Some uses of the African buffalo *Syncerus caffer* (sparrman, 1779) by the populations living around the Comoé National Park (North-East Ivory Coast)

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Key words: Ethnozoology, Use form, Buffalo, Comoé National Park, Ivory Coast

Submission Date 26/10/2020 ; **Acceptance Date** 15/02/2021; **Publication date** 28/02/2021,
http://m.elewa.org/Journals/about-japs/

1 ABSTRACT

The Comoé National Park (CNP) in Ivory Coast is home to significant biological diversity and is one of the priority areas of the West African protected areas network. It is subject to many anthropic pressures, the most intense in its history have been those of the periods of socio-political crisis that Ivory Coast has experienced. The anthropic pressures which weigh on this park are most often practiced by the riparian populations for their survival. The objective of this study is to list the buffalo's organs and their usual mode of use in order to identify the types of pressure that weigh on the species. It is mainly carried out in twelve villages on the periphery of the Comoé National Park: Bania, Kokpingé, Sanguinari, Mango, Lambira, Kalabo, Banvayo, Kakpin, Amaradougou, Gorowi, Tehini and Saye. It has made it possible to identify the forms of use that these residents make of the organs of this species. It was carried out on the basis of socio-economic and ethnozoological surveys of 168 people chosen at random from ecoguards and former hunters. The survey included eight sociolinguistic groups (Lobi, Koulango, Malinké, Lorhon, Agni, Yacouba, Toura, and Senoufo). These data made it possible to compare the frequency of usage citations within ethnic groups. Eleven organs of the buffalo are used by the populations living in the Comoé National Park for food, medicine and mysticism. 100 % of the respondents use buffalo meat as animal protein. About 76.92 % and 48.08 % of the respondents use the organs of this species in the medical and mystical fields respectively.

2 INTRODUCTION

Wild animals are an important source of protein in the diets of tropical countries where the trade in game meat is flourishing (Caspary *et al.*, 2001 ; Gonedelé *et al.*, 2016). Among these wild animals, the Bovidae occupy an important part of the spectrum of game traded in Ivory Coast. (Caspary, 1999 ; Koné, 2004 ; Gonedelé *et al.*, 2016). In addition, game constitutes, along with fish, the main sources of animal protein for most Ivorian populations. This is also the case in several regions of sub-Saharan Africa. In Ghana, 80 % of the animal protein consumed (including fish) comes from wildlife (Asibey, 1974). For centuries, the populations living along the shores

of protected areas in Black Africa have always exploited forest resources to feed and care for themselves (Kassé *et al*., 2006 ; Yaokokoré-Beibro *et al*, 2010). Man therefore has recourse to nature to solve the major problems of his existence (Agossou *et al*., 2018). In this logic, wildlife species have been used as medicinal and other sources since ancient times. (Alves, 2009). It is therefore one practice among many that impacts biological diversity. Thus, biodiversity is gradually being depleted due to therapeutic and food use and large-scale poaching (Harit, 2002). In addition, this practice contributes to the destruction and disappearance of flora and fauna species that populate planet earth. The use of animal organs in traditional medicine is an important recourse in the culture of African peoples. Some animal species (elephant, buffalo, hippopotamus, leopard) have a sacred character for people, and are very famous in legends, local myths and for popular use (Yaokokoré-Beibro, 1995 ; Caspary, 1999). This is why it is important to know the habits and customs of the local populations, in order to take them into account in wildlife management. Located in the north-east of the country, the Comoé National Park (CNP) is home to an important biological diversity and is one of the priority areas of the protected areas network in West Africa (Lauginie, 2007). Many wildlife species, including buffaloes, are threatened by intensive poaching and the information available on buffaloes is very patchy. However, the buffalo has a proven ecological role on vegetation, especially on the regeneration of higher plants (De vos et Bengis, 1994). In addition, it is a species with a high tourist value because it is part of the Big Five Games (Caro et Riggio, 2014). The African buffalo is listed as Near Threatened (NT) on the IUCN Red List (2019) and is classified in Appendix II of CITES as a partially protected animal (Neuenschwander *et al*., 2011). The various human actions to obtain the remains of animals that are constantly multiplying reinforce poaching in the Comoé National Park. It will therefore be extremely regrettable to provoke the progressive extinction of animal species whose contribution to the equilibrium of ecosystems is known to be non-negligible (Gbankoto, 2011). Thus, this study on the ethnozoology of the buffalo is necessary to constitute a data bank on this species. Its outcome will improve the knowledge of the species and the use made of its different components, in order to plan palliative measures to strengthen the protection of the Buffalo for a sustainable use of the species in accordance with the aspirations of the Convention on Biological Diversity.

