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Characterization of monitor lizard meat uses for food security and nutrition in Benin, Burkina Faso and Ivory Coast

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Abstract

Lizards (Varanidae) are a group of bushmeat consumed and sold in most markets in West Africa and is purchased in preference to domestic animals. The present study aims in general to characterize their uses. Therefore, 361 informants were surveyed in Benin, Burkina Faso and Ivory Coast. It appears that the species of monitor lizards met in Benin, Burkina Faso and Ivory Coast are: *Varanus exanthematicus* and *V. niloticus* with a pdominanc of *Varanus exanthematicus* (P<0.001). The preparation forms of the meat reported are: boiling of the fresh meat, the smoking, the braising and the frying. The distribution of sauces and dishes prepared using monitor lizard (*Varanus* sp.) meat by country (Benin, Burkina Faso and Ivory Coast) using Correspondence Factorial Analysis showed three groups (Benin, Burkina Faso and Ivory Coast). The first axis explains 54.1% of the variations while the second axis explains 45.9% of the variations. Benin is characterized by the lizard meat sauces and dishes named kalalou sauce, sesame sauce, palm nut sauce, vegetable sauce, peanut seed sauce and grilled meat. The Ivory Coast is characterized by the okra sauce, Gnanagnan sauce, Kedjenou Sauce, tomato sauce, Gouagouasoup sauce, Biokosoe dish and palm nut sauce. The Burkina Faso is characterized by the smoked lizard meat sauce, a soup, Piapia yangoila sauce, Soumbala sauce, peanut sauce and sorrel sauce. The cash incomes from monitor lizard trade provide an important contribution that complements the diverse livelihood strategies within a household for food security in Benin, Burkina Faso and Ivory Coast.

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Introduction

Food security is ensured when all people, in real time, have economic, social and physical access to sufficient, safe and nutritious food that meets their nutritional needs and dietary preferences to enable them to lead active and healthy lives (FAO, 2006; Tougan and Théwis, 2020). In the developing countries, where an ever-increasing populations are chronically undernourished (FAO, 2011; Tougan *et al*., 2020), the local production of domestic animal species for meat, milk and eggs have continued to fail in meeting existing demands (Hoffman *et al*., 2016). In West African Countries, the low disposable incomes of the populations, the weak capacity of most governments to fulfill their protein needs by food imports and the worldwide economic crisis increase famine and malnutrition rate. Therefore, the need to intensify protein production has lead Sub-Saharan African countries to improve the productivity of domestic animal species and unconventional animal species, through nutrition and genetic improvement programs, improved management methods and husbandry (Hoffman, 2008; Tougan *et al*., 2014; Hoffman, 2016; Tougan *et al*., 2019). Other valuable non-wood forest products (NWFPs) such as fish, insects, caterpillars, larvae, snails (Bikoue *et al*., 2007), and the wild *species Lepus crawshayi, Thryonomys swinderianus, Varanus* sp., *Hystrix* sp., *Heliosciurus gambianus, Xerus erythropus, Cricetomys gambianus, Cricetomys emini, Atelerix albiventris, Manis gigantea, Arvicanthis niloticus, Taterillus gracilis, Tatera kempi, Otomys irroratus, Mastomys natalensis, Lemniscomys striatus, Neotragus pygmaeus, Potamochoerus porcus, Taterillus gracilis, Tatera kempi, Otomys irroratus*, *Mastomys natalensis, Lemniscomys striatus, Neotragus pygmaeus* were considered in the further strategies of food security (Kurttila *et al*., 2018).

Nevertheless, the increasing pace of meat demand, hunting culture and the expensive cost of meat and meat products obliged the sub-Saharan Africa populations to harvest local wildlife species for subsistence generally called bushmeat (Milner-Gulland and Bennett, 2003). Bushmeat is an important source of animal protein and income for the people of these countries, and an essential component of food security and livelihoods in rural areas where people haven't other alternatives (Bakarr *et al*. 2002; Mainka and Trivedi 2002; Nasi *et al*., 2008). Virtually all wild animal species are edible in Africa but some that are taboo for one group of consumers are delicious for others. The species consumed range from antelopes to monkeys, rodents, monitor lizards and other reptiles and a range of invertebrates including snails (Stiévenaert, 1993), caterpillars (Malaisse and Latham, 2014), termites (Malaisse 2019) and bark beetles. According to Björn Schulte-Herbrüggen *et al*. (2013), the bushmeat, harvest value averaged less than US $1.0 per day for 89% of households and comprised less than 7% of household production value in West African cash-crop farmers living in a faunally-depleted landscape. In Benin for example, Bushmeat is sold in most markets and is purchased in preference to domestic animals. The grasscutter, *Thryonomys swinderianus* (Temminck, 1827), is the preferred species of most clients (Baptist and Mensah, 1986), followed by the monitor lizards [*Varanus exanthematicus* (Bosc, 1792), *V. niloticus* (Linnaeus, 1766), *V. prasinus* (Schlegel, 1839)]. In this country, Bushmeat production was estimated at 20 000 tonnes, or 40 million CFA francs since 1989.

Monitor lizards are a diverse group of reptiles, all well equipped with an effective set of teeth, long strong claws and a long muscular tail. Worldwide there are 78 species of varanids, including 25 subspecies, distributed throughout Africa, South East Asia, Australia, Papua New Guinea and West Papua, and across numerous islands of the Indo-Pacific region (Pianka *et al*., 2004; Welton *et al*., 2010; Vidal *et al*., 2012; Weijola *et al*., 2016). Most species are terrestrial, although semiaquatic and arboreal species also occur.

During the year 2009, 293 reptile species were added to the IUCN Red List including the lizards (*Varanus* sp.). Whole specimens and monitor lizard organs are used for feeding and medicinal recipes (Adeola, 1992; Bayless and Luisselli, 2001; De Buffrénil 2004; Kpéra *et al*., 2008; Sinsin *et al*., 2008).

