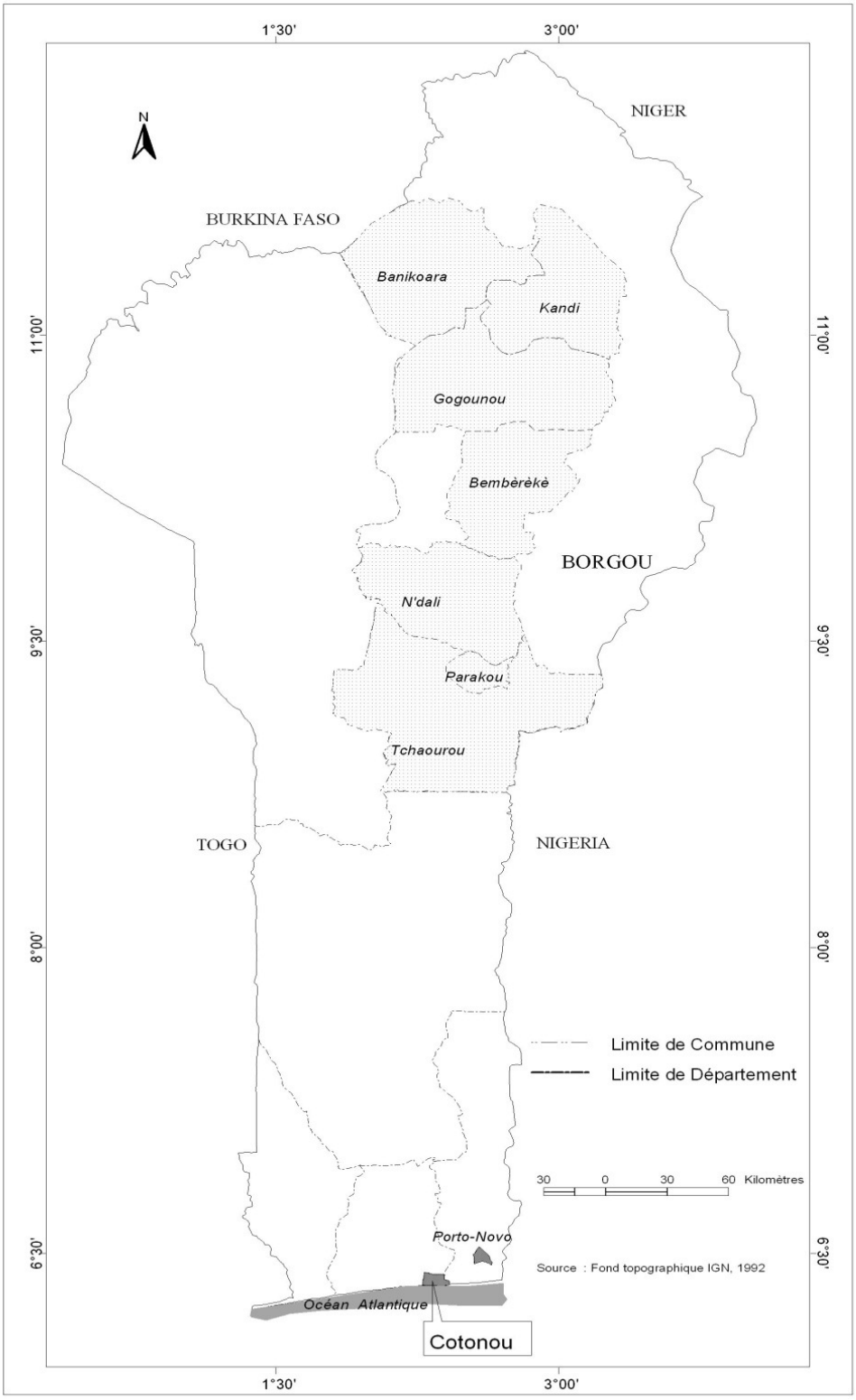

Figure 1. Map of Benin, of the Borgou department, and of the 7 townships of the study area.

1993): Gram staining, catalase reaction, peroxidase reaction, motility, mini sugar sets and API 20 E sugar sets (BioMérieux, France), as recommended by the manufacturer.

