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# Response to the Ebola-related bushmeat consumption ban in rural Côte d'Ivoire

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## Abstract

**Background:** Bushmeat represents an important animal protein source for populations in rural areas of Côte d'Ivoire; consequently, the exploitation of the bushmeat reserves has contributed to food security in these areas for long time. However, emergence of Ebola virus disease (EVD) in West Africa in 2014 has led to a ban and stigmatization of this essential food source in rural zones. The present study analyses the influence of the decision to ban bushmeat consumption due to EVD on the patterns of consumption of proteins sources and food security. It aims to characterize the different protein sources consumed in rural areas in the Toumodi region before and after the EVD outbreak in order to identify alternatives to bushmeat.

**Results:** The results demonstrated that fish remains the principal animal protein source (92.1% of households) even outside the EVD crisis. Among protein sources, only bushmeat and fish consumptions have been modified with the Ebola threat. The proportion of households that regularly consume bushmeat decreased to 19.8%, however, this reduction in consumption has been driving by sensitization and repression. Fish consumption frequency increased from 4 to 7 times per week in the EVD crisis period. Picking up in the bush is a main mode of supply of some protein sources such as snail or shellfish but their seasonal character limits their use in the households. Vegetable protein sources seem to play a minor role in the diet of the households assessed, whereas edible mushrooms are consumed frequently to complement or substitute animal protein sources.

**Conclusion:** The ban on bushmeat has led to a reduction in its consumption while fish and edible mushrooms seem to have filled related protein deficits in the households assessed. However, constraints in availability and utilization of these alternative sources build an inconsistent basis to fulfil the nutritional needs. To counteract potentially arising protein deficiencies among the population, the development and implementation of fish farming and livestock at short cycle are suggested in order to improve access to protein sources other than bushmeat.

**Keywords:** Bushmeat, Rural, Protein source, Ebola, Food security, Côte d'Ivoire

## Background

In Côte d'Ivoire, an average meal is composed of a starch or cereal-based staple and a sauce containing animal protein sources [1]. Proteins can be of animal or vegetable origin. However, animal sources provide a complete range of proteins (i.e. containing all essential amino acids), whereas vegetable sources generally lack one or more of the essential amino acids [2]. While the

food choices reflect the preferences and eating habits of the population, the composition of a meal also relies on the availability and accessibility of food sources. Thus, there can be a discrepancy in the supply and use of protein sources between rural and urban areas [3]. In rural areas, bushmeat has been considered as the favourite protein source for a long time, especially in sub-Saharan Africa [4]. Indeed, access to bushmeat is easier and more important in rural areas, compared with urban settings, because of the close proximity to the wildlife [5]. However, according to Ivorian laws, since 1974 hunting is forbidden all year (Ministerial order No 003/SEPN/CAB

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of 20 February 1974) [6]. Nevertheless, this measure is in reality not respected. The urge to find alternatives to hunting and bushmeat consumption has led to ongoing investigations on the domestication and the promotion of controlled breeding of some wild species, such as grasscutters or snails [7]. However, despite these initiatives to regulate the degree of poaching, the trade of wild animals has remained and has become an established business [8].

Exploitation of bushmeat has consistently been linked to the conservation issue of those species that are being poached, but also to a risk to the health of the actors involved. Those wildlife species that might potentially carry pathogens responsible for severe infectious diseases such as Ebola or HIV are of particular concern [9].

With the recent outbreak of Ebola virus disease (EVD) in West Africa, a national committee against EVD was established by the Ivorian authorities. Information and sensitization of population and institutions on EVD and preventive measures to be observed were made across posters, audio-visual education and seminars. Also, the statement of the bushmeat ban dating back to 1974 has been reinforced through punishment if disrespected [10]. Strong measures to stop slaughtering, marketing and consumption of bushmeat have taken place which, in turn, cut off an important component of the basic food supply from a proportion of the population. It seems therefore important to assess the resilience strategies of rural populations in Côte d'Ivoire that are most affected by the government measures of restricting access to this basic source of protein.