The present study aims in general the characterization of monitor lizards (*Varanus* sp.) uses in West Africa and the associated constraints and religious beliefs in order to promote their preservation and their production in captivity for food security improvement. Specifically, it is to:

- Identify the different species of monitor lizards (*Varanus* sp.) met and consumed in Benin, Burkina Faso and Ivory Coast;
- List the different forms of use and preparation of the monitor lizard meat in Benin, Burkina Faso and Ivory Coast;
- Identify the sources of supply of the monitor lizards and the means of capture used in Benin, Burkina Faso and Ivory Coast;
- Determine the taboos and religious beliefs associated with the exploitation of monitor lizard in the three countries;
- Show the distribution of sauces and dishes prepared using monitor lizards (*Varanus* sp.) meat by country (Benin, Burkina Faso and Ivory Coast) using Correspondence Factorial Analysis.

Materials and methods

Study area

The current survey was carried out in Benin, Burkina Faso and Ivory Coast all located in West Africa. With an area of 112.622 km² (CountryStat, 2012), the Republic of Benin is limited by the Niger River in the north, in the northwest by Burkina Faso, in the west by Togo, in the east by Nigeria and in the south by the Atlantic Ocean. This country lies between the Equator and the Tropic of Cancer. Benin's latitude ranges from 6°30′ N to 12°30′ N and its longitude from 1° E to 3°40′ E (Kormos and Boesch, 2003).

In Benin, the respondents to the current survey came from Cotonou, Porto-Novo, Avrankou, Pobe, Ketou, Cove, Sehoue, Abomey-Calavi, Ouidah, Come, Lokossa, Grand-Popo, Agoue, Sahoue, Bohicon, Abomey, Dassa, Glazoue, Thio, Ouedeme, Assante, Bante, Ouesse, Kokoro, Kilibo, Bethel, Savalou, save, Parakou, Bembereke, Perere, Nikki, Kalale, Segbana, Kandi, Natitingou, Malanville, Tanguieta, Porga, Kouande, Kerou, Pehunco, Copargo, Perma, Djougou, Wake and Bassila.

Burkina Faso (formerly Upper Volta) is a landlocked Sahel country that shares borders with six nations. It lies between the Sahara desert and the Gulf of Guinea, south of the loop of the Niger River, mostly between latitudes 9° and 15°N (a small area is north of 15°), and longitudes 6°W and 3°E. Burkina Faso has a total area of 274,200 km², of which 273,800 Km2 Island and 400 km² water.

In this country, the respondents to the current survey came from the following towns: Ba, Babora, Bagassi, Bandougou, Banfora, Banfora, Banfora, Banfora, Banfora, Beregadougou, Bitou, Bobo, Bogande, Boromo, Boussera, Dano, Dedougou, Didyr, Dolo, Ekoulkola, Fada, Gaoua, Garango, Goussina, Kampti, Kampti, Kampti, Koin, Langouerou, Lwanga, Manoa, Mounkuy, Orodara, Orodara, Orodara, Orodara, Ouagadougou, Ouarkoye, Pocker, Reo, Safane, Sarkadiaga, Sibi, Sideradougou, Sifarasso, Sokoulani, Souho, Tangare, Tenado, Tenkodogo, Tio, Toma, Toma, Tui, Zabre and Zouma.

Ivory Coast (Côte d'Ivoire) is a sub-Saharan nation in southern West Africa located at 8°00'N, 5°00'W. The country is approximately square in shape. The southeastern region of Ivory Coast is marked by coastal inland lagoons that start from the Ghanaian border and stretch 300 km (186 mi) along the eastern half of the coast. The southern region, especially the southwest, is covered with dense tropical moist forest.

The Eastern Guinean forests extend from the Sassandra River across the south-central and southeast portion of Ivory Coast and east into Ghana, while the Western Guinean lowland forests extend west from the Sassandra River into Liberia and southeastern Guinea. The mountains of "Dix-Huit Montagnes" region, in the west of the country near the border with Guinea and Liberia, are home to the Guinean montane forests. In Ivory Coast, the respondents to the current survey came from Abidjan, Gagnoa, Bingerville, Aboisso, Sassandra, San-pedro, Grand bassam, Yamoussoukro, Jacqueville, Gagnoa, Abengourou, Dabou, Bouafle, Grand bassam, Dimbokro, Agboville, Korhogo, Bouake and Daloa.

Methodology

Data were collected from November 2017 to December 2019 on 361 respondents in Benin, Burkina Faso and Ivory Coast through the use of well-structured questionnaire to elicit information on informant identity and activities, background on varanids, consumption and use forms of monitor lizards, source of varanid supplies, capture mode and materials, cooking modes of monitor lizard meat and associated menus or dishes. Sale price and price definition criterion, taboos and religious beliefs associated with the exploitation of monitor lizards. The respondents were hunters, eatery owners, bushmeat traders and bushmeat consumers.

During the survey, the methodology used is that of retrospective survey by direct interview with the informants. The surveyed populations remember themselves the various characteristics of exploitation of monitor lizards (*Varanus* sp.) in their country or agro-ecological area. Thus, we proceeded to a purposive sampling where any person that consumes produces or sells bushmeat was investigated. After interview, the answers obtained from the survey guide were analyzed. During the counting, the data collected were reviewed, and then coded and stored in a database designed on Excel. All information relating to the questionnaire was encoded by letters or numbers.

Statistical analysis

After examination of the survey files and encoding, data were analyzed using SAS software (2006). The *Proccorre sp* proceeding of SAS was used for Correspondence factor analysis (CFA). The variables taken into account were: the profile of the informant, monitor lizard species, consumption and use forms, source of monitor lizard supplies, capture mode and materials, lizard price, prohibition and religious beliefs associated to the uses of monitor lizards. A hierarchical cluster analysis based on the characteristics of the lizard exploitation on the most significant components of CFA was then performed. The groups of consumers and producers of bushmeat in Benin, Burkina Faso and Ivory Coast were then identified and each group corresponds to one type of exploitation of lizards (V*aranus* sp.).