A concentration method for faecal and intestinal content examination using saturated sodium chloride flotation solution was employed and performed to identify guinea fowl worm eggs. Two

Figure 2. A typical coop used to house poultry overnight.

grams (2 g) of fresh faeces or intestinal content were diluted in 90 ml of saturated sodium chlorite and strained through a fine sieve to retain large particles. A cover glass was then carefully placed on top of the liquid phase for half an hour, removed, then placed on glass slide and examined with a microscope at 400X (Thienpont et al., 1986).

Data analysis

Comparison of the mortality rates in the different townships and age groups was performed using the Z test (SAS, 1991).

RESULTS

Farmer perceptions on losses in guinea fowl

Most of the guinea fowl breeders (95%) practised a traditional farming system characterised by free-range (or scavenging) farming and keet raising conditions. Half of the flocks (53%) had a size of 7 to 12 adult male and female guinea fowls. Depending on the period of the year and on the farmer's need for money, guinea fowls were ready for sale at market between 8 and 18 months.

Young keets were raised according to the scavenging system by 93% of the farmers. Guinea fowl eggs were incubated and hatched by local hens so that the female guinea fowls could continue to lay eggs constantly. On those farms, the keets walked freely around the coops and followed the surrogate hen mothers until weaning age (2 months) along with the chicks, as they would with their biological mothers. Therefore, in all farm yards, keets very closely cohabitated with various poultry species, especially chickens of different ages. Overnight, the keets, chicks and surrogate hen mothers were housed in chicken coops, while adults roosted in trees in 74% of the farms. There were different coop designs generally made with local materials (Figure 2). Only 23% of the breeders cleaned the coops once during the laying season.

Although all interviewed farmers provided a handful of maize grain, sorghum, rice bran, and/or kitchen waste and household refuse on the ground, they did so only once a day, either in the morning or in the evening. Since all poultry must supplement their meagre daily ration while scavenging in their surroundings, the majority of the keet daily ration is therefore based on a wide variety of locally available flora and fauna specimens, such as earthworms, insects, the harvest residues and vegetable leaves. For watering, 35% of the farmers used rudimentary containers known locally as "canaries" (made of pieces of other broken vessels), but basically anything that can contain water. These containers were cleaned only once during the laying season. The remaining

Table 1. Mortality rates of keets (0-2 months of age) and adults (2-18 months of age) recorded during the 2005 laying season in 210 farms in 7 townships of the Borgou department (Benin) (First field investigation).

Townships (No. farms)	Keets(0-2 months)		Adults(2-18months)	
	Numbers	Mortalityrates (%)	Numbers	Mortalityrates(%)
Banikoara (37)	553	73[a]	149	16[a]
Bembérékè (27)	289	71[ab]	84	16[a]
Gogounou (27)	297	65[c]	100	7[b]
Kandi (26)	294	67[bc]	97	8[b]
N'Dali (31)	440	72[ab]	123	15[a]
Parakou (34)	521	70[abc]	156	7[b]
Tchaourou (28)	310	68[abc]	100	15[a]
Borgou Department	2704	70	809	12

[a, b, c] Means on the same column with different superscripts differ significantly ($p < 0.05$).

65% of farmers revealed that their animals were watered at natural water ponds.

Not surprisingly, the major burden reported by all farmers was the high keet mortality rate. Regarding the onset of diseases, the first clinical signs reported by all farmers were loss of appetite, prostration, somnolence, diarrhoea, and dehydration. Mortality usually started 24 to 48 h later and could persist for one week within the flock.

For the year 2005, the overall mortality rate reported for young keets from hatching to 2 months of age was 70%, with little variation between the townships (65 to 73%), and 12% for older and adult guinea fowls (7 to 16%) (Table 1). Most of the farmers (81%) suspected the most important causes of morbidity and mortality of keets to be due to bacteria and to sensitivity to the relative drop in temperature during the nights of the 2005 rainy season (between 29.7 and 36.2°C during the days down to between 21.6 and 24.4°C during the night) (Annual report, 2006). For adult guinea fowl, predators (dogs, pigs, snakes and ducks), road accidents (bicycles, motorcycles and cars) and children using catapults were viewed as the most important causes.

Nevertheless, only 12% of the farmers kept the keets in their own kitchen overnight, in closed baskets made from the bark of palm trees (*Elaeis guineensis*). The basket were sometimes covered with blankets and/or heated with petrol lamps to provide warmth. Only 10% of farmers reported the therapeutic use of antibiotics, in particular flumequine, because of the cost of such treatments.