The aim of this article was to analyse the impact of the recent Ebola outbreak in Guinea, Liberia and Sierra Leone, and the subsequent ban on bushmeat in Côte d'Ivoire on the food security of rural populations in the Toumodi region in south-central Côte d'Ivoire. The different protein sources consumed were characterized and alternatives to bushmeat were identified.

## Methods

### Study site

The study was conducted in rural area of Toumodi region which is located in south-central Côte d'Ivoire (Fig. 1). The area has been specifically chosen because Toumodi city is an important hub with regard to bushmeat trafficking owing to its intense animal product marketing and its supply with large quantities of animal carcasses (100 tons/year) from surrounding villages [3]. The existence of an official public market for bushmeat and the presence of many restaurants specializing in this niche of the food market made this region the 'capital of bushmeat' in Côte d'Ivoire [11, 12].

### Estimation of the household sample size

The chosen sampling unit was a household, and the sample size was calculated using the progressive method described by Magnani [13]:

$$n = t^2 \times p(1 - p)/m^2$$

where  $n$ , sample size required;  $t$ , 1.96 at a confidence level of 95%; proportion of bushmeat in rural area  $p = 90\%$ ; and margin of error  $m = 0.05$ .

The size obtained was multiplied by a factor 2, generally used for the food surveys. Subsequently, 10% were added to the initially calculated sample size to account for non-responses, refusals or recording errors. Finally, a minimum size of 304 households was obtained.

Then, villages and households were randomly selected. The global size of the sample of households to be investigated was distributed evenly villages selected, resulting in 61 households per village.

### Data collection

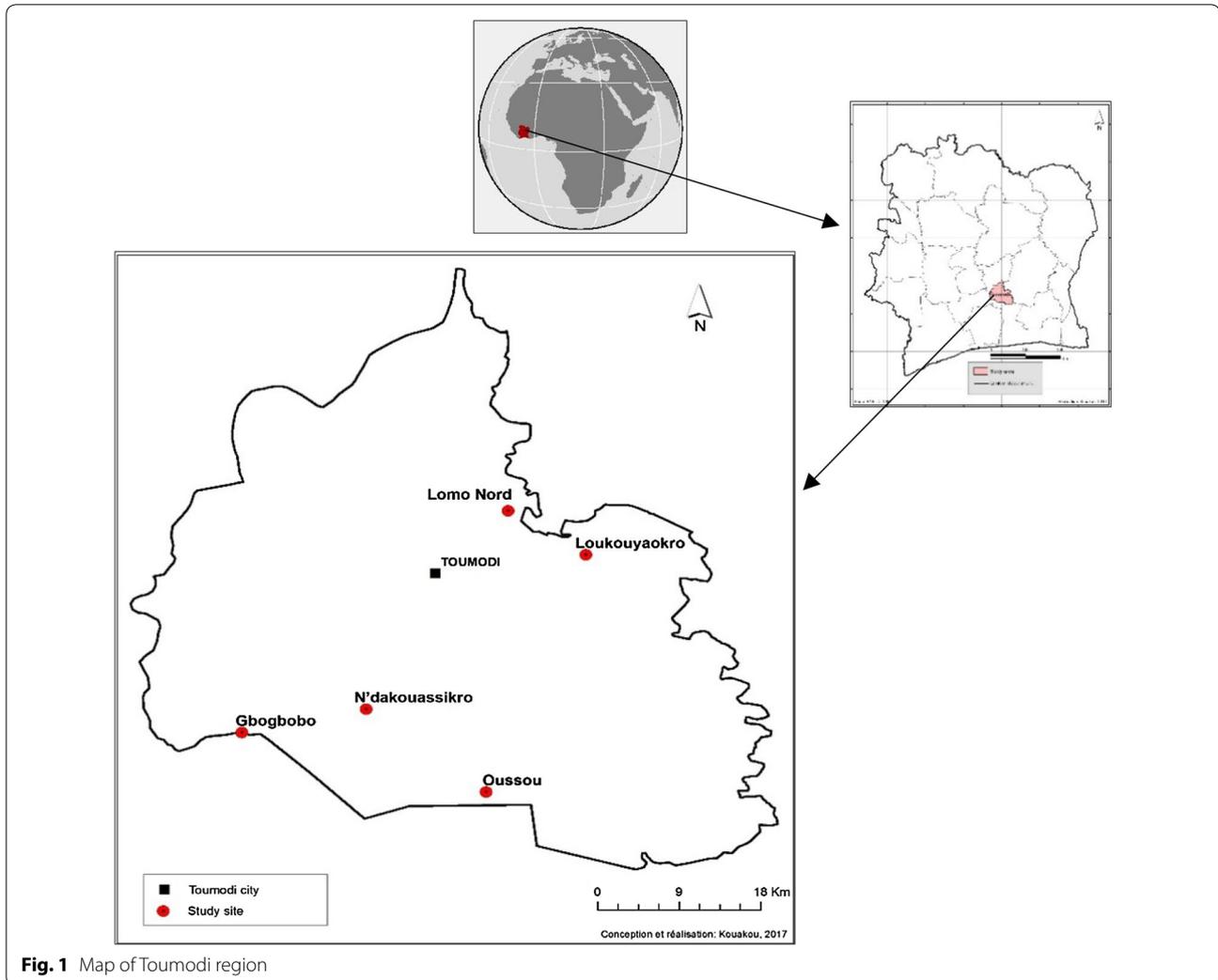
Within this transversal study, data were collected during the period of the Ebola virus outbreak crisis, in July and August 2015. Quantitative data were collected by conducting a questionnaire-based household survey, whereas qualitative information was obtained during group interviews in focus group discussions.