3 MATERIAL AND METHODS

3.1 Study area: The Comoé National Park (CNP) is located in north-east of Ivory Coast, between latitudes 8°30 - 9°37 north and longitudes 3°07 - 4°26 west and covers an area of 1,148,756 hectares (Fig. 1). It is crossed from north to south by the Comoé River in its western part. The climate of the CNP is of the subhumid tropical type with two seasons including a great rainy season and a great dry season (OIPR, 2015). The dry season is well marked and can last up to eight months from October to May. The rainy season is from June to September. March is the hottest month with temperatures around 37°C while January is the least hot with an average temperature of around 15°C. Annual rainfall is between 900 mm and 1200 mm with an average of 1084 mm per year (Fisher, 2002). The average annual temperature varies from 26°C to 27°C (OIPR, 2015). There are four main types of vegetation: gallery forests, forest islands, wooded savannas and shrubby savannas. Savannah formations occupy almost 89 % of the total area of the park and are therefore characteristic of the landscape of the CNP (Schweter, 2016). The indigenous populations bordering the CNP are essentially the Koulango, Lobi and Lorhon (ethnic groups).

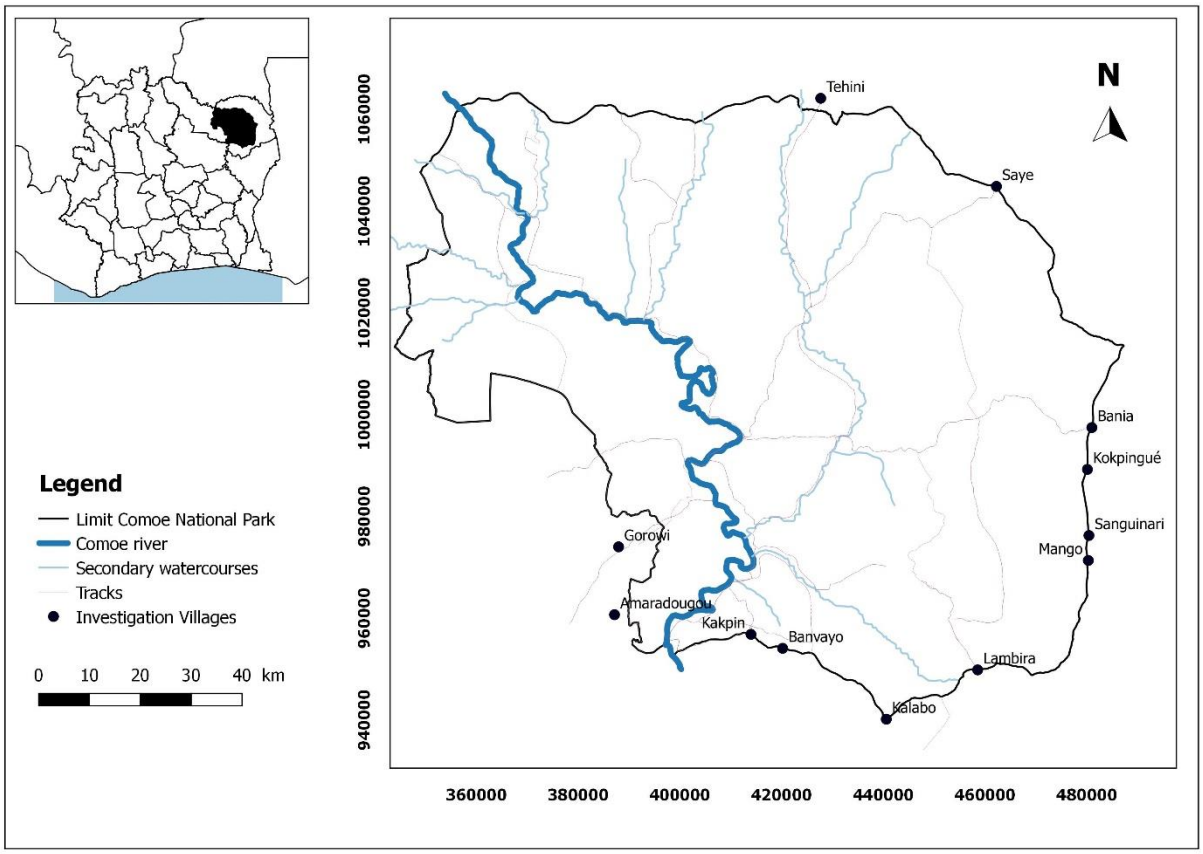

Figure 1: Location map of Comoé National Park, Ivory Coast.

