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Research Article

Management of Cattle Ticks *Rhipicephalus microplus* (Acari: Ixodidae) in Response to the Emergence of Resistance to Synthetic Acaricides

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Abstract | The tick *Rhipicephalus microplus* is an external parasite of livestock that is present in tropical and subtropical regions. It causes significant economic losses to cattle breeder directly through its destructive actions and indirectly by transmission of pathogens to livestock. In this study, we assessed the impact of *Rhipicephalus microplus* ticks on animal performance and identify control measures. Breeders were surveyed in Mono, Zou and Borgou departments with a rate of 60%, 63% and 67% of Peulhs on the total population of breeders'. The effect of ticks on milk production was influential in the department of Borgou where 65% of the breeders estimated that the decrease in milk production was linked to animal infestation by ticks against 46% and 41.10% respectively in the departments of Mono and Zou. A similar pattern was observed concerning the decrease in the live weight of the animals 63.75%, 58% and 45.21 %, respectively. In breeding farms, two types of products are adopted: traditional products and chemicals that are use against the ticks. As they are looking for efficient, accessible and less costly means, breeders use traditional products of control such as red oil, red oil mix with salt, black soap, seawater, plant, bush fire and also manual dipping. Chemical products used are essentially pyrethroids, amidine and phenylpyrazoles. The assessments of current study highlight that for most breeders ticks display negative impacts on livestock productivity and the current way to control are not efficient. It is important to put in place a better tick control strategy.

Keywords | Breeders, Chemical products, Traditional product, Livestock productivity, Animal infestation.

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INTRODUCTION

In Benin, the agricultural sector employs more than 70% of the working population. It is one of the vital sectors of the beninese economy, contributing nearly 32.7% of the gross domestic product (PIB) in 2012 (http://countrystat.org/home.aspx?c=BEN&tr=7). The contribution of livestock farming has grown from 16.87% in 2012 to 16.67% in 2013 (http://countrystat.org/home.aspx?c=BEN&tr=7). These figures clearly articulate that livestock production plays an important role in the emergence of the agricultural sector. In the year 2013, the size of cattle population of Benin was estimated to be 2166000 heads. However, there are many factors limiting breeding expansion in Benin, including parasitism. The beninese climate and its vegetation are favorable to the development and multiplication of livestock ticks (De Clercq et al., 2012). Indeed, besides the trauma they cause through their spoliatory action, many

tick species are capable of transmitting different pathogens to their hosts including virus, and bacteria that adversely affect the performance of these animals (Farougou et al., 2012). *Rhipicephalus microplus* is spreading over the country and can hybridize the other species such as *Hyalomma* causing more damage to livestock (Léger et al., 2013). Although it has a very short breeding cycle *Rhipicephalus microplus* ecological adaptation capacity is high (Chevillon et al., 2013). Despite research on other approaches of control: biological control, ecological control, genetic control, the use of acaricides are the most means way of control of ticks in farms cattle, but these various synthetic products have shown their limitations especially in to species *Rhipicephalus microplus* (Yessinou et al., 2016a, Yessinou et al., 2016b). Previous studies have shown that *Rhipicephalus microplus* become resistant to the commonly used acaricide after some years of trial; unlike *Amblyomma variegatum* ticks that are less invasive and sensitive to acaricides (Solomon et al.,1998, Madder et al., 2011). On the other hand chemical treatments can affect the environment and also meat and milk safety (Castro-Janer et al., 2010). The tick *Rhipicephalus microplus* constitutes a threat to livestock in our West African sub-region where she's currently present in Benin, Ivory Coast, Burkina Faso, Mali, Togo, Ghana and Nigeria (Adakal et al., 2013, De Clercq et al., 2013). Treatment cost is another aspect to mention, it's high and inaccessible to the poorest livestock farmers. Hence some breeders, in order to save cost, dilute the acaricides by reducing the recommended doses and treat more animals. This can lead to resistance occurrence. Meanwhile, some others in order to get better result increase the recommended dose. All these facts constitute a major constraint for tick control. The aim of this study is to provide in-depth and recent data on the management of ticks *Rhipicephalus microplus* in our breedings.

MATERIAL AND METHODS

The material used includes a survey form, cattle and a digital camera for pictures taking.

