International Journal of Biodiversity and Conservation Vol. 4(14), pp. 548-559, November, 2012
Available online http://www.academicjournals.org/IJBC
DOI: 10.5897/IJBC11.221
ISSN 2141-243X ©2012 Academic Journals

Full Length Research Paper

Bushmeat and food security: Species preference of sundried bushmeat in communities in the Serengeti - Mara ecosystem, Tanzania

Angela Mwakatobe[1, 2]*, Eivin Røskaft[1] and Julius Nyahongo[3]

[1]Department of Biology, Norwegian University of Science and Technology, NO-7491 Trondheim, Norway.
[2]Tanzania Wildlife Research Institute, P. O. Box 661, Arusha, Tanzania.
[3]Department of Biological Sciences, University of Dodoma, P. O. Box 259, Dodoma, Tanzania.

Accepted 2 March, 2012

Bushmeat is reported to be an important source of animal protein for people's diet and income to rural communities around protected areas. Data for bushmeat preferences among local people bordering Serengeti National Park, Northern Tanzania, were collected through various techniques, including a key informant survey, group discussions, meat taste experiments and questionnaires. Multiple responses were used to test for preferences on different processing methods of sundried bushmeat and reasons for the preference. Independent variables as chewability, smell, taste and appearance were used to test what factors that might influence species preference of sundried bushmeat. The results of this study indicate that sundried bushmeat was most frequently preferred by respondents, followed by boiled and the least preferred meat was smoked bushmeat. Beef was the most preferred sundried meat, followed by sundried impala, and then sundried wildebeest meat. Sundried zebra meat was least preferred among all four of tested meat samples. The distance of the village (in km) from SNP and type of sample specimen tested contributed statistically significantly to explain the variation in bushmeat preferences. We recommend further studies on quality analysis on different processed meat (fresh boiled, sundried and smoked) to check for different nutrients. Finally, based on our results on preference on individual species of sundried meat, sundried beef meat was mostly preferred; therefore we do recommend that communities around protected areas who are livestock keepers should be encouraged to process sundried beef meat during good environmental conditions which can be used as reserve in times of food shortage and periods of famine.

Key words: Sun-dried bushmeat, Serengeti ecosystem, preference rank, processing methods.

INTRODUCTION

Wildlife is a critically important resource, meeting the food and livelihood requirements of human communities in many biodiversity – rich areas of the world (Rao and McGowan, 2002). Bushmeat is reported to be an important source of animal protein for people's diet (Asibey and Child, 1990; FAO, 1997; FAO, 2003; Hofer et al., 1996; Nyahongo, 2007; Robinson and Bennett, 2000), income generation (Barnett, 2000; Bowen-Jones and Pendry, 1999; Geist, 1988; Juste et al., 1995; Kaltenborn et al., 2005; King, 1994; Loibooki et al., 2002; Wilkie and Godoy, 2001), and cultural needs (Nielsen, 2006; Robinson and Bennett, 2000) for local communities in areas surrounding protected areas in many African counties. Some studies have suggested that the contribution of bushmeat may be an important factor in poverty reduction in rural areas (Hoyt, 2004; Loibooki et al., 2002; Nyahongo et al., 2005; Wilkie et al., 2005). The sale of bushmeat can provide a large proportion of incomes in rural areas. A study in rural Gabon reported for example

*Corresponding author. E-mail: a_mwakatobe_99@yahoo.com. Tel: +255 754 817657. Fax: +255 (027) 2548240.

that hunting accounted for 15 to 72% of household incomes, with the proportion increasing for more remote communities (Starkey, 2004). Bushmeat is cheaper than domestic meat in rural areas, so it is particularly accessible to poor households (TRAFFIC, 1998). In addition to being a highly preferred food item in many areas of Africa, wild animal foods are life-saving reserves in times of food shortage and hunger (FAO, 1997).

Hunters have a variety of methods for the extraction of bushmeat from the wild which include trapping, snaring, netting, use of dogs and shooting (Bowen - Jones et al., 2003; Fa et al., 2002; Noss, 1998; Wilkie and Godoy, 2001). Bushmeat in Africa include ungulates such as forest antelopes, known as duikers (Noss, 2000; Robinson and Bennett, 2000); reptiles and large bodied birds (Hennessey, 1995); smaller bodied mammals, such as porcupines (*Erethizon dorsatum*) and cane rats (*Thryonomys swinderianus*) (Juste et al., 1995); and primates (Khatun, 2010). In West and Central Africa, bushmeat primates include monkeys and chimpanzees (*Pan troglodytes*) (Willcox and Nambu, 2007), Yellow baboons (*Papio cynocephalus*) and Black and white colobus monkey (*Colobus quereza*) (Chapman et al., 2006; FitzGibbon et al., 1996) and endangered mountain gorillas (*Gorilla beringei beringei*) (Grevengoed, 2001). Primates in West and Central Africa are reported to account for between a tenth and a quarter of all bushmeat harvested (Bowen-Jones and Pendry, 1999).