Interviews were carried out with the main person in charge of cooking the family meal—normally the mother. The questionnaire focused on three themes, namely eating habits of animal protein consumption before EVD (retrospectively), the frequency of consumption of animal protein sources in the household in the current EVD context and the use of vegetable proteins and other alternative sources to animal protein.

Focus group discussion was used to refine the quantitative data collected. Ten focus group discussions were conducted in total across the villages involved in the study. These group interviews involved two kinds of actors within the bushmeat sector, consumers and hunters. Discussions were structured according to two main themes, the perception of EVD and the impact of preventive health measures put in place regarding eating habits. Discussions were recorded via a voice recorder, and notes were taken in addition for later transcription.

### Data treatment and analysis

EpiData version 3.1 software was used for data registration. Data were subsequently imported into SPSS 20 software to constitute the database. Qualitative data derived from the group interviews were systematically transcribed to Word Office prior to transfer and processing using MAXQDA 10 software (coding, identification of categories and relevant themes and contents analysis).



**Fig. 1** Map of Toumodi region

The Chi-square test ( $\chi^2$ ) was applied in this study, with XLStat 2014.5.03 software version, to compare consumption proportions of the different types of protein sources. A pairwise comparison was made after the  $\chi^2$  test using the procedure of Marascuilo and Serlin [14] at a threshold of  $\alpha = 5\%$ , for multiple proportions comparison.

The currency used is CFA franc, 1 USD = 588.219 CFA franc [15].

## Results

### Characteristics of protein sources consumed

A pairwise comparison of sources allowed to categorize protein sources into homogenous subgroups (a, b, c, d). From habits before EVD crisis, four categories of animal protein sources were identified depending on the level and frequency of consumption in households (Table 1). Fish was the main source of protein consumed

and defined as category 1. The second category includes bushmeat, snails, poultry and the fifth quarter products of domestic animals (defined as feet, skin, bone from beef and pork in the current study). The third category is composed of shellfish and milk, while the fourth category includes egg, caterpillars and insects. These sources of protein were consumed smoked (53.3%), dried (22.4%) and fresh (22.2%) in the households assessed.