3.2 Sampling: The surveys consisted of interviewing (individual interviews) the populations living in the villages surrounding Comoé National Park (Gonedelé *et al.,* 2008). This is a survey of local people during their rest days over a year to get an idea of the different names of buffalo in the study area, the use of buffalo by local people, variations in knowledge of buffalo use and the diversity and distribution of knowledge among the respondents. For this purpose, a mixed questionnaire was developed with a photograph of the buffalo to give the respondent the opportunity to express himself and to lift the nuances to lighten acceptations. Ethnozoological surveys were conducted in twelve villages on the periphery of the Comoé National Park: Bania, Kokpingé, Sanguinari, Mango, Lambira, Kalabo, Banvayo, Kakpin, Amaradougou, Gorowi, Tehini and Saye (Fig. 1). The choice of these villages was motivated by their accessibility, their proximity to the park, and their particularity in relation to the presence of socio-cultural groups and the presence of people with a good knowledge of wildlife and its various uses (ecoguards and former hunters). In all the villages, the survey took into account eight sociolinguistic groups, namely the Lobi, Koulango, Malinké, Lorhon, Agni, Yacouba, Toura, and Senoufo. The survey was conducted through community meetings in order to minimize information disparities (Azanlin, 2007; Koue Bi *et al.*, 2017). The services of a former poacher who had converted to ecoguarding facilitated communication with the different target groups in addition to two local interpreters who were called upon to translate the interviews into Koulango, Lobi and Lorhon.

3.3 Data Analysis: The data collected was encoded using Microsoft Office Excel 2018 spreadsheet software, which was the basis for data analysis. To assess the social importance of the organs, the following parameters were calculated. These are :

3.3.1 Citation Frequency: Citation frequency is a measure of the diversity of uses by populations. According to Mouzoun (2014), it is calculated according to the formula below: CF = (n / N) x 100 with n= number of citations in a usage category and N= total number of respondents.

3.3.2 Value in Use: The Use Value is used to assess the relative importance of the species to the local community. It has been calculated using the formula of Ayantunde *et al.*, 2009 and Sop *et al.*, 2012. It can be translated as follows: VU = (Σ U) / N with (Σ U) = all the quotations of the organs and N= total number of respondents.

3.3.3 Informed Consensus Factor: The Informative Consensus Factor provides an understanding of the level of consensus of the populations on the uses of the parts of the species. It was calculated using the formula used by Monteiro *et al.*, 2006 and Ngom *et al.*, 2014. It can be translated as follows: IFC = (Nur - Nt) / (Nur - 1) where Nur= number of citations for each use category and Nt= total number of parties

3.3.4 Fidelity Level: The Fidelity Level was calculated using the formula of Sheikh-youssef *et al.*, 2011; Alexiades and Sheldon, 1996. It translates as follows: NF = Nci / Nct Nci= number of species citations for a use category and Nct= number of species citations for all use categories.

3.3.5 Diversity of Use: Diversity of Uses is used to measure the importance of use categories and how they contribute to the total value of uses. It was calculated using the formula of Byg and Baslev, 2001. It can be translated as follows:
UD = Ucx / Uct
where Ucx= number of registered indications by type of use and Uct= total number of indications (Uct), all categories.

3.3.6 Faimess of Use: Equitability of uses consists in measuring the degree of homogeneity of knowledge about use categories. It was calculated using the formula of Byg and Baslev, 2001. It can be translated as follows:
UE = UD / UD max where UD= value of diversity of uses and UDmax= maximum index value. The Kruskal-Wallis test compared the frequencies of usage citations within the eight ethnic groups. On the other hand, the comparison test of k sample allowed to compare the proportions of knowledge of uses according to ethnic groups. Mrascuilo's procedure made it possible to classify the proportions of usage knowledge according to ethnicity. The various tests were conducted with Xlstat 2016 software versions 18.02.01.

4 RESULTS

4.1 Different names of buffalo in the study area: A total of 168 stakeholders, heads of households, were interviewed in 12 villages around the CNP. The sample consisted of 30 women (17.65 %) and 140 men (82.35 %). All age categories were represented. There were youth between 20 and 40 years of age (29.76 %), adults between 41 and 60 years of age (63.10 %) and people over 61 years of age (7.14 %). Essentially, eight ethnic communities were surveyed. These were the Koulango (33.53 %), Lobi (28.82 %), Senoufo (2.35 %), Malinke (17.65 %, Yacouba (2.94 %), Toura (1.18 %), Lohron (12.35 %), and Agni (1.18 %). Approximately 41.51 % of respondents did not go to school, 5.66 % went to elementary school and 18.87 % went to high school. Nearly all of the respondents acknowledged having used buffalo organs. Its nomenclature varies according to the sociolinguistic target groups of the present study (Table 1).