For quantitative variables (Prices of young, medium and old monitor lizards), a single factor variance analysis was used and the country was the only source of variation. The Proc GLM procedure was used for analysis of variance and the F test was used to determine the significance of the effect of the country on the variables. The means were calculated and compared by the t test. The frequencies were calculated by *Proc freq* procedure of SAS (2006) and compared by the Chi-square test and the bilateral Z test.

Results and discussion

Results

Profile and activities of informants

The profile and activities of surveyed informants of Benin, Burkina Faso and Ivory Coast are given in table 1. It appears that proportion of the informant of male sex in the 3 surveyed counties varies between 67 and 72%. The female informants represent about 28-32% of the studied population in Benin, Burkina Faso and Ivory Coast.

Their education level varies significantly according to the country ($P<0.001$). 68% of the informants In Benin are from the University level to 30% and 34% respectively for Burkina Faso and Ivory Coast ($P<0.01$). Informants of the secondary education level were predominant in Burkina-Faso, followed by Ivory Coast, while the primary education level is most met in Benin ($P<0.01$).

The main activities of the surveyed population of Benin, Burkina Faso and Ivory Coast are various and consist of civil office, teaching, trading, craft, agriculture, household, study and research. The main activities the most met in Benin and Ivory Coast are Civil office, trading and study, while in Burkina Faso, the main activities the most reported are Civil office and study ($P<0.001$).

The secondary activities the most practiced by the informants met in Benin and Ivory Coast are agriculture, teaching, and scientific research, whereas the majority (75%) of the informants of Burkina doesn't have any secondary activity ($P<0.001$).

Call of lizard and associated Proverb in the main local languages of Benin, Burkina Faso and Ivory Coast

The different calls of monitor lizards in the main local languages of Benin, Burkina Faso and Ivory Coast are given in table 2.

Monitor lizard (Varanus sp.) *species, consumption and use forms*

The variation of monitor lizard (*Varanus* sp.) species, consumption and use forms among countries is given in table 3. All of the surveyed informants in Benin, Burkina Faso and Ivory Coast know the monitor lizard (*Varanus* sp.) and recognize their exploitation as food, medicinal and artisanal raw materials. The species of monitor lizards described by the surveyed populations are: *Varanus exanthematicus* (Fig. 1) and *V. niloticus* (fig. 2). The both monitor lizard species reported by the informants are respectively terrestrial, and semiaquatic. In Benin and Ivory Coast, all of them (the 2 species) were met by all respondents (100%) to 82.9% of surveyed population (P<0.001) in Burkina Fasso. The proportions of monitor lizard meat consumers vary significantly among country and were of 100%, 70% and 100% respectively for Benin, Burkina Faso and Ivory Coast (P<0.001).

The preparation forms of the meat reported in the current study for the three countries are: boiling of the fresh meat, the smoking, the braising and the frying. In Benin, all the informants use the boiled, smoked, braised and fried meat while in Ivory Coast, only the smoked and the boiled, smoked and fried meat is consumed with the predominance of smoked and boiled forms (30 – 31%; P<0.001). In Burkina Faso, all the 4 preparation forms were found with the predominance of smoked meat (P<0.001). Monitor lizard meat is conserved smoked, salted or sun-dried. Smoking is the most common form of conservation in the 3 surveyed countries. The sun-dried form is used for preparation of medicinal purpose.

Source of monitor lizard (Varanus sp.*) supplies, capture mode and materials*

The table 4 shows the source of monitor lizard (*Varanus* sp.) supplies, capture mode and materials used in Benin, Burkina Faso and Ivory Coast.

It comes out from the survey that the main sources of monitor lizard (*Varanus* sp.) supplies reported by the informants vary significantly according to the country. The main sources reported by the informants are: local market of smoked bushmeat, farms of monitor lizard breeding, fisherman, hunter, sale places of fresh bush meat, gift, and catcher of live monitor lizards. In Benin, the monitor lizard meat consumers found most the monitor lizard meat on the local market of smoked bushmeat, close to fisherman, catcher of live monitor lizard, hunter, and/or on sale places of fresh bush meat, while in Burkina Faso, monitor lizard meat is mainly provided by hunter and catcher of live monitor lizards (according to 85 - 87% of informants; P<0.001). In Ivory Coast, only the local market of smoked bush meat or sale places of fresh bush meat were the source of monitor lizard (*Varanus* sp.) meat for the consumer.

The tools and equipment used for the catching of monitor lizard are composed of shotgun, trap, cudgel, hook and net. Shotgun, trap, cudgel and catching of the live monitor lizard are most commonly used in Benin comparatively to the 2 others countries where trap and cudgel are most used (P<0.001). The responsible of the monitor lizard capture in the nature is mainly the men (97% in Benin; 88.7% in Burkina Faso and 100% in Ivory Coast). The women are most implicated in the catching or slaughtering of lizards in Burkina Faso than in Benin and Ivory Coast (P<0.001).

Lizard price, prohibition/taboos and religious beliefs

The table 5 shows the monitor lizard price. The prohibition/taboos and religious beliefs associated to the monitor lizard exploitation as food or craft raw materials are given in table 6. The monitor lizards of middle size, small size and heavy size are most expensive in Ivory Coast than in Burkina Faso and Benin (P<0.001). The criterions of price definition of monitor lizard are live weight, the size or length of the reptile, and the social rank of the customer with the predominance of the size or length of the reptile, and the social rank of the customer in Benin, the size in Burkina Faso, the live weight and the size in Ivory Coast.

Prohibition and taboos exist about the exploitation of monitor lizard for food or others purposes. This prohibition is highly reported in Benin and Burkina Faso by 60.6% and 55% of total informants respectively, to 10% in Ivory Coast (P<0.001). Similarly, religious beliefs exist about monitor lizard (*Varanus* sp.). These religious beliefs were most reported in Benin and Burkina Faso (39 to 49%) comparatively to Ivory Coast where only 5.71% of informants have attested the existence of religious beliefs exist about monitor lizard.