The supply of protein sources takes place mainly through purchase or by direct supply from the natural environment (i.e. bush and river). Women are usually in charge of the meal in a given household. They have an average budgeted of 200 CFA franc for the purchase of the protein source for preparing a meal for an average of seven people including children, which corresponds to buying an average of 143 g fish.

**Table 1 Characteristics of the consumption of protein sources in households—evaluation of habits before EVD ( $n = 305$ )**

Type of protein sources consumed	Proportion of households (%)	Consumption frequency (time/week)	Availability	Major period of consumption	Main mode of supply	Purchase price in the markets (CFA franc/kg)
<i>Animal protein</i>						
Fish	92.1 <sup>a</sup>	5.6 ± 1.6	All year	All year	Purchase	1400
Bushmeat	59.2 <sup>b</sup>	1.7 ± 1.5	All year	All year	Trap/hunting	4000
Domestic animal meat*	58.4 <sup>b</sup>	1.4 ± 1.0	All year	All year	Purchase	2000
Snail	53.1 <sup>b</sup>	1.6 ± 0.7	Seasonal	March to August	Picking up in the bush	6300
Poultry	50.5 <sup>b</sup>	Occasionally	All year	December, January, April	Purchase/own farm	2300
Shellfish	20.0 <sup>c</sup>	2.7 ± 2.0	Seasonal	April to August	Fishery	4300
Milk	15.7 <sup>c</sup>	Occasionally	All year	–	Purchase	3800
Egg	5.2 <sup>d</sup>	Occasionally	All year	–	Purchase	1765
Caterpillar	5.2 <sup>d</sup>	Occasionally	All year	–	Picking up in the bush	12,500
Insect	3.0 <sup>d</sup>	Occasionally	All year	–	Picking up in the bush	12,500
<i>Vegetable protein</i>						
Soya	14.4 <sup>a</sup>	Occasionally	All year	–	Own farm	500
Beans	16.4 <sup>a</sup>	Occasionally	All year	–	Own farm	500
Pistachio	25.6 <sup>b</sup>	Occasionally	All year	December to January	Own farm/purchase	3000
Peanut	83.9 <sup>c</sup>	1.8	All year	May to August	Own farm	700
<i>Edible mushroom</i>						
	83.2	1.46	Seasonal	March to August	Picking up in the bush	3400

For both types of protein source animal and vegetable, letters a, b, c, d define categories of protein sources based on their consumption level

\* Domestic animal meat represents fifth quarter products of domestic animal

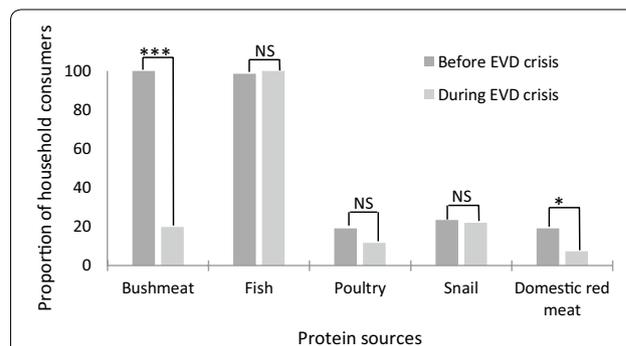
Domestic breeds including poultry, sheep, goats and pigs are kept in 44.1% of households but are not commonly used as day-to-day nutritional source. Instead they represent a type of saving for non-food needs as indicated by some of the remarks documented by a focus group participant ‘... *Sheep and goat which is reared are sold to help our children who are in school...*’

The availability of snails and shellfish is high in the rainy season during which housewives pick them up in the bush for cooking. Main consumption of poultry takes place during feast times, particularly over Easter and New Year (i.e. January, April and December), whereas fifth quarter products of domestic animals are consumed all year (Table 1).

