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Original article

Cattle keepers' perception on the most important infectious diseases that limit milk production in Benin and municipalities at higher risks

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ABSTRACT

In Benin herders are confronted with a number of infectious diseases whose epidemiology remains unclear. The objective of the present study was to assess cattle keepers' perception on municipalities of Benin at higher risks of the most important infectious diseases that affect dairy cattle. A total of 114 cattle keepers were enrolled from 22 municipalities known for their high dairy production in the country and their neighbouring municipals. Data were collected from August 2013 to January 2014 and subjected to a principal component analysis (PCA) followed by an ascending hierarchical classification (AHC). The study revealed that the most important infectious diseases that affect milk production according to herders are dermatophilosis, Foot-and-Mouth disease and CBPP. Tchaourou (in the North) and Dassa-Zoumè (in the Centre) were reported as municipalities at higher risks of contamination. The estimation of the prevalence of these diseases and the identification of their associated risk factors is needed for devising adequate control strategies.

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1. Introduction

Dairy sector in sub-Saharan Africa is operated in a much diversified agro-climatic and socio-economic environment where sanitary constraints are enormous and complex with a number of diseases that vary from one

region to another. Moreover, existing control measures differ according to countries. Also, priority pathologies in dairy cattle vary based on agro-ecological zones and production systems. The agro-ecological zones are used to identify predominant epizootics and vector-borne diseases of livestock. The production system serves to assess the adequacy of the means available to prevent and control these diseases; such means can concern the choice of genotypes, buildings, vaccination programs etc (Lahlou et al., 1994). As in many regions of the globe, warm regions are confronted with a number of infectious and parasitic animal diseases that represent serious economic constraints and/or risks to public health. These sanitary problems increase under the effects of environmental and socioeconomic changes that lead to modifications of animal populations and production systems and a flux of animals and animal products (Lancelot et al., 2011). The development of urban and peri-urban dairy cattle production has led to the intensification of animal productions via genetic improvements of local breeds and the introduction of exotic breeds resulting into new dimensions in the epidemiology of animal diseases (Boussini et al., 2012). Many infectious diseases affect livestock and humans (Including those with zoonotic potentials) with serious negative impacts on animal productivity and public health (Perry et al., 2002; Grace et al., 2007).

According to the Beninese Directorate of Livestock, the national cattle population in 2013 was estimated at 2 166 000 and the average milk production per cow was 200 litres/year/cow (DE, 2014). The dairy production was estimated at 107310 tons of milk in 2013 (Countrystat, 2014). The increase of the volume of milk produced by a cow per day in a dairy herd depends on genetic selections; the control of diseases and management factors that lower the yield; feeds' amendment and improvement of reproductive efficiency (Ferguson, 2003). Most cattle keepers are not trained or specialized in milk and meat production; however, they prioritize the format and number of animals to the detriment of their productivity and resistance to diseases (Alkoiret et al., 2009). Well-managed dairy production has long been marginalized in Benin despite the efforts of policy makers. Moreover, milk is commonly regarded as the business of women and primarily auto-consumed within the households. Nevertheless, the local production is insufficient to satisfy the increasing demand (Mama Sambo, 2013).

In Benin, several studies have been conducted on cattle pathologies to improve milk production (Koutinhouin et al., 2003; Adehan et al., 2005; Farougou et al., 2007b; Farougou et al., 2012). Furthermore, the A and O serotypes of Foot-and-Mouth Disease (FMD) virus were identified in the country (Gorna et al., 2013). However, the national program for prophylaxis of priority epizootics considered vaccinations only against pasteurellosis and contagious bovine peripneumonia (CBPP) (Koutinhouin et al., 2009). In 2013, the Directorate of Livestock listed a number of enzootic disease foci including: FMD, CBPP, nodular dermatosis, bovine tuberculosis, and pasteurellosis (DE, 2014). Koutinhouin et al. (2003) and Adehan et al. (2005) revealed the presence of bovine brucellosis in Benin. Furthermore, Kadja (2010) reported the presence of sub-clinical mastitis in the field. Meanwhile, no detailed study has been conducted on the epidemiology of these infectious enzootic diseases (bovine brucellosis, bovine tuberculosis, FMD, CBPP, bovine pasteurellosis, dermatophilosis and clinical mastitis). The present study was based on farmers' perception and experiences to identify which of these diseases constitute a major threat to milk production and what are the municipalities at higher risks.