Clinical signs of losses in guinea fowl in the farming systems

Based on the answers to the questionnaire, a second field investigation was performed during the 2006 laying season in 39 chosen guinea fowl farms in 6 townships (8 in Banikoara, 6 in Bembèrèkè, 6 in Kandi, 6 in N'dali, 7 in Parakou and 6 in Tchaourou: Figure 1). The aim of this second investigation was to collect more specific information about the causes of high morbidity and mortality rates in the keets and to define more precisely the circumstances and parameters involved.

During the 3 weekly visits made by the technician, a total of 1209 keets were followed: 1007 (83%) showed clinical signs and 810 died (67%) (Table 2). The most frequent clinical signs observed were identical to those recorded in the questionnaire: loss of appetite, prostration, somnolence, diarrhoea, and dehydration. Whitish diarrhoea was observed in 486 and respiratory distress in 130 of the diseased keets (48 and 13%, respectively). Also as reported in the questionnaire, disease and clinical signs extended progressively through the flock for about one week before becoming less frequent. The morbidity rate was lower (13%) amongst the 409 adult guinea fowls followed (Table 2). The prominent clinical signs were prostration and chronic dehydration of the feet (2%), but the majority of deaths were caused by predators (dogs, pigs, etc), road accidents (bicycles, motorcycles, etc) and children using catapults.

As reported during the first survey, death usually began between 24 and 48 h after the onset of the clinical signs in the flock and reached a peak after 48 to 72 h, mostly as a consequence of starvation, dehydration, and/or increased sensitivity to the relative drop in temperature during the night (from between 29.8 and 38.8° C during the day down to between 21.6 and 24.6 °C during the night in 2006 rainy season) Annual report, (2006).

The mortality rates in these 39 breeding farms were very close between the six townships with no statistically significant difference (Table 2) with mean values of 67% in the keets and 13% in the older and adult guinea fowls. Nevertheless, the keet mortality rate was clearly influenced by environmental factors, particularly the monthly rainfall values (Figure 3) with both parameters

Table 2. Mortality rates of keets (0-2 months of age) and adults (2-18 months of age) recorded during the 2006 laying season in 39 farms in 6 townships of the Borgou department (Benin) (Second field investigation).

Townships(N° farms)	Keets(0-2 months)		Adults(2-18months)	
	Numbers	Mortality rates (%)	Numbers	Mortality rates(%)
Banikoara(8)	245	68[a]	78	14[a]
Bembérékè (6)	178	66[a]	61	14[a]
Kandi (6)	176	64[a]	63	12[a]
N'Dali (6)	195	65[a]	68	15[a]
Parakou (7)	227	68[a]	73	10[a]
Tchaourou (6)	188	65[a]	66	13[a]
Borgou Department	1209	66	809	13

[a] Means on the same column with the same superscripts not differ significantly ($p < 0.05$).