Before EVD, bushmeat was consumed in 59.2% of all households 1.7 ± 1.5 times per week. Among these households, 51.7% households do not consume bushmeat regularly, stating scarcity as the main reason. For those 48.2% of households which consume bushmeat regularly, it is the first animal protein resource used for 7.4% of them. Figure 2 shows the dynamic of protein sources consumptions among regular consumers of bushmeat in

relation to the occurrence of the EVD crisis. We observed a significant reduction in the consumption of bushmeat from 100% of regular consumers to 13.2% and domestic red meat.

With regard to vegetable protein sources, those eaten by people are: *Glycine max* (soybean), *Vigna angularis* (red bean), seed of a species of cucurbits (misleadingly



**Fig. 2** Dynamic of the consumption of animal protein sources among regular consumers of bushmeat ( $n = 168$ ). \*\*\* $p < 0.001$ ; \*\* $p < 0.01$ ; \* $p < 0.05$ ; NS no significance

called 'pistachio') and peanut. Households often have their own grown supply of vegetable protein (76.5%); however, the consumption level is low, except for peanuts (Table 1).

### Perception and attitudes to the Ebola virus disease crisis

#### Perception and knowledge of EVD

The concept that people have of EVD is reflected by their knowledge of the mode of transmission and the symptoms of the disease. Some think that the disease is contracted through consumption of bushmeat or by breathing the same air as a sick person. Others relate the symptoms of Ebola to those of typhoid fever or madness. A proportion of 49.4% of respondents think that bushmeat consumption may present a health risk, whereas 27.2% affirm the opposite and 23.4% did not know whether to think of it as risky or not.

Not every respondent was convinced of the existence of EVD because for them, hunting and bushmeat consumption is a cultural heritage that has never been a health problem in their society. They consider those wild animals that they are mainly consuming (i.e. 98.5% are rodents and antelopes) as sedentary and unable to move tens of kilometres to feed. They feel, therefore, that rodents and antelopes cannot carry a disease from one country to another, in contrast to bats, which are perceived as more likely to carry EVD, owing to their capability of moving along long distances.

#### Resilience to EVD and bushmeat alternatives

A  $\chi^2$  test was performed to compare proportions of consumption frequencies before and during EVD crisis for each animal protein source. Different modifications were only noticed for bushmeat and fish consumption. Before the EVD crisis, the majority of the households assessed consumed bushmeat 1 and 2 times per week. With the EVD crisis, this consumption frequency has considerably decreased ( $p < 0.001$ ), with most people consuming less than once weekly ( $p < 0.001$ ). We also observed a significant decrease ( $p < 0.001$ ) for 4 times weekly consumption and an increase ( $p < 0.001$ ) for consumption of 7 times/week, concerning fish (Fig. 3). Furthermore, 34.6% of people questioned have confirmed to not have consumed any bushmeat since the Ebola crisis, 19.7% of respondents stated continued consume despite the Ebola-linked prohibitions and 45.7% did not give a response. Discussions in focus groups allowed revealing that in all localities, people affirmed awareness of the illegal nature of bushmeat hunting and consumption and that non-compliance with those laws would lead to punishing legal actions by the relevant social institutions (e.g. water and forestry administration, chiefdoms). For them, repressive measure by the authorities is the most important

factor that limits the consumption of bushmeat. Thus, the marketing method and bushmeat consumption have changed. Indeed, meat is not being sold to outside buyers any longer for trade in the cities. Selling is now limited within a network of relatives and friends, and consumption is done discreetly at home or in the fields.

The survey revealed also that in the majority of households (64.1%), vegetable protein sources are rarely used to replace animal protein sources in case of a deficit. Edible mushrooms were found to be the main food used as a substitute for animal protein sources (83.2%) followed by seasoning cubes (13%), almonds of the species *Ricinodendron hedeulotii* commonly known as apki (8.2%) and leafy vegetables (6.7%). A type of fermented fish called 'adjuevan' was also used by 23.6% of household as alternative.