Study Sites

The work was carried out in three agro-ecological zones distributed as follow Athiémé, Grand-Popo, Bopa and Comé town in zone VIII; Parakou, Tchaourou and Djidja town in zone V, and the town of Zangnanado and Covè, in zone VI (Figure 1). These study zones belong to three departments including Mono, Zou and Borgou.

The Mono department has a sub-equatorial climate with a succession of four seasons. The annual rain fall varies between 850 mm and 1160 mm, and the maximum temperature and the relative humidity were 27.9°C and 55% to 95% respectively. The Zou department was a plateau area with 200 m to 300 m of altitude. The climate was transitional between the sub-equatorial and the humid tropical north Benin sudano-guinean climate. The annual rainfall was between 900 mm and 1 200 mm. In the Borgou department, the climate was sudanic with only one rainy season. The annual rainfall varies between 900 and 1300 mm per year. The average annual temperature was around 26 °C with a maximum of 32 °C in March and a minimum of 23 °C in December-January. The relative humidity varies between 30 % and 70% (Figure 1).

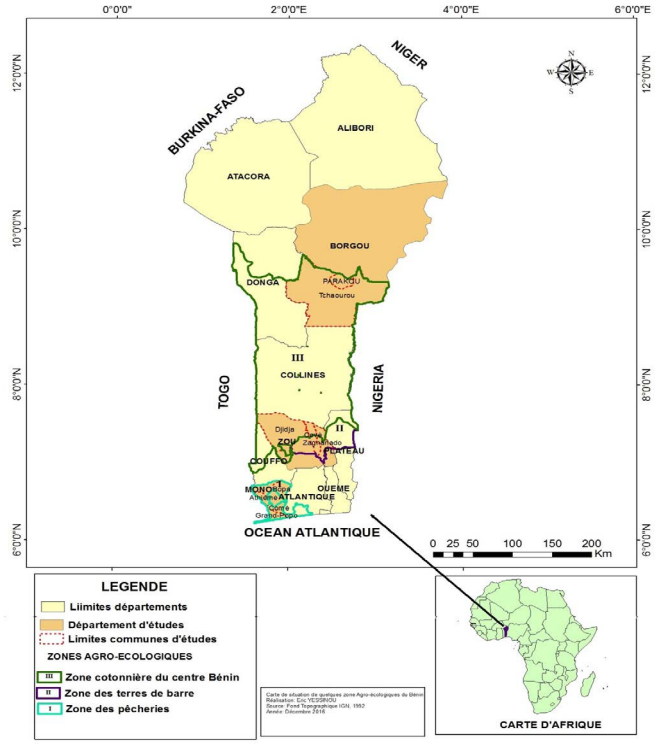

Figure 1: Geographical location of the study area

Data Collection

A direct interview survey was carried out among two hundred and three breeders in the above mentioned three agro-ecological zones. The work was carried out from March 2015 to August 2016. To overcome the language barrier, a translator was involved in the survey team. The choice of breeders by locality was made randomly within available breeders. The information's were collected based on the retrospective memory of the breeders. Interviews with breeders were summarized on a questionnaire addressing breeder's status; the acaricides used for tick's control, interval between acaricides application, use of pesticide or insecticide for tick control, traditional remedies used to treat animals against ticks and the effect of ticks on livestock production.

STATISTICAL ANALYSIS

The collected data were analyzed with R software. The frequencies were calculated and compared by the Chi 2 test and the bilateral test of Z. For each relative frequency P,