In Burkina Faso, religious beliefs on the monitor lizards (*Varanus* sp.) are observed in the socio-cultural groups Dafin, Samo, Bissa, Lyele, Bwaba and Gourmatche. Indeed, the following beliefs exist in Burkina Faso:

✓ Find monitor lizards (*Varanus* sp.) lying in the middle of the road is a sign of misfortune;

✓ The arboreal monitor lizard is a dangerous messenger for its finder;

✓ The monitor lizards (*Varanus* sp.) are sacred reptiles; fetishist must not consume them;

✓ The arboreal monitor is very sacred according to Dafin socio-cultural groups. When monitor lizard dies, it is treated like a human, and buried with rites. Moreover, according to this socio-cultural group, there is a period when terrestrial monitor lizards leave their natural environment and invade the city. In this case, sacrifices are obligatory in order to allow them to regain their sources. In Dedougou and among Bobo, when you kill a monitor lizard, a Bobo dies too.

✓ In Samo socio-cultural group, women of childbearing age and pregnant women do not consume monitor lizard meat. If a woman has killed a monitor lizard, even without being the author of the slaughter, she must obligatorily name her child "Boussi".

✓ According to Sambo, Lyele and Gourmatche, it is strictly forbidden to kill the monitor lizard. According to legend, the monitor lizard and specifically *Varanus exanthematicus* would have saved the lives of their ancestors.

In Benin, sacred *Varanus niloticus* of Sam is the only population of sacred monitor lizard reported in Benin. This species of monitor is considered as deity and worshipped.

Regardless the consumption of lizard meat, monitor lizard is also used in traditional medicine, craft, and international trading. The proportions of informants that use monitor lizard in traditional medicine, craft, and international trading in Benin is 100% to respectively 52.11%, 15.49%, and 2.82% for Burkina Faso and 22.86%, 7.14% and 2.86% in Ivory Coast (P<0.001).

Distribution of sauces and dishes prepared using monitor lizard (Varanus sp.*) meat by country using Correspondence Factorial Analysis*

The distribution of sauces and dishes prepared using monitor lizard (*Varanus* sp.*)* meat by country (Benin, Burkina Faso and Ivory Coast) using Correspondence Factorial Analysis is given in fig. 3.

The first axis explains 54.1% of the variations of sauces and dishes prepared using monitor lizard meat and oppose Burkina Faso to Benin and Ivory Coast. The second axis explains 45.9% of the variations of sauces and dishes prepared using monitor lizard meat and oppose the Benin to the Ivory Coast and in a lesser measure to the Burkina-Faso. Indeed, the Benin is characterized by the sauces and dishes prepared using monitor lizard meat whose names are: kalalou sauce, sesame sauce, palm nut sauce, vegetable sauce, peanut seed sauce and grilled meat. The Ivory Coast is characterized by the okra sauce, Gnanagnan sauce, Kedjenou Sauce, tomato sauce, Gouagouasoup sauce, Biokosoe dish and palm nut sauce. The Burkina Faso is characterized by the smoked lizard meat sauce, a soup, Piapia yangoila sauce, Soumbala sauce, peanut sauce and sorrel sauce.

Characteristics of types of lizard exploitations

Three axes were selected for the interpretation of the correspondence analysis results. Each axis corresponds to a group of monitor lizard users and each group corresponds to a type of lizard exploitations. Group 1 corresponds to lizard exploitation type 1, group 2 to the monitor lizard exploitation type 2 and group 3 to the monitor lizard exploitation type 3. The results of the factorial correspondence analysis are given by group of lizard users in Fig. 4.

The type 1 corresponded to lizard users who weren't provided with schooling or had rarely reached the primary or secondary level. This type of monitor lizard exploitation included the hunters, farmers, students, craftsmen, bush meat sellers, and housewives. They were distributed in almost all studied countries (Benin, Burkina Faso and Ivory Coast) and represent 68.8% of the surveyed population. In this group, informants were predominantly men (69.01%) and did hunting, agriculture, fishermen, craft, bush meat trading, and household as main activities. Terrestrial and semi-aquatic lizards are the most common known lizard species. Almost all of them consume monitor lizard meat. Their main catching methods of monitor lizard and sources of monitor lizard meat supply are hunting, trapping, purchase, hook and net fishing. In this group, knowledge about taboos, prohibition and religious beliefs on monitor lizards are reported. The caught or slaughtered monitor lizard are sold or bought according to their size.

The Type 2 corresponded to monitor lizard users who had rarely reached the primary or secondary level. Only a few wasn't provided with formal education. This type of monitor lizard exploitation included the public officers, bush meat restaurant manager, agro-livestock breeders, and lizard breeders. They were most concentrate in Benin, and Ivory Coast. In this group, informants are men (69.71%) and women (30.29%). They do public service, restoration, agro-livestock production and monitor lizard rearing as main activities. Terrestrial and semi-aquatic monitor lizards are the most common known species. All of them (100%) consume monitor lizard meat. Their main sources of lizard supply are bush meat market, the nature (savanna), hook and net fishing. In this group, there are no taboos, prohibition and religious beliefs about monitor lizards. The caught or slaughtered monitor lizards are sold or bought according to their size. Regardless of capture in the bush, monitor lizards are sometimes bred in captivity. Their diet is provided by insects, fry and fruits. They are raised on the ground in buildings with galleries on the walls whose upper walls are tiled to prevent animals from going out. The reproduction is of natural type but with the peculiarity that the fertilized eggs are collected and incubated under a litter of chips to obtain the small ones.

Finally, in the Type 3, lizard users were provided with higher education level. This type of lizard exploitation included the teachers, scientific researcher, and civil administrators. They were distributed in almost all studied countries (Benin and Burkina Faso) and represent 48.3% of the surveyed population. In this group, informants were predominantly men and did teaching, research and civil office management as main activities. Terrestrial and semi-aquatic lizards are the most common known lizard species. Almost all of them consume lizard meat. Their main sources of lizard meat are hunters and local market of smoked bush meat. In this group, no taboos, prohibition and religious beliefs about lizards were reported. The monitor lizards are bought very expensive. The peanut sauce is their main soup prepared with smoked monitor lizard meat followed by grilled meat.