2. Materials and methods

2.1. Study area

Study was performed in milk extract land of Benin. Benin is located in 6° 10' N and 12° 25' N and 0° 45' E and 3° 55' E. Rainy and dry season varied with latitude. Below the latitude of 7° 45' N, two rainy seasons (from April to July) and two dry seasons occurred. The first rainy season occurred from April to July and the second rainy season occurred from October to November. The first dry seasons occurred from December to March and the second dry seasons occurred from August to September. Over the latitude of 8° 30' N a rainy season occurred from May to October and a dry season occurred from November to May. Hence, data collection took into account the administrative districts of Banikoara, Gogounou, Nikki, Kalalé, Tchaourou, Péhunco, Bassila, Dassa-Zoumé, Ouidah, Athiémié, Abomey, Kétou, Houéyogbé, Lokossa, Agbangnizoun, Djidja, Zangnanado, Djougou, Parakou, Bembèrèkè, Kandi, Sinendé as it was shown in Fig. 1.

2.2. Data collection

Survey was conducted from August 2013 to January 2014. Data was collected on herders identification, herd organization, food and drink management, transhumance practice, health monitoring, breeder's perception on

symptoms, distribution and prevalence of infectious diseases that reduce milk production such as tuberculosis; CBPP; FMD; brucellosis; mastitis; bovine pasteurellosis and dermatophilosis. To collect data on infectious diseases inside herds and from the period of time taking into account with the survey, a description of symptoms was done to herders in order to help them recognized diseases. Accessibility and availability of herders were the most criteria used to select herds. Additional criteria used to select herds was that, distance between two herds should be average 15 kilometers. The study enrolled a total of 114 herds, from 22 municipals out of the 77 in 9 Regions out of the 12 of the country (Fig. 1). A questionnaire was used for investigation. A GPS was used to collect geographical coordinates of herds.

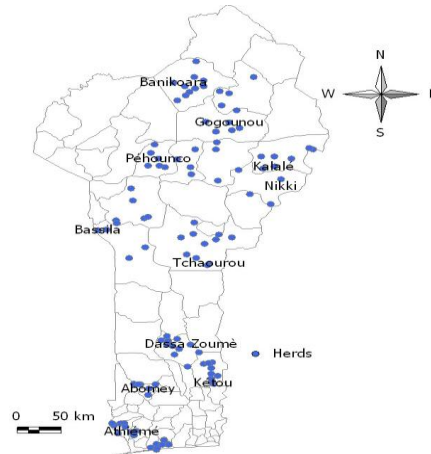


Fig. 1. Localisation of investigated herds.

2.3. Statistical analysis

Data concerning herds and enzooties related to each administrative district was registered in sheets using Microsoft Excel software. Frequencies of cows related to each administrative district with its confidence interval were calculated. To calculate confidence interval related to frequency, the following formula was used: $CI = \text{Mean} + qt(\text{quantile}, ddf) * \sqrt{\text{variance}/ddf}$. Proportion of cows related each variable of herd's management system with their confidence interval was calculated. To calculate confidence interval related to proportion, the following formula was used: $CI = P + qnorm(\text{quantile}) * \sqrt{P * (1 - P)/N}$.

PCA and ascending hierarchical classification were performed using R software with the package FactoMineR. About PCA, two main axis with high Eigenvalue were selected. Diseases related to each axis were selected according to value of correlation, \cos^2 and contribution of variable. Selected diseases must owned \cos^2 value higher than 50% for the first axis and 25% for the second axis. Diseases selected contribution should show value of axis higher than the mean. In order to determine if the PCA is realistic and effective, an analysis of classification was carried out. The used method was the algorithmic method of ascending hierarchical classification. The objective was to search the most characteristic initial variables of each class. A map of herds' distribution was performed using Manifold System.