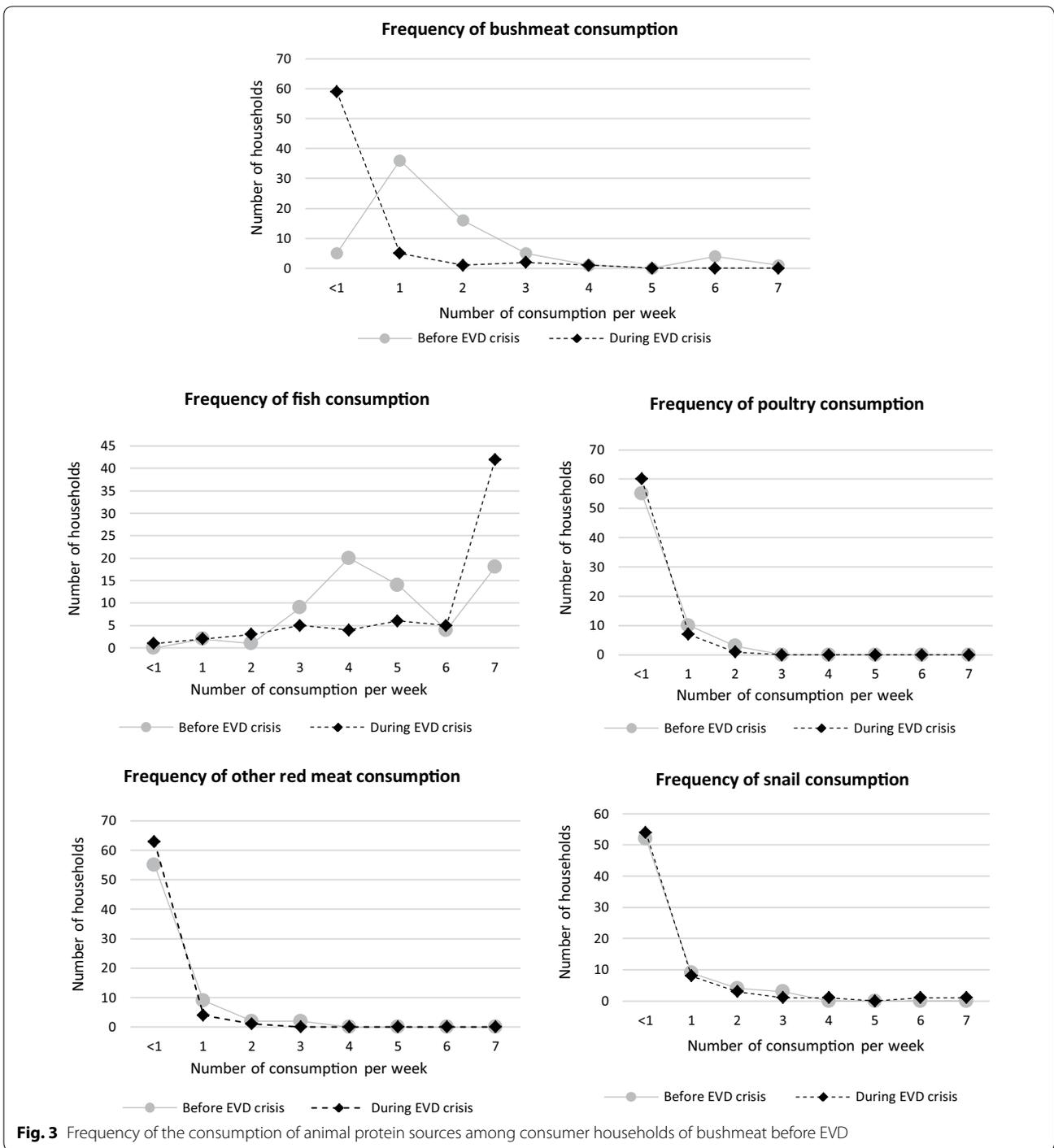
### Discussion

Our results demonstrate that the Ebola crisis in West Africa and the subsequent decision of the Ivorian authorities to prosecute hunt, trade and consumption of bushmeat had a marked influence on the perception of EVD and the consumption of certain protein sources. The ban had repercussions on each pillar of food security of the rural population: availability, access, use and stability.