Table 1: Désignations locales du buffle par les groupes ethniques enquêtés.

Ethnic Groups	Number of people surveyed	Local name
Koulango	57	Han
Lobi	49	Nah
Malinké	30	Sigui
Senoufo	4	Sénon
Yacouba	5	Bli dou
Toura	2	Douho
Lohron	21	Hainara
Agni	2	Eouô

4.2 Use of buffalo by local populations: A total of three areas of use were identified about buffalo by the populations visited: food, traditional medicine and mythology (Fig. 2). With regard to the Citation Frequency, food is by far the most frequent (CF= 100 %), followed by traditional medicine with 76.92 %. With a Citation Frequency (CF) equivalent to 48.08 %, the use of Buffalo in African mythology is the least cited. As for the total use value of the species obtained is 17.98. The organs of the species *Syncerus caffer* are widely used by riparian populations for a variety of reasons (Fig. 3). However, these organs do not have the same values and therefore are not used in the same way from one survey respondent to another. Citation frequencies of the parts used are calculated to measure the diversity of uses by the populations. Examination of figure 3 reveals that the high citation frequency is recorded in the food category with flesh + skin, because all the local residents surveyed feed on buffalo flesh and/or skin as protein. Similarly, the lowest frequency is recorded in the dung and urine. The Kruskal-Wallis non-parametric statistical test performed on flesh and skin (100 %), tail (47.06 %), hoof and heart (23.96 %), horn and leg bones (23.21 %) and lung (21.39 %) shows that there is no significant difference ($P = 0.392$; $P > 0.05$). However, there are significant differences with respect to knowledge of use according to the domains. For example, a significant difference was observed for food, medicine and magic ($p = 0.01$).

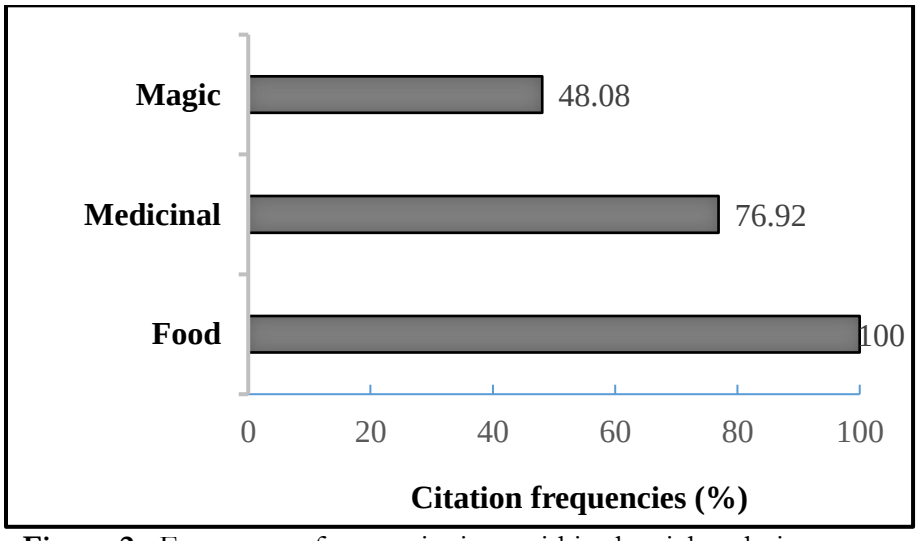

Figure 2 : Frequency of usage citations within the eight ethnic groups.