3. Results

3.1. Structure of the herds

The average number of the herd registered during survey was 63.32 ± 7.98 and the average numbers of cows was 29.3 ± 4.12 . According to 37% of herders (28-46; 95% IC), cows with high milk performance was between 5 to 6 years old. For 34% (25-43; 95% IC) of herders, cows with high milk performance was between 7 to 10 years old. Local breed and crossbreed was observed frequently in the herds. According to herders, the best performance of cows' milk production was in the raining season.

3.2. Feeding and watering of the animals

All herds were fed on natural grazing, but some farmers used cassava peelings and harvest residues as field supplement. The use of commercial feed supplements was only recorded in State farms. Only 25% (17-33; 95% CI)

of the breeders used licking stones but they all used kitchen salt. Most farmers used stream and river water for their animals. Others used in addition wells water, water from boring, or pounds water.

3.3. Transhumance practice and health monitoring

Transhumance was practiced by 51% (42-60; 95% IC) of herders. Hence 46% (37-55; 95% IC) of herders think that transhumance practice was associated with some herds' diseases. According to the health monitoring, survey conducted revealed that 41% (32-50; 95% IC) of herders carry out a prophylactic measures and 57% (48-66; 95% IC) request to veterinarian for administration of drug. However, 70% (62-78; 95% IC) of herders did not request to veterinarian for administration of drug. Taking into account survey data, 91% (86-96; 95% IC) of herds was vaccinated against CBPP and pasteurellosis. Plants were reported to be used by 70% (62-78; 95% IC) of herders to treat animals for cases like snakebites, lack of appetite, pasteurellosis, brucellosis; placental retention, FMD, wounds and abscesses; trypanosomosis; refusal of calve adoption; dermatophilosis; agalaxia; fracture; diarrhoea; babesiosis; CBPP; and intestinal worms. About 58% (49-67; 95% CI) reported that their animals are often sick during the rainy season.

3.4. Herders' perception on administrative districts with low performance of milk production due to high risk of major enzooties

The result of survey showed that for 84% (77-91; 95% IC) of herders, herds were healthy. Nevertheless, 80% (73-87; 95% IC) of herders has think that diseases of cattle explained decrease of milk production performance.

3.5. Distribution of diseases in the municipalities

PCA performed showed that diseases such as Brucellosis, Dermatophilosis, FMD, Pasteurellosis and CBPP were distributed at Dassa, Ketou, Tchaourou and Banikora (Fig. 2). No diseases were really reported in the other municipalities. Indeed, Brucellosis, Dermatophilosis, FMD were frequently reported by herders at Dassa, Ketou and Tchaourou municipalities. Pasteurellosis and CBPP were frequently reported at Banikoara' municipality.

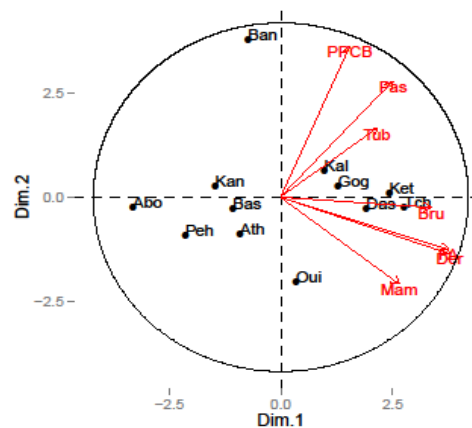


Fig. 2. Correlation between municipalities and cattle' diseases.