Table 1: Distribution of breeders by ethnicity and grade level

Variables		Mono (50)		Zou (73)		Borgou (80)		Test
		%	IC	%	IC	%	IC	
Ethnic group	Adja	$^{a}22.00$	11.48	$^{b}0.00$	0.00	$^{b}0.00$	0.00	***
	Fon	$^{a}10.00$	8.32	$^{a}12.33$	7.54	$^{b}0.00$	0.00	
	Bariba	$^{a}8.00$	7.52	$^{a}10.96$	7.17	$^{a}10.00$	6.57	
	Dendi	$^{b}0.00$	0.00	$^{ab}6.85$	5.79	$^{a}11.25$	6.92	
	Djerman	$^{a}0.00$	0.00	$^{a}2.74$	3.74	$^{a}3.75$	4.16	
	Gando	$^{a}0.00$	0.00	$^{a}4.11$	4.55	$^{a}2.50$	3.42	
	Nagot	$^{a}0.00$	0.00	$^{a}0.00$	0.00	$^{a}5.00$	4.78	
	Peulh	$^{a}60.00$	13.58	$^{a}63.01$	11.07	$^{a}67.50$	10.26	
School level	literacy	$^{a}20.00$	11.09	$^{b}1.37$	2.67	$^{ab}7.50$	5.77	***
	Coranic	$^{ab}0.00$	0.00	$^{a}8.22$	6.30	$^{ab}2.50$	3.42	
	Primary	$^{a}14.00$	9.62	$^{b}0.00$	0.00	$^{b}3.75$	4.16	
	Secondary	$^{a}4.00$	5.43	$^{a}9.59$	6.75	$^{a}2.50$	3.42	
	Tertiary	$^{b}0.00$	0.00	$^{a}12.33$	7.54	$^{ab}3.75$	4.16	
	None	$^{b}62.00$	13.45	$^{ab}73.97$	10.07	$^{a}80.00$	8.77	

Key: Frequency followed by the same letter is not significantly different (p > 0.05); ***: p<0,001; IC: confidence interval.

Table 2: Impact of ticks on livestock production

Variables		Mono (50)		Zou (73)		Borgou (80)		Test
		%	IC	%	IC	%	IC	
Effect of ticks on milk production	Increase	$^{a}0.00$	0.00	$^{a}0.00$	0.00	$^{a}0.00$	0.00	NS
	Constant	$^{a}38.00$	13.45	$^{a}39.73$	11.23	$^{b}13.75$	7.55	***
	Low	$^{b}46.00$	13.81	$^{b}41.10$	11.29	$^{a}65.00$	10.45	**
	no idea	$^{a}16.00$	10.16	$^{a}19.18$	9.03	$^{a}21.25$	8.96	NS
Effect of ticks on body weight	Increase	$^{a}0.00$	0.00	$^{a}0.00$	0.00	$^{a}0.00$	0.00	NS
	Constant	$^{a}36.00$	13.30	$^{a}38.36$	11.15	$^{a}25.00$	9.49	NS
	Low	$^{ab}58.00$	13.68	$^{b}45.21$	11.42	$^{a}63.75$	10.53	NS
	no idea	$^{a}6.00$	6.58	$^{a}16.44$	8.50	$^{a}11.25$	6.92	NS
Wounds on cattle	Increase	$^{ab}88.00$	9.01	$^{b}73.97$	10.07	$^{a}95.00$	8.33	***
	Constant	$^{ab}12.00$	9.01	$^{a}26.03$	10.07	$^{b}5.00$	8.33	***
	Low	$^{a}0.00$	0.00	$^{a}0.00$	0.00	$^{a}0.00$	0.00	NS
	no idea	$^{a}0.00$	0.00	$^{a}0.00$	0.00	$^{a}0.00$	0.00	NS

Key: Frequency followed by the same letter is not significantly different (p > 0.05), NS: Non Signification (p>0,05) ; *** : p<0,001 ; ** : p<0,01 ; IC: confidence interval.

a 95% confidence interval (ICP) was calculated following the formula below:

$$ICP = 1,96\sqrt{\frac{[P(1-P)]}{N}}$$

P is the relative frequency and N is the sample size.

RESULTS

Status of Breeders

The status of breeders in Mono, Zou and Borgou departments was recorded in Table 1. A large variation in ethnicities and literacy levels was noted in the three study areas (P <0.001). The breeders surveyed were mostly Peulh representing 60%, 63% and 67% of the total number of breeders' survey respectively in Mono, Zou and Borgou (P>0.05). The majority of the breeders, 62%, 73.97 % and 80% respectively in the department of Mono, Zou and Borgou cannot write or read to french (P <0.05) (Table 1).