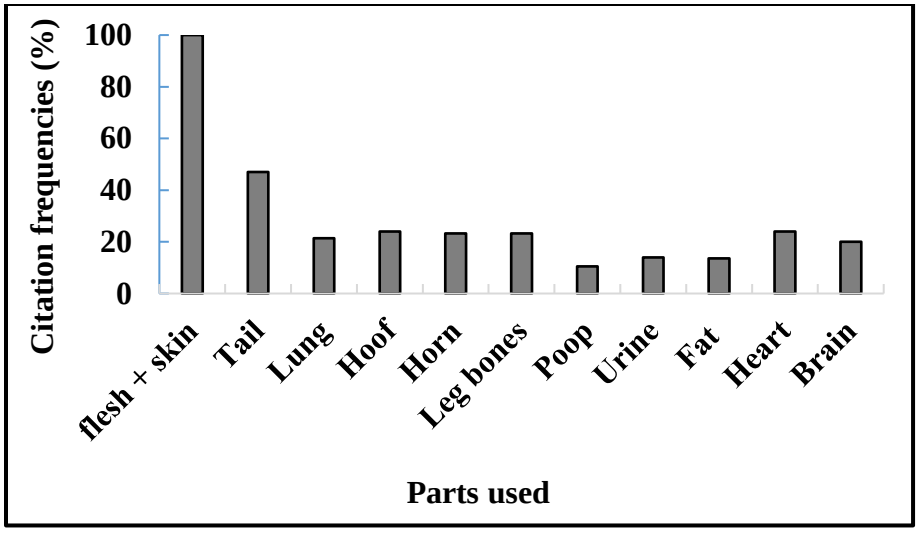

Figure 3 : Parts used and citation frequencies.

4.3 Knowledge of buffalo uses: The evaluation of the knowledge on the uses of the buffalo according to gender was done and it appears that there is not the same level of knowledge. Indeed, regardless of gender (male and female), the level of knowledge about food use is the same (100 %) for both sexes. On the other hand, levels of knowledges in other areas are unequal. Thus, 12.25 % of the women indicated the therapeutic use of the organs of the species and 7.31 % of the women indicated that the tail of the species is quite used in magic especially its tail. Buffalo is a source of animal protein for the local population (Fig. 4). Thus four parts and organs are reported by the populations namely flesh + skin (100 %), heart (30.43 %), fat (6.52 %) and brain (3.62 %). These four preferred parts in the human diet have levels of fidelity (NF): 33.33 % for flesh + skin, 10.14 % for heart, 2.17 % for fat and 1.21 % for brain.

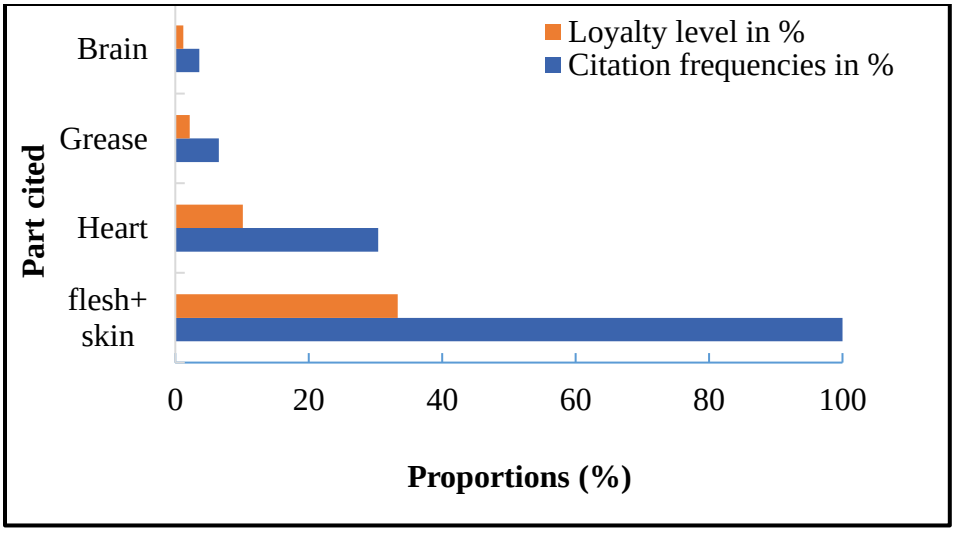

Figure 4: Body according to frequency of citation and preference in the diet.

Local residents populations have very precise knowledge about human diseases and the buffalo organs to be used to treat them (Table 2). Almost all parts and organs of the animal are

used for these purposes. The most used organ in this area is the leg bones with a citation frequency of 42.75 %. This organ is used in the treatment of most of the common pathologies in the area such as malaria, wounds, earache and bellyache. The tail is the second preferred organ (FC = 36.23 %), it is used against stomach aches, malaria, constipation, earaches, headaches, miscarriages, protection against witchcraft, unfaithfulness in women, bad spells, wounds, evil spirits, physical fatigue. The values of the consensus factor (IFC) according to the parts used are presented in Figure 5 and 6. The organ of the species most used is the leg bones (CFI = 4.8 %) and the organ least used is the droppings (CF = - 0.5 %).

Table 2 : Parts used in the pharmacopoeia and citation frequencies.