#### Availability and access of protein sources consumed

The survey showed that fish remains the primary source of animal protein consumed, which is in accordance with the situation across Côte d'Ivoire. Indeed, at the national level, fish represents two-thirds of the animal protein intake in the diet of the Ivorian population [16]. However, bushmeat represents a natural reserve that is exploited in the absence of financial means for purchasing fish. According to an evaluation by Caspary, bushmeat is considered a daily food source in rural areas and is consumed by 89.6% of the rural population [3]. Compared with the work of Caspary, our investigation indicates a reduction in the consumption of bushmeat in the households (59.2%) even before the occurrence of EVD and indicates a general decrease in the abundance of this foodstuff in rural areas. Works on duikers, a species of antelopes in Toumodi [11] and species of wild animals sold in the Soubré region (south-west of Côte d'Ivoire) [8] have already reported a scarcity of bushmeat due to overexploitation of wildlife.

Edible mushrooms, the main animal protein substitute, are taken directly from nature (i.e. fields, bush and forest) and do not require any financial resources. Among the non-animal protein sources, edible mushrooms are more consumed than vegetable proteins. The low consumption of plant proteins is related to the fact that these foods are not part of the culinary heritage or the eating habits of the 'Baoulé' who are indigenous to Toumodi. Rather than



being viewed as food source, home-grown vegetables are a source of financial income for some women who are selling the largest part of the harvest on the market. Abundance of mushrooms and certain other animal protein sources including shellfish and snails decreases outside the rain period. Women who are generally in charge

of feeding the family [17] have developed mechanisms for supplying protein resources to a household. One strategy is to maximize profit from seasonal resources during periods of abundance. In addition, efforts have been made to extend the provision of seasonal protein sources. Dibaluka et al., for instance, have obtained promising

results with their 'out-of-season' culture trials of edible mushrooms [18].

Besides the problem of EVD which concerns only bushmeat, the major challenge for accessing protein sources is of economic nature. Domestic animal flesh sold is often not economically accessible for low-income populations that justify use of fifth quarter products which is the cheapest. The inaccessibility of domestic animal flesh also renders the bushmeat consumption particularly important to households because it is free and they can have all the parts of the animal. Fish is a relatively affordable commodity and it is available in many forms (even in small cuts) and in varying prices. The average household budget available for the daily purchase of protein sources (200 CFA franc) allows getting fish but not meat [1]. Those widely encountered financial limitations explain the increase in fish consumption and the use of edible mushrooms. Indeed, the substitution of bushmeat in rural areas requires the existence of equally cheap alternatives [19, 20]. The development of fish farming or domestic animal production at low cost, as provided by the Ivorian Department of Animal and Fishery Resources, represents a good start to improving access to affordable animal sources of protein [16].

With the recent Ebola crisis, the observed decrease within bushmeat consumption indicates a strong impact of government communications made on the health risks associated with the Ebola virus [21]. However, it should be recognized that the drop in consumption is not mainly due to an awareness of the health threat of EVD but to the repressive measures taken by the government in case of non-compliance with the laws. It is likely that bushmeat consumption would continue if the ban was not accompanied by repressive actions. In addition, this dynamic has evoked a certain resistance to the ban imposed.

#### Utilization

Animal and vegetable protein sources are used with different preference in the diet of rural populations of Toumodi. The former protein source is considered almost obligatory in the composition of a meal, whereas the latter plays a minor role in the daily diet.