Bru= brucellosis; Tub= breast tuberculosis; Mam= Clinical Mastitis; Pas= pasteurellosis; Der= dermatophilosis; FA= FMD; PPCB= CBPP. Abo= Abomey; Ath= Athiémé; Ban= Banikoara; Bas= Bassila; Das= Dassa-Zounmè; Gog= Gogounou; Kal= Kalalé; Kan= Kandi; Ket= Kétou; Oui= Ouidah; Peh= Péhunco; Tch= Tchaourou

The diagram in Fig. 2 has shown a strong correlation between the first main component and the initial variables. The first axis classifies the municipals in ascending order according to the relevance on the perception of farmers on the presence of the diseases in the municipalities investigated. With regard to the correlations of the initial variables with the second main component, it is noted that the second axis distinguished CBPP and Pasteurellosis from Mastitis, FMD and Dermatophilosis. From the representation's quality of these pathologies (Table 1), it was noticed that on the first component dermatophilosis and FMD are well represented; whereas on the second component it is CBPP and pasteurellosis that are predominant. Thus, on the first main plan, the four

most represented variables in the decreasing order are: Dermatophilosis, FMD, CBPP and Pasteurellosis. The diagram of Fig. 2 reveals 2 important groups of variables:

- FMD and dermatophilosis well represented on the first component which brings 47.76% of information;
- CBPP and Pasteurellose well represented on the second component which brings 25.04% of information.

Table 1

Correlation, contribution and quality of representation of variables.

	Correlation of variables		Contribution of variables		Quality of representation		
	Dim.1	Dim.2	Dim.1	Dim.2	Dim.1	Dim.2	Sum
Bru	0.7950312	-0.05807924	18.907002	0.1924179	0.6320747	0.003373199	0.635447899
Mas	0.6251466	-0.49065454	11.690096	13.7326744	0.3908083	0.240741881	0.631550181
Tub	0.5081945	0.39018523	7.725280	8.6845062	0.2582617	0.152244515	0.410506215
Pas	0.5922036	0.65682209	10.490503	24.6092834	0.3507051	0.431415252	0.782120352
Der	0.8921629	-0.32045171	23.809078	5.8577207	0.7959546	0.102689299	0.898643899
FMD	0.8841687	-0.29600362	23.384310	4.9980146	0.7817543	0.087618143	0.869372443
CBPP	0.3653947	0.85730781	3.993731	41.9253829	0.1335133	0.734976687	0.868489987

Bru= brucellosis; Tub= breast tuberculosis; Mam= Clinical Mastitis; Pas= pasteurellosis; Der= dermatophilosis; FA= FMD; PPCB= CBPP.

According to the perception of investigated farmers, the first group of variables concern priority diseases of high prevalence while the second regroups priority diseases of low prevalence. From the various observations, it is concluded that according to the perception of farmers, the preoccupying enzootic diseases (high prevalence with direct impact on milk production) are by order of importance, dermatophilosis, FMD and pasteurellosis.

3.5.1. Clustering of municipalities relate to diseases’ perception

Distribution of diseases performed using hierarchical classification showed four clusters of diseases distribution (Fig. 3). First cluster was Abomey and Pehunco. Second cluster included Ouidah, Kandi, Bassila and Athiémè. The third cluster of diseases distribution as perceived by herders was Banikoara. The last cluster of diseases distribution as perceived by herders was Gogougou, ketou, Tchaourou, Kalalé and Dassa. According to diseases distribution (Table 2) as perceived by herders, some of prevalence relate to each disease occurring at Ketou and Tchaourou was equal to the prevalence observed at Dassa.

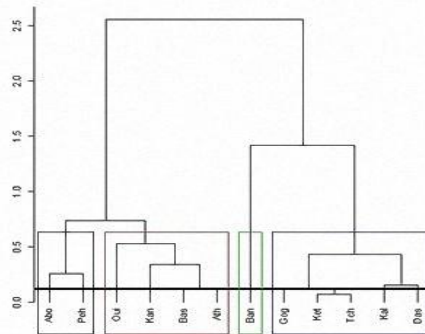


Fig. 3. Ascending hierarchical classification.

Abo= Abomey; Ath= Athiémé; Ban= Banikoara; Bas= Bassila; Das= Dassa-Zounmè; Gog= Gogounou; Kal= Kalalé; Kan= Kandi; Ket= Kétou; Oui= Ouidah; Peh= Péhunco; Tch= Tchaourou.