Parts used	Frequency of citation in %	Loyalty level in %	Pathology treated
flesh + skin	28,26	9,42	Diarrhea and eye aches
Tail	36,23	12,08	Folie
Heart	30,43	10,14	Heartache
Leg bones	42,75	14,25	Bone strengthening of weak small children and the elderly
Horn	21,01	7,00	Sexual impotence (aphrodisiac)
Poop	4,35	1,45	Ringworm
Urine	8,70	2,90	Gonococcie
Fat	13,04	4,35	Asthma, fever
Brain	14,49	4,83	Memory impairment
Hoof	19,57	6,52	Itchy skin
Bile	26,81	8,94	Stomach aches and hernia

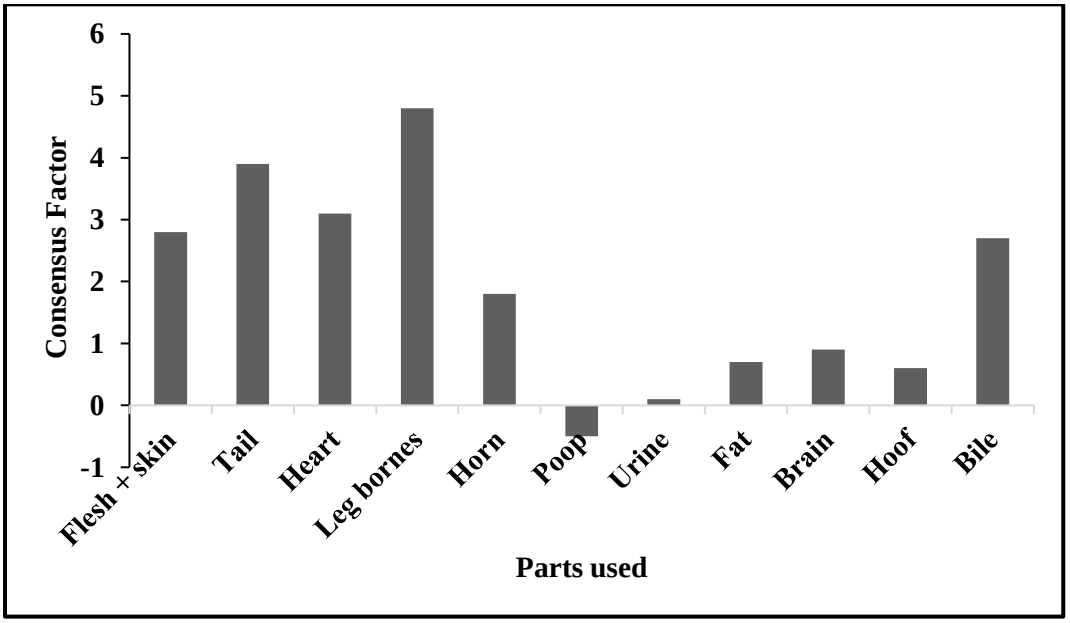

Figure 5 : Values of the Stakeholder Consensus Factor in African Medicine

Figure 6 : Horn and brain taken from the skull of a buffalo for the pharmacopoeia

The divine and mythical powers attributed to buffaloes justify the importance that the population of the study area gives them. Nearly all the organs of this animal are used by the socio-cultural groups in our sample. A review of Table 3 indicates the organs commonly used, their forms of use, citation frequencies and level of fidelity. A total of seven organs are used for the ten forms of use listed. The value of the consensus factor varies between 0.83 and 10.83 (Fig. 3). Thus, the most used organ is the tail with 10.83 as the consensus factor value. The tail comes in two categories: traditional medicine and mythology. The least used are the bile and the hoof, given the value of the consensus factor assigned to them.

Table 3 : Parts used in magic and quotation frequencies

Parts used	Frequency of citation in %	Loyalty level in %	Mystical use
Flesh + skin	30,43	10,14	Turning away bad looks at oneself
Tail	52,17	17,39	Conjure bad luck, fight against witchcraft
Heart	28,99	9,66	Banish fear in the face of any situation
Heart	14,49	4,83	To provide energy to the farmers for the realization of field works
Horn	28,26	9,42	Send bad spells back to the one who sends them, a reminder and a good luck charm
Hoof	11,59	3,86	Counter-attacking criminals, preparation of anti-ball talisman
Bile	8,70	2,90	Keeping a woman at home