Discussion

Exploitation of monitor lizards as a food resource

According to Klemens and Thorbjarnarson (1995), reptiles have served as an important source of protein for human populations around the world. Exploitation for food is heaviest in the tropical and sub-tropical regions, but also occurs in temperate areas. In the current study, monitor lizards are consumed by almost all the informants of Benin, Burkina Faso and Ivory Coast as protein resource. The preparation forms of the meat reported in the current study for the three countries are: boiling of the fresh meat, the smoking, the braising and the frying. In Benin, all the informants use the boiled, smoked, braised and fried meat while in Ivory Coast, only the smoked and boiled meats are consumed.

In Burkina Faso, all the 4 preparation forms were found with the predominance of smoked meat. Monitor lizard meat is conserved smoked, salted or sun-dried. Smoking is the most common form of conservation in the 3 surveyed countries. This finding confirms that monitor lizard is among the bushmeat consumed in West Africa and therefore contributes to

the reduction of animal protein deficiency and malnutrition. Bushmeat includes a large variety of wild species that are eaten as food (Bennett and Robinson, 2000; Wilkie *et al*., 2005; Nasi *et al.,* 2015, Hema *et al.,* 2019; Luiselli *et al.,* 2019). According to Nasi and Fa (2015), animal source foods, such as wildlife, are rich in energy, protein, and micronutrients that have greater bioavailability than vegetable sources although their consumption is linked to the transmission of zoonotic diseases, such as Ebola (Ordaz-Németh *et al*., 2017).

However, there is some evidence that indicates a strong causal link between bushmeat consumption and human nutrition (Neumann *et al*., 2003). In a study of children of 12 years old in rural northeastern Madagascar, the lack of access to wild meat caused a 29% increase in the numbers of children suffering from iron deficiency anaemia and a tripling of anaemia cases among children in the poorest households (Golden *et al*., 2011).

Thus, if consumption of sufficient amounts of nutrients to meet the body's needs is limited, including those contained in meats, chronic malnutrition will occur over time and will result in growth retardation in children (stunting) and eventually ill health in later life. If food security is taken as the provision of nutritionally adequate and safe foods, that have a steady supply during the year, and to which households have access at all times, to sufficient amounts, for an active and healthy life (Maxwell and Wiebe 1999; Pinstrup-Andersen 2009), the contribution of monitor lizard as bushmeat to human nutrition in sub-Saharan Africa is very important. Moreover, Starkey (2004), Cawthorn and Hoffman (2015) and Nasi and Fa (2015) also reported that wild animals as monitor lizards are a great source of income for rural populations, and play an important role in the practice of traditional medicine.

Accoding to Deutsch and Murakhver (2012), common edible lizards include iguanas (*Iguana* spp.), tegus (*Tupinambis* spp.), monitor lizards (*Varanus* spp.), geckos (infraorder Gekkota), and to a lesser extent worm lizards (sub-order Amphisbaenia).

Exploitation of monitor lizards for trading and medicinal receipts

In the current study, regardless the consumption of lizard meat, monitor lizard is also used in traditional medicine, craft, and international trading. The proportions of informants that use monitor lizard in traditional medicine, craft, and international trading in Benin is 100% to respectively 52.11%, 15.49%, and 2.82% for Burkina Faso and 22.86%, 7.14% and 2.86% in Ivory Coast. This finding confirms the report of Schulte-Herbrüggen *et al.* (2013) who showed that bushmeat is an important resource in the livelihoods of many rural communities in sub-Saharan Africa and may be a crucial safety-net for the most vulnerable households, especially during times of economic hardship. Therefore, despite the small cash incomes from monitor lizard trade, they provide an important contribution that complements the diverse livelihood strategies within a household, especially for the poorer sectors of rural society. Moreover, there are non-financial benefits of non-timber forest products trade that are commonly overlooked (Shackleton and Shackleton, 2004).

According to Brashares *et al.* (2011), the harvest of wildlife such as monitor lizards catching for human consumption is valued at several billion dollars annually and provides an essential source of meat for hundreds of millions of rural people living in poverty. This harvest is also considered among the greatest threats to biodiversity throughout Africa, Asia, and Latin America. Economic development is often proposed as an essential first step to win–win solutions for poverty alleviation and biodiversity conservation by breaking rural reliance on wildlife. In West and Central Africa, the bushmeat trade reaches five million tonnes every year (Fa *et al.,* 2002).

About medicinal uses of monitor lizards, several informants of the current survey had reported the exploitation of lizard organs in the treatment of several illnesses such as female sexual dysfunction, ailments, including haemor-rhoids, rheumatism, body pain and burns, as well as spider and snake bites. They are also used as a cure for arthritis. The fat and meat of lizards are also reported to work like testosterone and are

considered a delicacy and an aphrodisiacin in South India (da Nóbrega *et al*., 2008).

According to these authors, the meat of lizards is also reported to be effective in curing the tension, hyperglycemia, asthma and cough (Subramanean and Vikram Reddy, 2012).

This result confirms the report of FAO (2002), Cawthorn and Hoffman (2015), and Nasi and Fa (2015) who showed that wild animals are not only a source of income, but also play an important role in the practice of traditional medicine. In Africa, whole specimens and reptile organs (crocodiles, snakes, turtles, monitor lizards, etc.) are used for feeding and medicinal recipes (Bayless and Luisselli 2001, De Buffrénil 2004, Kpéra *et al.,* 2004*;* Sinsin *et al*., 2008).

The capture technique of semi-aquatic monitor lizard found herein and based on the use of hook was also reported by Buffrenil and Hemery (2007).