Four groups of municipals were obtained (Fig. 3):

- The first class contains Abomey and Péhunco; where mastitis and tuberculosis are the dominant diseases;
- The second class is made of Athiémé, Bassila, Kandi and Ouidah. This second class regroups municipals that were less represented with less represented variables. No variable characterizes this class;
- The third class contains only Banikoara where the prevalence of CBPP is believed to be the highest;

- The fourth class regroupes: Kalalé, Gogounou, Kétou, Dassa-Zounmè and Tchaourou, where FMD, Dermatophilosis and brucellosis are reported predominant.

Table 2

Contribution of variables to the classes.

	Class 1			Class 3			Class 4	
	v.test	p.value		v.test	p.value		v.test	p.value
Mastitis	-2.037386	0.04161133	CBPP	2.254885	0.02414054	FMD	2.710348	0.006721257
Tub	-2.263597	0.02359892				Der	2.532224	0.011334154
						Bru	2.198901	0.027884975

Bru= brucellosis; Tub= breast tuberculosis; Mam= Clinical Mastitis; Pas= pasteurellosis; Der= dermatophilosis; FA= FMD; PPCB= CBPP.

It was therefore concluded that the two analyses gave relatively similar results. The analyses of classification are similar to the findings of PCA. Both analyses revealed that dermatophilosis and FMD are the most important pathologies according to farmers' perception with Tchaourou and Dassa-Zounmè as the municipals at higher risk. In a least proportion CBPP and pasteurellosis are also predominant in Banikoara.

4. Discussion

4.1. Structure of the herds

Average number of herds (63.32 ± 7.98) and average number of cows (29.3 ± 4.12) registered in this study was similar to that reported by Dehoux et Hounsou-Ve (1992). An average number of 28 cows per herd was reported in Nigeria by Olafadehan and Adewumi (2010). In this study, cows aged from 5 to 6 years old were frequently registered. This result contrast with those of Alkoiret et al. (2009) who reported that young cows aged from 3 to 4 years were frequently registered in 1997 in herd at Gogounou in northern Benin. Nevertheless, study conducted by Boukary et al. (2011) in Niger from a period of 2007 to 2009, has shown a similar age for cows as it was observed in this study. This study also show that as it was reported by Youssao et al. (2013) and Djenontin (2010), the local breed name Borgou was frequently observed.

Concerning health monitoring, only an average of 76.5 % of herds were frequently vaccinated against CBPP and Pastereullosis. Hence, according to Alkoiret et al. (2010), clusters of infectious diseases may be appear and be maintained.

4.2. Feeding and watering of the animals

Results obtained in this study showed that cattle were frequently moved to pasture for food and to river or public well for drinking. Taking into account the studies conducted by Amadou et al. (2012) in Burkina-Faso, Mali and Nigéria and Katale et al. (2013) in Tanzania, food and drink management system was the same as that reported in this study. Alkoiret et al. (2009) added using the results of their study that cooked residues and the salt were used to complete cattle food.

4.3. Transhumance practice and health monitoring

Transhumance practice was reported on herds following in this study. As observed, transhumance practice was a grouping together of herds from a multiple areas to others for food and drinking. Transhumance practice was reported by Bronsvoot et al. (2004) in Cameroon. Proportion of herders that practiced transhumance and proportion of herders that thought that transhumance practice involved diseases in herds was similar according to Bronsvoot et al. (2004). Hence transhumance practice may involve diseases dissemination in studies areas.

Concerning health monitoring, the study show that few herders carry out a prophylactic measures when large number of herders registered did not request to veterinarian for administration of drug. Hence lack of request to veterinarian may be due to a probable confidence crisis between herders and veterinarian. This situation may maintain diseases resistance in herds. Taking into account ethno medicine solution, plants were reported to be used by a large number of herders to treat diseases inside herds. However, study reported that herders weren't totally satisfied with usage of plants in herds' diseases treatments. For herders, plants didn't treat all pathologies

reported in this study. Nevertheless, Alkoiret et al. (2009) found that at Gogounou in Republic of Benin, 73.5% of herders used plants to treat herds' diseases. Gabalebatse et al. (2013) reported a similar situation from herds in Botswana. This study showed also that herds diseases was largely distributed in rainy season.