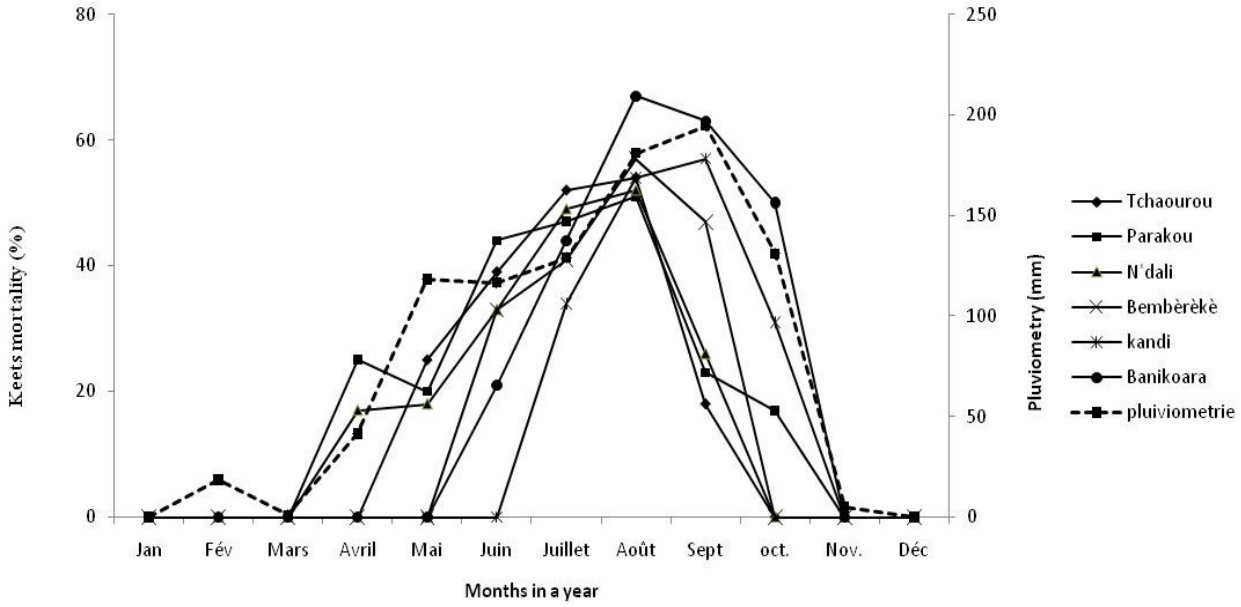

Figure 3. Keet (0-2 months of age) mortality rate (%) in the 6 townships of the second field survey and monthly pluviometry values in the Borgou department during the 2006 laying season.

reaching peak values between July and September.

Bacteriological and parasitological results from post-mortem examination and analyses

In order to identify more precisely the cause of the keet morbidity and mortality, necropsy and complementary bacteriological and parasitological analyses were performed on 120 of the dead or diseased (following euthanasia) keets. No post-mortem examination was performed on adult guinea - fowl. Lesions were observed on the intestines and on most internal organs (Table 3) with the digestive and respiratory tract organs most frequently affected. Lesions were more frequent and larger on the liver, intestines and caecum, umbilicus and vitellus, kidneys, and respiratory tract, while less frequent and smaller lesions were observed on the spleen, muscles, eyes, heart and feet.

Two hundred and seventy-two internal organs with gross lesions were sampled and inoculated onto different agar plates as described earlier, of which 160 (59%) gave a positive bacterial growth. The organs with only small lesions were not sampled for bacterial growth, neither were the lesions of the respiratory tract in 27 keets sampled for bacterial growth. Sampling was not necessary because the lesions in these keets were attributed to the attachment of *Syngamus* parasites, since 26 (96%) out of the 27 keets that were positive for the presence of *Syngamus* eggs in their intestinal contents

Table 3. Organ lesions recorded at necropsy in keets (0-2 months of age) during the second field survey in 39 farms in 6 townships of the Borgou department.

Organs	Type of lesions	No. Keets	% keets
Liver	Inflammation, discoloration	108	90
Intestine, caecum	Inflammation	84	70
Umbilicus-vitellin	Omphalitis	50	42
Kidney	Inflammation	30	25
Respiratory tract	Inflammation, discoloration	27	22
Spleen	Discoloration	18	15
Muscle	Inflammation	7	6
Eye	Keratoconjunctivitis	4	3
Heart	Inflammation	4	3
Feet	Malformation	4	3

Table 4. Worm eggs identified in the intestinal contents of the 84 keets (0-2 months of age) with large lesions on the intestine/caecum at necropsy (see Table 3) during the second field survey in 39 farms in 6 townships of the Borgou department.

No. samples (%)	Helminth species and number of positive samples (%)			
	***Ascaris* sp.**	***Ascaris-capillaria***	***Ascaris-Syngamus***	***Raillietina* sp.**
84(100)	7(8)	12(14)	26(31)	1(1)