Taboos and religious beliefs associated to the exploitation monitor lizards

Food prohibition is an act of not allowing a pre-determined group of person from eating some kinds of foods (Anyanwu *et al.,* 2015). This act or taboo exists in all socio-cultural groups and generally aims to protect the practitioners from unseen problems. In the current study, prohibition and taboos exist about the exploitation of monitor lizard for food or others purposes. This prohibition is highly reported in Benin and Burkina Faso (55 to 60.6% of informants) but weakly reported in Ivory Coast (10%).

Similarly, religious beliefs exist about monitor lizard in the 3 studied countries and were most reported in Benin and Burkina Faso. This finding on the existence of prohibition and religious beliefs about the consumption of monitor lizards is in accordance with the results of Bolton (1972), Odebiyi (1989), Onuorah and Ayo (2003), Waibel (2013), Anyanwu *et al.* (2015). According to Anyanwu *et al.* (2015), in the African setting, these acts are usually strongly adhered to and are most often associated with some traditional ancestral worship which religiously serves as the symbol for the forbidden food articles. These practices, by their nature often limit the availability of freely available protein foods to the local communities that are believers and practitioners.

Furthermore, many religious congregations in the world also are characterized by food prohibition or taboo mostly due to regulations, rules and laws from their holy book and also by their wills to prevent health problems in their devoted adepts or believers (Waibel, 2013).

In Sub-Saharan Africa, the practice of food prohibition has existed among the various local indigenous sects for several generations (Anyanwu *et al*., 2015). This practice is generally attached to some myths or beliefs among the practicing population. Stories, folklores, legends and even religious practices are the main means of transmission of myths or beliefs from generation to generation. For instance, the people of Orogun, an Urhobo community in Nigeria prohibit the slaughtering and consumption of Iguana Lizard. These lizards are called “mother” and are allowed to pick whatever food items they want both at home and in the farm, and to go about ‘majestically’, unmolested and can go into the traditional homes of the people uninhibited.

According to Anyanwu *et al.* (2015), the person involved in any accidental death of these big lizards has to spend huge sums of money for burial ceremony for these reptiles which are recognized ‘god’ or the worshiped deity.

In Olomu Kingdom of Nigeria, crocodile is also seen as a god. It is a strict taboo to kill and eat the meat of a crocodile, and anybody who does so will develop severe rashes all over his body, with severe itching and scratching. No medication works, and the person must perform certain rites. Failure to do this ceremony will result into the culprit developing, swollen body, and abdomen and death eventually (Akpokona, 2014; Anyanwu *et al*., 2015).

In Gambia, according to Odoi (2014), there are also certain practices originating from past beliefs.

Among these beliefs are taboos: members of the Ceesay family should not touch or eat sole fish and monitor lizards, and members of the Sanyang family should not touch iguanas or eat turtle meat.

In Benin, sacred *Varanus niloticus* of Sam is considered as deity and worshipped. Beyond the cultic and cultural, the importance of these sacred lizars in the protection of populations against bites of reptiles like the snakes that enter in the diet of these monitor lizards is recognized (Ciliberti, 2011; Pianka *et al.*, 2004). These sacred lizards regulate also the damage in grain stocks because the rodents who are responsible for it enter in their diet (Sinsin *et al.,* 2008; Savey, 2009).

Conclusion

The characterization of the different uses of monitor lizards and associated taboos, prohibitions and religious believes carried out in this study presents a large diversity of use of monitor lizard (*Varanid* sp.) in Benin, Burkina Faso and Ivory Coast. Overall, it comes out from the survey that all of the surveyed informants in Benin, Burkina Faso and Ivory Coast know the monitor lizards and recognize their exploitation as food, medicinal and artisanal raw materials. The preparation forms of the meat reported in the current study for the three countries are: boiling of the fresh meat, the smoking, the braising and the frying.

Monitor lizard meat is conserved smoked, salted or sun-dried. The main sources of monitor lizard supplies reported by the informants are: local market of smoked bushmeat, farms of monitor lizard breeding, fisherman, hunter, sale places of fresh bush meat, and gift. The tools and equipment used capture of monitor lizards are composed of shotgun, trap, cudgel, catching of the live lizard and net.

These species of monitor lizards are hunted for feeding, commercial and craft purposes. The cash incomes from monitor lizard trade provide an important contribution that complements the diverse livelihood strategies within a household of monitor lizard catchers or trader.

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References

Adeola MO. 1992. Importance of wild animals and their parts in the culture, religious festivals, and traditional medicine of Nigeria. Environ. Conserv **19,** 125-134.

Akpokona O. 2014. In Olomu Kingdom, Crocodile is god. Niger Delta Voice. Lifestyle extra pp. 06.

Anyanwu EB, Abedi Harrison O, Edafiadhe EW. 2015. Food Prohibition among the Urhobo Nation: Ethical Consideration. American Journal of Public Health Research **3(4),** 174-179. http://pubs. sciepub. com/ajphr/3/4/8.

Bayless MK, Luisselli L. 2001. A review of predation on African monitors lizards (Varanidae). Bulletin de la Société herpétologique de France **97,** 19-26.

Bennett EL, Robinson JG. 2000. Hunting of Wildlife in Tropical Forests: Implications for Biodiversity and Forest Peoples. Global Environment Division; The World Bank, Washington DC.

Bikoué CM, Essomba H, Tabuna H, Degre A, Tchoundjeu Z, Walter S. 2007. Gestion des ressources naturelles fournissant les produits forestiers non ligneux alimentaires en Afrique centrale. COMIFAC/FAO, Département des Forêts, Produits forestiers non ligneux, Document de travail No.5, Yaoundé. 83p.

Bolton JM. 1972. Food taboos among the Orang Asli in West Malaysia: a potential nutritional hazard. The American Journal of Clinical Nutrition **25,** 789-799. 1972.

Bonou A, Adégbidi A, Sinsin B. 2013. Valeur économique des Produits Forestiers Non Ligneux (PFNL) du Bénin. Editions Universitaires européennes. ISBN 978-613-1-51998-7. 101p.

Brashares JS, Christopher D Golden, Karen Z Weinbaum, Christopher B Barrett, Okello GV. 2011. Economic and geographic drivers of wildlife consumption in rural Africa. PNAS **108(34)**, 13931-13936.