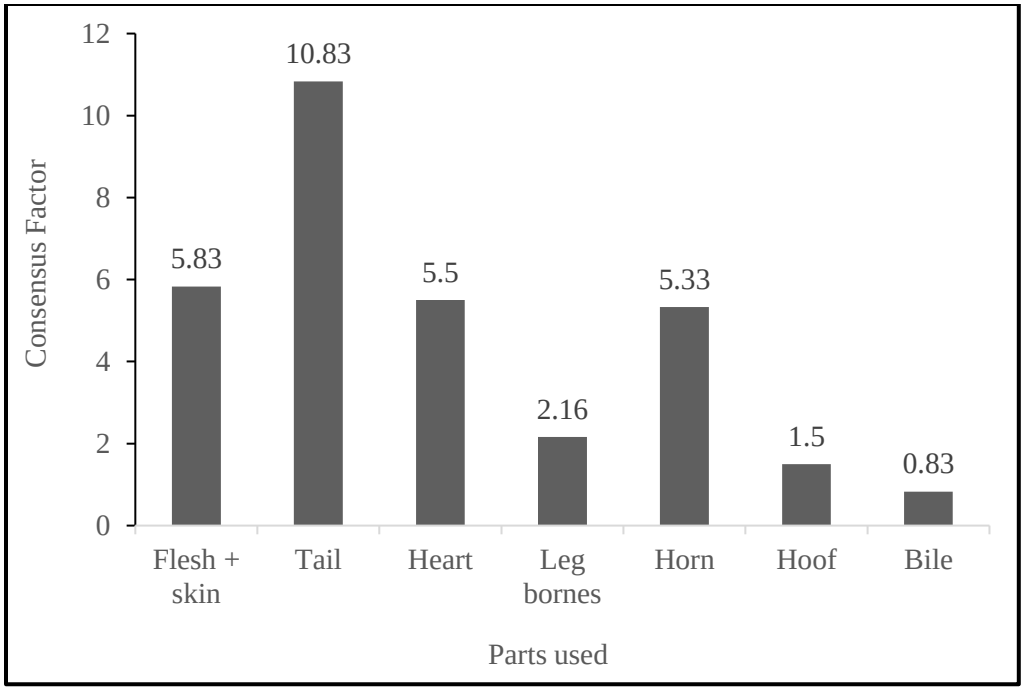

Figure 6 : Consensus Factor values of the different parts of the buffalo used for magic

4.4 Diversity and distribution of knowledge among respondents : Table 4 provides information on the values of diversity (UD) and equitability (UE) of buffalo use among all respondents. It shows that food and medicinal (pharmacopoeia) uses are the most mentioned by the different ethnic groups. Overall, the set of values for diversity of use for the different domains is low. For the pharmacopoeia, the diversity values are respectively 0.98; 0.79 and 0.69 for the Lobi, Koulango and Lohron. The equitability value is 1 for all categories of use in lobi. This reflects a homogeneity of the degree of knowledge of lobi in relation to all categories of use. For the pharmacopoeia use category (African medicine), the values obtained are 0.81 and 0.63 respectively for the Koulango and Lohron ethnic groups. Overall, these values are higher than 0.5 (EU > 0.5) and therefore, respondents from these different ethnic groups have a homogeneous degree of knowledge about the medicinal use of organs of the species. The magical use category of the species recorded an equitability value greater than 0.5 (EU > 0.5) among the Lobi (1) and Koulango (0.59) ethnic groups. The classification of the proportions of knowledge of use according to the ethnic groups reported by the respondents shows that the importance of these uses varies according to ethnicity. The comparison test of k sample carried out at the threshold $\alpha = 5\ \%$ shows that there is a significant difference for all use categories according to ethnicity (P-value = $0.0034 < \alpha = 0.05$). Table 5 shows the proportions in relation to knowledge of use among the ethnic groups surveyed. The proportion of knowledge of buffalo use varies from one ethnic group to another. The ethnic groups with high proportions of reported knowledge of medicinal and magical uses are Lohron, Malinke, Koulango and Lobi. The proportions are 56.5 %, 53.3 %, 39.1 %, and 35.3 %, respectively. These ethnic groups reported respectively a total of eleven (flesh + skin, tail, heart, leg bones, horn, poop, urine, fat, brain, hoof, bile), eight (flesh + skin, tail, heart, leg bones, horn, urine, fat, brain, hoof, bile) parts of the species for therapeutic purposes. It should be noted that these values are influenced by the number of respondents by ethnicity.