Effects of Ticks on Livestock Production

The effect of ticks on dairy production was very remarkable in the department of Borgou where 65% of breeders, compare to 46% and 41.10% respectively in the department of Mono and Zou. Breeders were estimated that the decrease

in milk production were related to animal infestation by ticks (P <0.05). In the Mono and Zou departments, 38% and 39.75% respectively of the breeders considered that tick-borne infestation has no effect on milk production, compared to 13.75% in Borgou (P <0.05). The breeders of the three departments were unanimous that the infestation of animals by ticks does influence milk production. Breeders in the departments of Mono, Zou and Borgou (58%, 45.21% and 63.75% respectively) were noted a decrease in animals live weight (P <0.05). Actually, the presence of the ticks on the animals' body provokes irritations that behavior prevented animals in the pastures from feed properly. However, some breeders (38.36%, 36% and 25% from Zou, Mono and Borgou) were estimated that the live weight of the animals was constant despite the presence of ticks (P>0.05). Moreover, 6%, 16.44% and 11.25% of the breeders respectively of Mono, Zou and Borgou were no idea about the effect of ticks on the live weight of the animals. Wound proliferation was also linked to ticks presence, 88%, 73.97% and 82.5% of breeders respectively from Mono, Zou and Borgou departments were recognized such fact (P <0.05) (Table 2).

Use of Chemicals for Tick Control

Conventional chemicals used to control ticks varied from one department to another. Thus, in the department of Mono, 44% of the breeders' used pyrethroids, which include alphacypermethrin (2%), cypermethrin (32%), Flumethrin (6%) and deltamethrin (4%). Amidines were also used in the fight against ticks. In Mono, 56% of breeders treated cattle with amidines mainly with antitic (4%), amitix (22%), abotik (16%) and taktic (4%). Breeders were also used phenylpyrazoles. Products of this category were frontline (4%) and topline (5%). In the department of Zou 46.58% of the breeders adopted the pyrethroids. Commonly used products of this family were alphacypermethrin (17.81%), cypermethrin (27.4%) flumethrin and deltamethrin were used in the proportion of 1.37% and 1.37% respectively. Amidines and phenylpyrazoles were respectively used in the proportion of 41.1% and 10.96%. In the Borgou region, 51.25% of the breeders adopted pyrethroids (15% of alphacypermethrin and 36.25% of cypermethrin). The use of these synthetic products was not regulating by any legislation; breeders could buy them freely on the local markets. We found out that the breeders select the products to be used on the basis of their personal experiences or after consulting a neighbor. As a result, in the department of Mono 8%, 16% and 4% of the breeders treat their animals respectively with insecticides, herbicides and cresol. The similar pattern was observed in the department of Zou where 36.99%, 21.92% and 6.85% of the herders use herbicides, insecticides and cresol respectively. In the department of Borgou survey found that breeders used insecticides, herbicides and cresol in the proportion of 41.25%, 26.25% and 11.25% against 21.25% respectively (Table 3).

Efficacy of Synthetic Products

Overall, breeders were unsatisfied with the efficacy of the commonly used synthetic product. Hence 56%, 57.33% and 82.5% of the respondent in the department of Mono, Zou and Borgou are confirmed that the synthetic products have a low effectiveness on the ticks especially *Rhipicephalus microplus*. This was often due to improper planning of acaricides used (Figure 2).

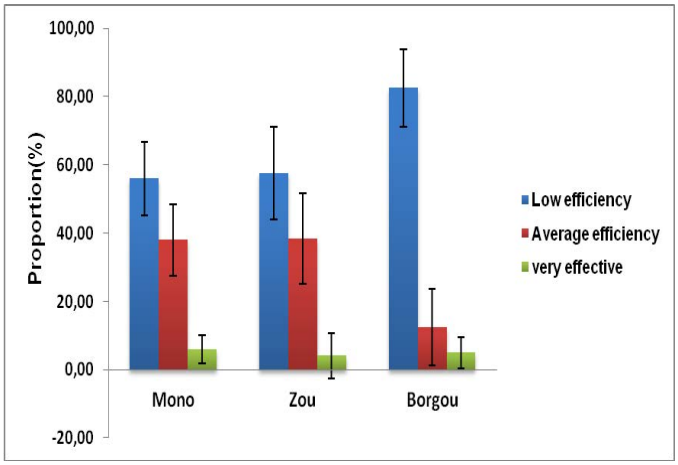

Figure 2: Effectiveness of acaricides against tick

Investigation of Tick Control Through Traditional Practices

Breeders in search of an efficient, accessible and less costly means of ticks control used different traditional methods of control such as red oil + salt, black soap (kotô), seawater, plants, manual dipping, bush fire and sometimes a mixture of two or more product. In the department of Mono, they used motor oil, red oil mixed with cooking salt and seawater respectively in the proportions of 24%, 22% and 20%. Manual dipping was the preferred mean in the department of Zou. Similar observation was made in the department of Borgou where 32.5% of the breeders use motor oil and 20% manual dipping (Table 4).