Cawthorn DM, Hoffman LC. 2015. The bushmeat and food security nexus: a global account of the contributions, conundrums and ethical collisions. Food Research International **76,** 906-25.

Ciliberti A, Berny P, Delignette-Muller M-L De Buffrénil V. 2011. The Nile monitor (*Varanus niloticus*. Squamata: Varanidae) as a sentinel species for lead and cadmium contamination in sub-Saharan wetlands.

Ciliberti A. 2011. Le varan du Nil (*Varanus niloticus*) indicateur de la pollution des zones humides d'Afrique sub-saharienne. Thèse de Doctorat. Université de Lyon, Lyon 158 p.

Codjia JTC, Assogbadjo AE, Mensah MR. 2003. Diversité et valorisation au niveau local des ressources forestières alimentaires du Bénin. Cahier d'Agriculture **12,** 321-331.

CountryStat/Benin. 2012. Base de données statistiques. http://countrystat.org/ben.

da Nóbrega Alves, RR, da Silva Vieira, WL Santana GG. 2008. Biodivers. Con-serv **17,** 2037-2049.

De Buffrénil V Hemery G. 2007. Harvest of the Nile monitor, *Varanus niloticus,* in Sahelian Africa. Part I: Demographic impact of professional capture technique. Mertensiella **16,** 181-194.

De Buffrénil V. 2004. L'exploitation et le commerce des *Varans africains:* Le cas du varan du Nil (*Varanus niloticus*) au Tchad. Bulletin de la Société Zoologique de France **129,** 75-89.

Deutsch J, Murakhver N. 2012. They eat that? A cultural encyclopedia of weird and exotic food from around the world. ABC-CLIO Santa Barbara, California.

Fa JE, Peres CA, Meeuwig J. 2002. Bushmeat exploitation in tropical forests: an intercontinental comparison. Conservation Biology **16,** 232-237

FAO. 2002. Current issues in biodiversity conservation. Edited by D. Williamson 53p.

FAO. 2006. Etat de l'insécurité alimentaire dans le monde. 8p.

FAOSTAT. 2018. Bases de données statistiques de la FAO, Food and Agriculture Organization of the United Nations, Rome. http://faostat3.fao.org/home

Golden CD, Fernald LCH, Brashares JS, Rodolph Rasolofoniaina BJ Kremen C. 2011. Benefits of wildlife consumption to child nutrition in a biodiversity hotspot. Proceedings of the National Academy of Sciences, USA **108,** 19653-19656.

Hema ME, Ouattara V, Gnoumou P, Di Vittorio M, Sirima D, Dendi D, Guenda W, Petrozzi F, Luiselli L. 2019. Bushmeat consumption in the West African Sahel of Burkina Faso, and the decline of some consumed species. Cambridge University Press **53(1),** 145-150.

Hoffman LC, Cawthorn DM. 2012. What is the role and contribution of meat from wildlife in providing high quality protein for consumption? Animal Frontiers **2(4),** 40-53.

Hoffman LC. 2008. The yield and nutritional value of meat from African ungulates, camelidae, rodents, ratites and reptiles. Meat Sci **80,** 94-100.

Klemens MW, Thorbjarnarson JB. 1995. Reptiles as a food resource. Biodiversity & Conservation **4(3),** 281-298.

Kormos R, Boesch C. 2003. West African chimpanzees: status survey and conservation action plan, International Union for Conservation of Nature and Natural Resources, IUCN/SSC Primate Specialist Group 219 pages. ISBN 2-8317-0733-1, ISBN 978-2-.

Kpéra GN, Mensah GA Sinsin B. 2004. Utilisation des produits et sous-produits de crocodile en médecine traditionnelle au nord du Bénin. Bulletin de Recherche Agronomique du Bénin **44,** 12p.

Kurttila M, Pukkala T, Miina J. 2018. Synergies and Trade-Offs in the Production of NWFPs Predicted in Boreal Forests. Forests **9(417),** 1-15.

Lenz S. 2004. Varanus niloticus. In Pianka ER, King DR, King RA, eds, Varanoid Lizards of the World. Indiana University Press, Bloomington, IN, USA 133-138 pp.

Luiselli L, Hema EM, Segniagbeto G, Ouattara H, Valy E, Di Vittorio EA, Massimiliano A, Nioking P, Gnoumou P, Akani N, Sirima GC, Djidama G, Wendengoudi Fa, Barineme B, Dendi D Fa JE. 2019. Understanding the influence of non-wealth factors in determining bushmeat consumption: Results from four West African countries. Acta Oecologica **94,** 47p.

Malaisse F, Latham P. 2014. Uman consumption of Lepidoptera in Africa : an updated chronological list of references (370 quoted !) with their ethnozoological analysis. Geo-Eco-Trop **38(2),** 339-372.

Malaisse F. 2019. Human termitophagy in Africa. Geo-Eco-Trop **43, 1,** 1-24.

Mankor A. 2009. Evolution du secteur de l'élevage Ouest africain, Consommation urbaine de viande en Afrique de l'Ouest : l'exemple de Dakar. Grain de Sel. **46-47,** 16-17.

Maxwell D Wiebe K. 1999. Land tenure and food security: exploring dynamic linkages. Development and Change **30,** 825-849.

Mensah GA, Baptist R. 1986. Aspects pratiques en élevage d'aulacodes (*Thryonomys swinderianus*) I. Modes d'accouplement et durée de la gestation. Revue d'élevage et de médecine vétérinaire en pays tropicaux **39,** 239-242.

Nasi R, Fa JE. 2015. The role of bushmeat in food security and nutrition. XIV world forestry congress, Durban, South Africa 7-11.

Nasi R, Taber A, Van Vliet N. 2011. Empty forests, empty stomachs? Bushmeat and livelihoods in the Congo and Amazon Basins. International Forestry Review **13,** 355-368.