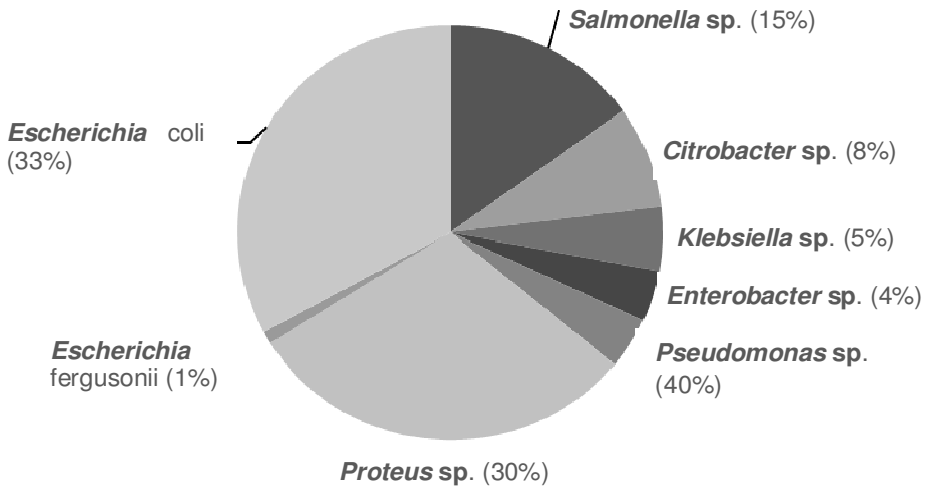

Figure 4. Bacterial genera and species identified in 160 cultures obtained from 272 internal organs with gross lesions from dead keets (0-2 months old) in the Borgou department during the 2006 laying season.

(Tables 3 and 4). The most frequent bacterial species identified (Figure 4) were *E. coli* (33%), *Proteus* sp. (30%) and *Salmonella enterica* (15%).

Parasitogical examination was performed on the intestinal contents sampled from the 84 intestines/caeca with large lesions. The most frequent helminth parasite eggs belonged to three genera: *Ascaris* (54%), *Syngamus* (31%) and *Capillaria* (14%) (Table 4). Associations between *Ascaris* and *Syngamus* or *Ascaris* and *Capillaria* were observed in 45% of the samples. Moreover bacteria and helminths were associated in 45 keets (Table 5).

DISCUSSION

According to the answers given by the farmers in the questionnaire and to the observations made during the

Table 5. Associations of bacteria and parasites recorded in 45 dead keets (0-2 months of age) during the second field survey in 39 farms in 6 townships of the Borgou department.

Associations	Numbers of samples	%
Ascaris-Syngamus-E-coli-salmonella	11/45	24
Ascaris-Syngamus-E-coli	14/45	31
Ascaris-Capillaria-E-coli	12/45	27
Ascaris –E coli	7/45	16
Railletina-E coli	1/45	2

two field surveys, guinea fowl (Numida meleagris) farming and breeding systems in Borgou (North East Benin territory) have not changed for decades. They are still very similar, if not identical to previous descriptions made not only in Benin (Belco, 1985; Dahouda et al., 2007), but also in several other sub-Saharan African countries: Burkina Faso (Bessin et al., 1998), Niger (Bessin et al., 1998), Tanzania (Maganga and Haule, 1998), and Zimbabwe (Saina, 2005). In this scavenging system, none of the raising and farming conditions, and certainly not the housing and the management of feeding/watering, is optimal for keet survival, nor is it an efficient system for meat production.

Although the present study reveals that three out of four farmers housed animals in coops overnight, the housing conditions were unhygienic in almost all cases: no cleaning at all or only once during the laying season, cohabitation with various other poultry species of all ages, overcrowding, lack of aeration, etc. Feeding and watering procedures were, as expected, inappropriate for keet growth and meat production. These procedures were also unhygienic with keets supplementing their meagre daily grain ration from the surrounding wildlife fauna (insects, earth worms, etc) and flora (grains, leaves, etc), particularly abundant and diverse during the rainy season, and from household refuse. The keets also drank from stagnating water in natural ponds and/or in rudimentary containers cleaned only once (maximum) during the laying season. In reality, the approach to feeding used by breeders is aimed at keeping keets and guinea fowls close to their house in order to “domesticate” them rather than at facilitating guinea fowl growth, fattening and meat production (Belco, 1985; Ayorinde, 1990). In summary, though keet growth is facilitated by the higher efficacy of helmeted guinea fowls compared to chickens in consuming non-conventional feed from the local fauna and flora (Bonds, 1997), the overall feeding policy is neither appropriate, nor rational for optimal meat production. Regarding the level of hygiene, although not all keet deaths are the consequence of infections and/or infestations, such housing and feeding/watering conditions undoubtedly predispose all poultry species to the onset and spread of infectious diseases and parasite infestations among all poultry species, especially young birds (Maganga and Haule, 1998; Bessin, 1998; Villate, 2001; Dahouda, 2007).