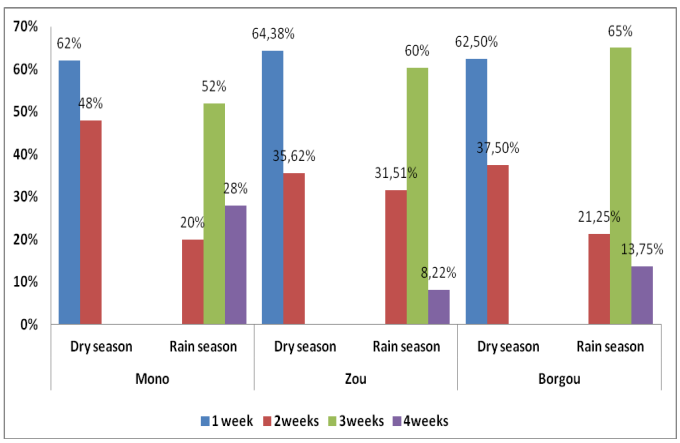

Figure 3: Pace of acaricidal treatment

Table 3: Synthesis of chemicals

Acaricide family	Chemical product	Name of active ingredient	Mono (50)		Zou (73)		Borgou (80)		Test
			%	IC	%	IC	%	IC	
Pyréthrinoïde	Alfapor	Alphacypermethrin	$^{b}2.00$	3.88	$^{a}17.81$	8.78	$^{a}15.00$	7.82	*
	Cyperfly 6%	Cypermethrin	$^{a}22.00$	11.48	$^{b}6.85$	5.79	$^{b}1.25$	2.43	***
	Cypertop	Cypermethrin	$^{a}6.00$	6.58	$^{a}17.81$	8.78	$^{a}21.25$	8.96	NS
	Inothrine	Cypermethrin	$^{b}6.00a$	6.58	$^{b}2.74$	3.74	$^{a}13.75$	7.55	*
	Bayticol	Flumethrin	$^{a}6.00$	6.58	$^{a}1.37$	2.67	$^{a}0.00$	0.00	NS
	Vectocide	Deltamethrin	$^{a}4.00$	5.43	$^{a}1.37$	2.67	$^{a}0.00$	0.00	NS
Amidine	Antitic	Amitraz	$^{ab}4.00$	5.43	$^{a}13.70$	7.89	$^{b}3.75$	4.16	*
	Amitix	Amitraz	$^{a}22.00$	11.48	$^{a}6.85$	5.79	$^{a}21.25$	8.96	NS
	Abotik	Amitraz	$^{a}16.00$	10.16	$^{b}1.37$	2.67	$^{ab}6.25$	5.30	**
	Taktic	Amitraz	$^{b}4.00$	5.43	$^{a}19.18$	9.03	$^{b}6.25$	5.30	**
Phenylpyrazoles	Frontline	Fipronil	$^{ab}4.00$	5.43	$^{b}0.00$	0.00	$^{a}8.75$	6.19	*
	Topline	Fipronil	$^{a}6.00$	6.58	$^{a}10.96$	7.17	$^{a}2.50$	3.42	NS
	Insecticide		$^{c}8.00$	7.52	$^{b}21.92$	9.49	$^{a}41.25$	10.79	***
	Herbicide		$^{b}16.00$	10.16	$^{a}36.99$	11.07	$^{ab}26.25$	9.64	*
	Cresyl		$^{a}4.00$	5.43	$^{a}6.85$	5.79	$^{a}11.25$	6.92	NS
	None		$^{a}72.00$	12.45	$^{b}34.25$	10.89	$^{b}21.25$	8.96	***

Key: Frequency followed by the same letter is not significantly different ($p > 0.05$), NS: Non Signification ($p>0,05$) ; *** : $p<0,001$; ** : $p<0,01$; * : $p<0,05$; IC: confidence interval.