Nellemann C, MacDevette M, Mers T, Eickhout B, Svihus B, Prins AG, Kaltenborn BP. 2009. The environmental food crisis – The environment's role inaverting future food crises. A UNEP rapid response assessment.United Nations Environment Programme, GRID-Arendal. www.grida.no.

Neumann CG, Bwibo NO, Murphy SP, Sigman M, Whaley S, Allen LH, Guthrie D, Weiss RE Demment MW. 2003. Animal source foods improve dietary quality, micronutrient status, growth and cognitive function in Kenyan school children: Background, study design and baseline findings. Journal of Nutrition **133(11, Suppl 2),** 3941S-3949S.

Odebiyi AI. 1989. Food taboos in maternal and child health: the views of traditional healers in IIe-Ife, Nigeria Soc Sci Med **28(a),** 985-96.

Odoi DA. 2014. Taboos as Scientific Restrictions for Healthy Living among the Mafi-Evɛ. Journal of Alternative Perspectives in the Social Sciences **5(4),** 733-743.

Onuorah, CE Ayo, JA. 2003. Food taboos and their nutritional implications on developing nations like Nigeria – a review. Nutrition and Food science **33(5),** 235-240.

Ordaz-Németh I, Arjelovic M, Boesch L, Gatiso T, Grimes T, Kuehl HS, Lormie M, Stephens C, Tweh C, Junker J. 2017. The socio-economic drivers of bushmeat consumption during the West African Ebola crisis. PLoS Negl Trop Dis. **11(3),** e0005450. doi: 10.1371/journal.pntd.0005450.

Petrozzi F, Amori G, Franco D, Gaubert P, Pacini N, Eniang EA, Akani GC, Politano E Luiselli L. 2016. Ecology of the bushmeat trade in west and central Africa. Tropical Ecology **57(3),** 545-557.

Pianka ER, King DR, King RA. 2004. Varanoid Lizards of the World. Bloomington, Indiana: Indiana University Press.

Pinstrup-Andersen P. 2009. Food security: definition and measurement. Food Security **1,** 5-7.
SAS. 2006. SAS/STAT User's guide, vers, 6, 4th ed, Cary, NC, USA, SAS Inst.

Savey C. 2009. Les affections des lézards liées aux conditions de captivité. Thèse de Doctorat Vétérinaire, Ecole Nationale Vétérinaire d'Alford. 136p.

Schulte-Herbrüggen B, Cowlishaw G, Homewood K, Rowcliffe JM. 2013. The Importance of Bushmeat in the Livelihoods of West African Cash-Crop Farmers Living in a Faunally-Depleted Landscape. PLoS ONE **8(8),** e72807. Science of The Total Environment. **409,** 4735-4745.

Shackleton C Shackleton S. 2004. The importance of non-timber forest products in rural livelihood security and as safety nets: a review of evidence from South Africa. South African Journal of Science **100(11-12),** 658-664.

Sinsin B, Zannou A, Djossa B, Kpéra GN, Tchibozo N. 2008. Biologie des principaux spécimens de la convention Internationale sur le commerce des espèces en Danger (CITES) au Bénin : cas des varans, tortues, caméléons et scorpions. LEA/FSA/UAC et PGFTR/MEPN. 41 p.

Starkey M. 2004. Commerce and subsistence: the hunting, sale and consumption of bushmeat in Gabon. PhD Dissertation, Cambridge University, UK.

Stiévenaert C. 1992. Biology of some Achatinidae known as edible snails. In: Hardouin J. & Stiévenaert C. (Eds.), Proceedings of the seminar Invertebrates (minilive stock) farming, EEC-DGXII/CTA/ IFS/DMMMSU/ITM, Philippines. 145-154.

Subramanean J, Vikram Reddy M. 2012. Monitor lizards and geckos used in traditional medicine face extinction and need protection. Current Science **102(9),** 1248-1249.

Tougan UP, Théwis A. 2020. Covid-19 and Food Security in Sub-Saharan Africa: Implications and Proactive Measures to Mitigate the Risks of Malnutrition and Famine. International Journal of Progressive Sciences and Technologies (IJPSAT) **20 (1),** 172-193. http://ijpsat.ijsht-journals.org.

Tougan UP, Yayi-Ladekan E, Imorou-Toko I, Guidime C, Thewis A. 2020. Dietary behaviors, food accessibility and handling practices during SARS-CoV-2 pandemic in Benin. North African Journal of Food and Nutrition Research; Special Issue "Nutritional Insight on Novel Coronavirus COVID-19 (NINC-19)". In press 23 pp.

Vidal N, Marin J, Sassi J, Battistuzzi FU, Donnellan S, Fitch, AJ, Fry BG, Vonk FJ, Rodriguez de la Vega RC, Couloux A Hedges SB. 2012. Molecular evidence for an Asian origin of monitor lizards followed by Tertiary dispersals to Africa and Australasia. Biology Letters 8, 853-855.

Waibel AR. 2018. Religion and Dietary Practices. 2013. Available: http://www.faqs.org/Nutrition/Pre-sma/Religion-and-Dietery_Practice.html. [Assessed on 06/07/2018].

Weijola V, Donnellan S, Lindqvist C. 2016. "A new blue-tailed Monitor lizard (Reptilia, Squamata, Varanus) of the Varanus indicus group from Mussau Island, Papua New Guinea". ZooKeys **568(568),** 129-54.

Welton LJ, Siler CD, Bennett D, Diesmos A, Duya MR, Dugay R, Rico ELB, Van Weerd M Brown RM. 2010. A spectacular new Philippine monitor lizard reveals a hidden biogeographic boundary and a novel flagship species for conservation. Biology Letters **6(5),** 654-658.

Wilkie DS, Carpenter JF. 1999. Bushmeat hunting in the Congo Basin: An assessment of impacts and options for migration. Biodiversity and Conservation **8,** 927-955.

Wilkie DS, Starkey M, Abernethy K, Nstame Effa E, Telfer P Godoy RA. 2005. Role of prices and wealth in consumer demand for bushmeat in Gabon, Central Africa. Conservation Biology **19,** 1-7.