Table 4 : Diversity Index (UD) and Equitability Index (UE) values for different uses

Category of use	Food		Medical		Magic	
	UD	UE	UD	UE	UD	UE
Koulango	0,7	0,78	0,79	0,81	0,53	0,59
Lobi	0,9	1	0,98	1	0,9	1
Senoufo	0,5	0,56	-	-	-	-
Malinké	0,17	0,19	0,27	0,28	0,07	0,08
Yacouba	0,2	0,22	-	-	-	-
Toura	0,5	0,56	-	-	-	-
Lohron	0,48	0,53	0,62	0,63	0,29	0,32
Agni	0,5	0,56	-	-	-	-

Table 5: Classification of the proportions of knowledge of use according to ethnic groups

Ethnic Groups	Food (%)	Médicinal (%)	Magic (%)
Lobi	32,4 a	35,3 c	32,4 e
Malinké	33,3 a	53,3 c	13,3 ef
Koulango	34,8 a	39,1 c	26,1 e
Lohron	43,5 a	56,5 c	0 f
Senoufo	100 b	0 d	0 f
Yacouba	100 b	0 d	0 f
Toura	100 b	0 d	0 f
Agni	100 b	0 d	0 f

The proportions followed by the same letter are statistically identical to the threshold α = 5% according to the Mrascuilo procedure.

5 DISCUSSION

The ethnozoological characterization reveals that buffalo is used by local populations in three different ways, including dietary, medicinal and magical. These results are similar to those described by Azanlin (2007) according to whom the use of animals in the diet as the main source of protein by populations living in classified forests and wildlife reserves is very intense. Buffalo organs and products are mentioned as effective in the treatment of several ailments according to the results of our investigations. The same mentions were made by Agossou *et al.* (2018) on the same species. Several other researchers have investigated the use of the organs of several vertebrates in the food, medicinal and mystical categories. This is the case of Costa-Neto and Marques (2000); Yaokokoré-Beibro *et al.*, 2010; Natta *et al.*, 2014; Koue Bi *et al.*, 2017. Their results are very similar to ours in that these organs and products are widely used in Ivory Coast. In addition, the sacredness of the buffalo may justify its use for magical rituals. In Africa, wild animals are used in healings or rituals practiced by initiates. They thus provide them with numerous magical powers (Adeola, 1992; Adjakpa and Ogouvide, 1998). Consequently, the buffalo by its organs shows a great usefulness around the Comoé National Park. For most of our respondents, buffalo meat represents a vital element of their daily life as a source of protein. In this logic, several buffalo products are used, including skin, flesh, leg bones, dung, horns, urine, brain, and are used for medicinal and mystical purposes. This situation is not very good for the species, as it does not benefit from any particular protection provisions at the national level. The buffalo is currently pursuing a survival strategy in the study area and if nothing is done it will be extinct. Indeed, with regard to the ethnozoological

knowledge of the interviewees, the results reveal that men have more advanced ethnozoological knowledge than women. This variability of knowledge is also observed at the level of the different socio-cultural groups around the Comoé National Park. Thus, for the buffalo that is the subject of our study, the uses and knowledge vary from one socio-cultural group to another. Thus, the socio-cultural groups: Lobi and Koulango have a deeper knowledge and use than the other groups. This variation lies in the fact that these socio-cultural groups are much more involved in poaching on the one hand, and they are still mostly traditional practitioners on the other. The low value of user knowledge for the other groups is simply explained by the fact that the values obtained are influenced by the number of respondents by ethnicity. These socio-cultural groups are mostly engaged in livestock farming to the detriment of poaching, but also because of the nomadic nature of their activities. In the study area, based on the responses to the questionnaires, the informants say that the buffaloes killed are mainly for domestic consumption because the species is very difficult to find because of the downward trend in its population in village terroirs. It should be pointed out that the respondents are very suspicious because of the repression of the water and forestry agents, which is why no one wanted to give any information on the selling or buying price of buffalo meat.

6 CONCLUSION

The study showed that the buffaloes of the Comoé National Park play an important role in the daily lives of the neighboring populations. This species is used in various ways by local residents. It plays an important role in food, traditional medicine and magic. Several organs are used for food, medicine and magic. The results also reflect the perception of the populations on the species. Indeed, the latter believe that the buffalo is a mythical species. The species is said to be in clear regression, hence the importance of modeling the buffalo habitat in order to know the living environments that offer optimal living conditions.

7 ACKNOWLEDGEMENTS

We would like to thank the Ivorian Office of Parks and Reserves (OIPR), for allowing us to conduct research activities in the Comoe National Park. This work also benefited from the institutional and financial support of the African Center of Excellence (CEA-CCBAD). We would also like to thank all the OIPR agents of the Northeast Zone Direction and the residents of the Comoé National Park.

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