Table 4: Means of traditional control

Traditional wrestling	Mono		Zou		Borgou		Test
	%	IC	%	IC	%	IC	
Motor oil	$^{a}24.00$	11.84	$^{a}38.36$	11.15	$^{a}32.50$	10.26	NS
Red oil + Kitchen salt	$^{a}22.00$	11.48	$^{b}4.11$	6.30	$^{b}0.00$	0.00	***
Black soap	$^{b}0.00$	0.00	$^{a}16.44$	8.50	$^{a}7.50$	5.77	**
Sea water	$^{a}20.00$	11.09	$^{b}0.00$	0.00	$^{b}0.00$	0.00	***
Plants (K. C. V. M. A. Ci. P)	$^{b}0.00$	0.00	$^{a}5.48$	5.22	$^{a}11.25$	6.92	*
Manual dipping	$^{a}8.00$	7.52	$^{a}16.44$	8.50	$^{a}20.00$	9.64	NS
Bushfire	$^{a}12.00$	9.01	$^{a}5.48$	5.22	$^{a}8.75$	6.19	NS
Mixture	$^{a}14.00$	9.62	$^{a}9.59$	6.75	$^{a}13.75$	7.55	NS

K : *Khaya seneganesis* (écorce), C : *Crossopteryx febrifuga* (feuille), V : *Vernonia amygdalina* (feuille), M : *Manguifera indica* (écorce), A : *Anacadium occidental* (écorce), Ci : *Citrus limon* (feuille et racine), P : *Piliostigma reticulatum / thonningii* (feuille).

Key: Frequency followed by the same letter is not significantly different ($p > 0.05$), NS: Non Signification ($p>0,05$) ; *** : $p<0,001$; ** : $p<0,01$; * : $p<0,05$; IC: confidence interval.

Frequency of Acaricidal Treatment

In the three communes surveyed, acaricidal treatments were more frequent in the rainy season than in the dry season. In the dry season, acaricidal treatments varied between two and four weeks with a high proportion of acaricide treatment did every three weeks. During the rainy season acaricide was applied every one or every two weeks approximately in the respective communes. During the occurrence of important infestation, breeders do not respect any longer the proper dose to apply and the frequency of application (Azokou et al., 2016) (Figure 3).

Ticks, by their direct impact and the diseases they transmit, constitute one of the major constraints to the development of breeding. This survey was evaluated the impact of *Rhipicephalus microplus* on breeding and was identified the acaricides used in the fight against ticks. Majority of breeders perceived the negative effects of ticks on livestock productivity and used a variety of chemicals to control them. However, they were not satisfied with the efficacy of these products. It was important to put in place a control strategy to better manage tick control in our countries.