4.4. Distribution of diseases in the administrative districts and herders' perception on low milk production performance

The present study revealed according to farmers perception that the most important diseases that affect milk production in cattle are by order of importance, dermatophilosis, FMD, CBPP and Pasteurellosis. This perception on FMD as one of the top priority diseases is in accordance with observations of Beninese Directorate of Livestock (DE, 2003; DE, 2004; DE, 2005; DE, 2007; DE, 2008; DE, 2009; DE, 2010; DE, 2014). In 2013, 89 propagation foci of FMD were recorded (DE, 2014). This result is also similar to those ported in Botswana (Gabalebatse et al., 2013).

Tchaourou and Dassa-Zounmè were identified as the risky municipals for FMD and dermatophilosis. Tchaourou (situated in the North-East of the country) is the second municipal (after Boukoumbé) that receive most of trans-border transhumant herds. It also constitutes an important zone for the national transhumance. The municipal has a slaughterhouse, a cattle market and a vaccination park (DE, 2014). Moreover, the municipal of Parakou, which is surrounded by Tchaourou, has three slaughterhouses, a cattle market and big butcher centre (DE, 2014). Dassa-Zounmè (in central Benin), is also a zone of transhumant herds reception. The perception of farmers on these two areas confirms the observation of Couacy et al. (2006) who reported that zones at risk are areas of high animal concentrations with drinking points, available grazing space, and large cattle markets. They further pointed out that Benin regions with high animal population are Borgou, Atacora and Zou. These regions (constituted of primary and secondary sources of infection) form a vast territory of FMD maintained mainly by the density of sensitive animals, animal movements, population displacements, and animal products trade. Furthermore, studies of Noudeke (2011) reported that from 2006 to 2010, the municipality of Parakou (entirely surrounded by Tchaourou) had the highest risk of FMD among others.

In the field, it's common to confound dermatophilosis with other cutaneous affections like nodular dermatosis, demodectic, moths, cutaneous actinobacillosis etc. This shows that farmers could have made such mistakes in their perceptions. In Nigeria Oyekunle and Ojo (1988) demonstrated that there is a similitude between cutaneous lesions due to *Dermatophilus congolensis* and *Nocardia* sp and that clinical observations alone are not sufficient to make a diagnosis. Nevertheless, this perception of farmers can also be considered normal because of the role of ticks in the transmission of *Dermatophilus congolensis*, and the threat that cattle ticks constitute currently in Benin (Farougou et al., 2007a; Farougou et al., 2007a; Farougou et al., 2007b; Farougou et al., 2012). Existing tick control methods, based on the use of acaricides and antibiotics, are compromised by the development of resistance (Maillard et al., 2003). It is therefore likely that dermatophilosis has a high prevalence in the investigated herds.

The perception of cattle keepers on CBPP and pasteurellosis corresponds to the reality. The pulmonary forms of bovine pasteurellosis can mimic symptoms of classical CBPP (Dabo et al., 2007). According to reports from the Directorate of Livestock (DE, 2014), pasteurellosis and CBPP are classified just after FMD as infectious diseases with a number of foci. Banikoara was reported by farmers as the municipal at higher risk of these diseases. In 2013, Banikoara with its 218800 cattle possessed the largest number of cattle in the entire country. In this municipal, many farmers are transhumant. In the same year 56 foci of CBPP and 76 of pasteurellosis were recorded (DE, 2014). Moreover, cattle movements are responsible for the transmission of CBPP from one herd, region or country to another. Therefore, the mode of production plays an important role in the epidemiology of this disease (Masiga et al., 1996).

5. Conclusion

This study reveals that dermatophilosis and Foot-and-Mouth Disease are the top priority diseases that affect milk production in the country. Herders also identified Tchaourou and Dassa-Zoumè Municipalities as being the zones at higher risks where these diseases have their highest prevalence. These perceptions are in accordance with reports from authorities in charge of the livestock sector in the country. It is therefore important to conduct a nationwide research in order to determine the prevalence of these diseases in the country and to identify risk factors so as to devise adequate control strategies.

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