Analysis of the results showed that people are aware of the beneficial impact of daily protein intake to their health. According to Food and Agriculture Organisation (FAO), the availability of protein in Côte d'Ivoire was 59 g per person in 2014 as compared with an availability of more than 150 g in Europe [22], whereas our study reveals 143 g of fish used for the family meal (7 persons). Thus, between 5 and 10% of rural households in the Toumodi region were in states of food insecurity [23]. Indeed, problems of availability and access to protein sources can, therefore, cause protein deficiency in a

population. In addition to the low quantity of fish used, the seasonality of edible mushrooms poses another risk factor for protein deficiency being a more popular alternative to animal protein than vegetable.

#### Stability

EVD puts the safety of bushmeat into question and it strongly threatens the stability of access to protein sources, especially for 7.4% of the population for which bushmeat was the primary source of animal protein. However, some people still do not believe that consumption of bushmeat is linked to a health issue in their society owing to the EVD non-endemic status of Côte d'Ivoire. One single Ebola-positive patient who survived the infection was documented in Western Côte d'Ivoire in 1994 [24, 25]. This perception of EVD indicates that people are lacking awareness of the concept of emerging and re-emerging diseases and of the potential natural reservoirs for viruses in the sub-Saharan African wildlife [26]. It has been shown multiply that ecological disruptions due to increasing urbanization in those regions and an increased interaction between humans and wildlife can lead to the emergence or re-emergence of zoonoses [27, 28].

Even if it was accepted that the ban on bushmeat consumption contributes to reducing the risk of exposure to EVD, the recent experience in Guinea has demonstrated again that the key transmission route for the Ebola virus is from person to person [26]. A more integrated risk management strategy would therefore be desirable and may combine limiting the exploitation of bushmeat for subsistence with setting up plans for surveillance and efficient response measures to contain any zoonotic outbreak at early stages [29]. Although prohibitions to hunting bushmeat have contributed beneficially to limiting large-scale exploitation, a support mechanism needs to be put in place for those population groups that are most affected by those governmental prohibitions. Because a large part of the population are farmers which are constantly in contact with wildlife, it would be difficult to stop hunting in a sustainable way [30]. Besides, certain animal species are a threat to their crops and laying traps can regulate the damage to the fields [31].

#### Conclusion

Among different animal and vegetable-derived protein sources available, fish and bushmeat were consumed the most in the households assessed in rural Toumodi before the Ebola crisis. Fish is the cheapest protein source on the market, whereas bushmeat is free and has a long tradition of consumption. With the Ebola crisis, consumption of bushmeat has decreased significantly in the households assessed. The trade and consume of bushmeat has

become secretive and limited to the family circle. Sensitization and repression by the government has been driving this reduction in consumption. As response to the EVD outbreak in West Africa, fish and edible mushrooms seem to be the most popular alternatives within the households assessed, most likely owing to their low cost. Improving the availability of edible mushrooms and the access to fish, but also fish farming and livestock at short cycle would contribute to shifting the population habits away from consuming bushmeat and to strengthen the resilience of populations that are most affected by the government ban.

#### Abbreviations

$\chi^2$ : Chi-square; CFA: Communauté Financière Africaine; EVD: Ebola virus disease; FAO: Food and Agriculture Organisation.

#### Authors' contributions

AOD led the works on the field and is the principal author of the study and manuscript. AJM performed the focus group discussions and interpreted these results. AGK contributed to the preparation of field works and to the analysis of survey results. GF contributed to the preparation of survey and focus group discussions and to the analyses and interpretation of results. KY contributed to writing the manuscript. ELJCE contributed to the methodology for the choice of localities and households involved in the survey and also to the statistic analyses. AF contributed to writing the manuscript. MK contributed to writing the manuscript. BB is the major contributor in writing the manuscript. All authors read and approved the final manuscript.

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#### Competing interests

The authors declare that they have no competing interests.

#### Availability of data and materials

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

#### Consent for publication

All participants provided written or oral informed consent for using information that they have given, also for their publication.

#### Ethics approval and consent to participate

The study protocol received clearance from the ethics committee of Côte d'Ivoire (Reference No. 07-2015/MSHP/CNER-P). Additional permission to carry out the study was obtained from local administrative authorities. All participants provided written or oral informed consent.

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