The obvious consequence of these unhygienic management conditions is that the farmer invariably has to bear the major burden of high keet mortality (Table 2). Here again, our findings are in full agreement with those of previous studies in Benin (Belco, 1985) and in other sub-Saharan African countries: Burkina Faso (Bessin et al., 1998), Nigeria (Nwagu and Alawa, 1995), and Ghana (Teye and Adam, 2000). In addition to the general lack of hygiene and to the presence of infectious and parasitic agents, our second field survey of 2006 reveals that the mortality rate is also influenced by climatic factors, particularly by monthly rainfall values and the circadian rhythm of temperature. This last factor can represent an important non-infectious cause of mortality because thermo-regulation system in young guinea fowl is not very efficient during the first month of life (Le Coz Doin, 1992). As a result, young keets are very sensitive to the differences between day and night temperatures during the rainy season (up to 8.1°C in 2005 and up to 8.2°C in 2006). Nevertheless, we found that only a minority of breeders (12%) took measures to protect keets against this nightly drop in temperature. In contrast, a high proportion of the mortality rate of adult guinea fowls during the dry season (13%; Table 2) was found to be caused by accidents, predators, road accidents and “hunters” (children with catapults), and not by infectious diseases to which these birds are also more resistant.

The role of climatic factors is perhaps the most indirect and somewhat double edged. On the one hand, the raised hygrometry in the coop during the rainy season favours the survival and multiplication of pathogenic microorganisms and parasites (Carlson and Whenham, 1968; Smith, 1997) and hygrometry of up to 75% also increases the sensitivity of animals to infections and infestations (Brugère et al., 1987). On the other hand, high rainfall and hygrometry values also reduce the dust concentration in the air, decreasing the contamination rates of keets and older guinea fowl via the aerosol route (Beard and Anderson, 1967).

The most frequent clinical signs and lesions were observed at the height of the intestinal tract (Table 3), but none was specific to any particular bacterial, viral, or parasitic disease. These observations are identical to those in the studies carried out in other African countries on local helmeted guinea fowls: Nigeria (Okaeme, 1981, 1983), Burkina Faso (Bessin et al., 1998) and Tanzania

(Cooper et al., 1996). They are also comparable to the observations on commercial guinea fowls in France (Galor, 1990; Le Coz Doin, 1992).

In agreement with all these observations, no specific pathogenic bacterial and/or parasite species could be isolated from the different samples that were examined, here. Similar results were also previously reported in Nigeria (Okaeme, 1981) and Burkina Faso (Bessin et al., 1998; Sanfo et al., 2007). Moreover, with the exception of *Salmonella* sp., the isolated bacteria are not considered primary pathogens. Instead, they mostly represent members of the resident commensal microbiota, which invade the body around or after death. Nevertheless, some bacterial species and strains of at least three genera (*Escherichia, Klebsiella, Enterobacter*) are clearly secondary pathogens (Dho-Moulin and Fairbrother, 1999) benefiting from favourable conditions (stress, weakening, cold, viral infection, heavy parasitism). In that respect, the helminth species identified in this study are considered to be of low pathogenicity, responsible primarily for a decrease in productivity, for a predisposition to bacterial or viral infections and/or for an increased sensitivity to adverse environmental conditions (Fabiyi and Offiong, 1979; Hien et al., 2009). Such associations of different infectious and non-infectious causes have often been observed (Bessin et al., 1998; Boko, 2004). Further bio-, sero-, patho-, and antibio-typing of different bacterial species (*Salmonella* sp., *Escherichia* sp., *Klebsiella* sp., *Enterobacter* sp.) and *in vivo* challenge experiments would help to better understand their actual primary or secondary aetiological role in the high mortality rate of keets. Such *in vivo* experimental studies of disease reproduction would also aid in the investigation of the medicinal power of local plants and in the recommendation to breeders of easy-to-apply and inexpensive therapeutic alternatives.

Although the struggle against bacteria, viruses and parasites is of the utmost importance, guinea fowl breeding via the scavenging system practised in sub-Saharan African countries will be successful only after; first, improvement of hygienic parameters, such as housing, crowding, feeding, and watering conditions. Also, there is need to consider the general raising conditions, such as the presence of predators, the incidence of vehicle accidents and catapult hunting by children. In order to reduce morbidity and mortality rates, simple hygienic measures need to be implemented before any prophylactic and/or therapeutic policy. These measures include: ventilation and regular cleaning of the coops (once a month, or ideally up to once a week), indoor housing of keets during the night (from 5 pm to 9 am), a well formulated diet for the birds using local natural resources and the use of clean containers for food and water distribution. Only then, will it be possible to go one step further and reduce the actual incidence and prevalence of viruses, bacteria and parasites. This involves the efficient and successful training of breeders on how to take proper care of keets during the most critical period of their life, from July to September.

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