DISCUSSION

The breeders were mostly Peulh representing 60%, 63% and 67% of the total number of breeders' respectively in Mono, Zou and Borgou (P>0.05). The majority of the Peulh were mainly engaged in raising livestock, this activity was transmitted from father to sons. The Peulh were renowned for their knowledge's in breeding. They mastered the techniques of grazing and take animals care, which motivates certain people to entrust them the animals. This explains why they were widespread over in the three departments Mono, Zou and Borgou. This result corroborates that of Youssao et al. (2013) on the diversity of breeding systems in the Sudanic zone of Benin, which showed that the Peulh represent the majority ethnic group of the breeders (62.5 to 95, 8%) a contrary, Soro et al. (2015) research on breeders in northeastern of Ivory Coast showed that Lobi ethnic group represents 59.4% of total breeders compared to 16% for Peulh. We noted in the department of Zou and Borgou a diversity of breeder and this was explained by a concentration of the cattle herd, more than 85% were in the northern part of Benin. In this zone, the climate was favorable for breeding and a very large grazing surface was to be noted with a low human density (UEMOA, 2013). The survey revealed that 62%, 73.97 % and 80% breeders' respectively in the department of Mono, Zou and Borgou couldn't write or read french. The low level of education of the breeders did not allow a proper use of the acaricide. These results were in agreement with those of Alkoiret et al. (2011) who reported in a survey on the typology of cattle farms in the commune of Ouaké in north-west of Benin that 45.4%-92.9% of breeders were untrained illiterates. In these situations, breeders treated cattle without taking into account dose of acaricide prescribed and without measuring the consequences for the animal, the environment and their own health. The waiting times for milk and meat consumption were not respected because of the ignorance of the dangers. In this study 88%, 73.97% and 82.5% breeders' respectively from Mono, Zou and Borgou estimated that wound proliferation was linked of tick's presence. A decrease in the weight and the milk production of cattle were being noted in the farms where the ticks especially the species *Rhipicephalus microplus* were present. The wounds left by engorged females on the skin of cattle might get infected and were potential gateways of infectious pathologies. Rafique et al. (2015) and Adane et al. (2012) respectively have reported similar observation on the impact of *Rhipicephalus microplus* on dairy cattle production in Pakistan and on cattle production in pastoral and agro-pastoral production systems in southern Ethiopia. Ticks can transmit pathogens such as *Anaplasma, Babesia* and *Theileria* responsible for certain parasitosis, (Frisch et al., 1999) that may influence directly or undirectly milk and meat production (Gharbi et al., 2011, Onu et al., 2013). According to Jonsson et al. (2006, 1998) cited by Brito et al. (2011), ticks negatively affect animal production through the transmission of pathogens agent whose protozoa, rickettsiae and viruses, causing serious diseases in cattle. In addition to these diseases, each engorged female was able to ingest 1.0 ml of blood during its parasitic phase on the bovine, resulting in a weight loss of approximately 1 g and a reduction in milk production 8.9 ml. In economic terms, these ticks cost ranchers about US $ 7.30 / head / year when considering production losses and processing costs. The acaricides were used by the majority of breeders for tick control in the region. These results were close to those obtained by Mendes et al. (2011) who have proved that acaricides mainly pyrethroids and organophosphates were used for the control of ticks. The repeated use of chemicals for long periods and short intervals between treatments has favored the emergence of tick resistance especially the *Rhipicephalus microplus* species which have monotonic short cycle and which were much more prone to develop resistances mechanisms (Guerrero et al., 2012). The work carried out by Fernandez-Salas et al. (2012) showed that 100% of breeders used acaricide as the main method of tick control. In Mexico, early in 1993, amitraz was used intensively to control of ticks *Rhipicephalus microplus* resistant, at organophosphates and synthetic pyrethroids. Similar studies in several countries have shown that, for the most part, chemicals (cypermethrin, deltamethrin, and flumethrin, alpha-cypermethrin, fipronil) for tick control and were the root cause of resistance to synthetic acaricides (Yessinou et al., 2016b). The failures of conventional products to successfully fight against the ticks have compelled the breeders to look for other means of struggle which was not recommended and has serious consequences on animal's productivity, breeder's health and environment. The work carried out by Mendes et al. (2011) in the city of São Paulo, have been shown that 82.6% and 86.36% of *Rhipicephalus* microplus have been shown to be insensitive to cypermethrin and deltamethrin, which were contrary to the results which showed that 76.7% of acaricides were effective on ticks (Daher et al., 2012). According to Castro-Janer et al. (2011), acaricidal inefficacy was noted in the Brazilian states of Rio Grande do Sul, Mato Grosso do Sul and São Paulo at fipronil. The work performed by Raynal et al. (2013) showed decreased efficacy of organophosphates, pyrethrinoids (cypermethrin and deltamethrin) and amitraz at ticks *Rhipicephalus microplus*. Overall, endogenous control was more widely used in small-scale breeding to control these ectoparasites (Azokou et al., 2016). Our results were similar to those obtained by Dougnon et al. (2015) and Azokou et al. (2016) respectively in Benin and Ivory Coast.

CONCLUSIONS

The cattle tick *Rhipicephalus microplus* is a tick invasive that increasingly extends its geographic range in Benin

(De clercq et al., 2012). The fight against this tick is increasingly ineffective because of the resistance it develops with respect to conventional acaricides. The control of *Rhipicephalus microplus* by the use of plant extracts seems to be a promising alternative since a very large number of plants with acaricide activity against this tick is used by the breeders.

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CONFLICT OF INTEREST

There exists no conflict of interest.

AUTHORS CONTRIBUTION

All the authors have equal contribution for this manuscript.

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