In Tanzania, local communities surrounding protected areas including the Western Serengeti, like many other poor African communities, are relying on bushmeat hunting as important activities for food security and income generation (Holmern et al., 2004; Kaltenborn et al., 2005; Loibooki et al., 2002). Traders may earn between 300 and 500 USD per months and about 66 % of the human population in Tanzania prefers bushmeat protein (Damalu, 2011). In the Serengeti Mara Ecosystem the hunters use dried meat for home consumption, sale to generate income, or bartering with other commodities (Hofer et al., 2000; Kaltenborn et al., 2005; Kideghesho et al., 2007; Loibooki et al., 2002; Mfunda and Røskaft, 2010). About 82% of the communities around Serengeti National Park consume bushmmeat and 32% are engaged in bushmeat hunting (Loibooki et al., 2002). Bushmeat is cheaper than livestock meat and therefore consumed more frequently than livestock meat (Ndibalema and Songorwa, 2007). Also, in other ecosystems like Katavi (Andimile and Eves, 2009) and Udzungwa Mountainous (Nielsen, 2006; Rovero et al., 2010) bushmeat is reported to play a significant role in the livelihood of the rural communities surrounding protected areas.

Generally, many species of wild animals are utilized for bushmeat and species selection within particular areas depends largely on location, habitat type and availability of species in the local markets (Barnett, 2000; Hoyt, 2004). Sun-dried bushmeat is known for its distinct taste, aroma, and nutritive value, and it is generally safe for consumption because it retains little or no fat as it undergoes the heating process (FAO, 1997). According to Nyahongo (2007), in Western Serengeti, communities living far away from SNP preferred beef, while people from villages close to national park boundary prefer topi and those in the intermediate villages prefer impala, which might be linked to experience and accessibility. Bushmeat trade is driven by cultural proclivity. It is traditionally cuisine, and familiarity perpetuates the preference for it (Wilkie et al., 2006). Bushmeat is reported to provide trophies for cultural artefacts and medicinal values (Kaltenborn et al., 2005; Kideghesho, 2008; Mockrin et al., 2005; Robinson and Bennett, 2000; Wilkie and Carpenter, 1999; Wilkie et al., 2005) and it contains certain properties that are not found in domesticated animals (Peggy et al., 2009). They claim that ingesting bushmeat, especially primate bushmeat, makes one feel stronger and more vigorous (Dresden, 2004).

There is evidence that different tribes prefer certain bushmeat species (Fa et al., 2002; Mfunda and Røskaft, 2010; Ndibalema and Songorwa, 2007). Its consumption in urban areas connotes devoted social economic status (Bowen - Jones et al., 2003; Wilkie and Carpenter, 1999). One such eating establishment in Nairobi is descriptively named “The Carnival” (Dresden, 2004). This commodity trade chain of bushmeat extends beyond Africa to Europe and the United States (Brown, 2006). Understanding why people eat bushmeat and the role that bushmeat consumption plays in household nutrition and income, is critical to developing politically acceptable ways to manage wildlife hunting and trading and halt unsustainable exploitation (Schenck et al., 2006). Also, understanding on the species preference on bushmeat is vital towards sustainable utilization of wildlife resources.

The aim of this study was to investigate the bushmeat preference in villages along a gradient of distance from the Serengeti National Park. We hypothesize that sun-dried bushmeat is preferred over boiled fresh bushmeat because this is the most common and most sustainable method of bushmeat processing. Furthermore, we hypothesized that sundried bushmeat was more preferred than sundried beef meat (in terms of smell, taste chewability and appearance) as sundried bushmeat is commonly used in an area.

MATERIALS AND METHODS

Study area

The Serengeti Ecosystem covers an area of 25,000 km^2 on the border of Tanzania and Kenya (Figure 1), and is defined by the movement of wildebeest (Homewood et al., 2001; Nelson, 2009). The eastern boundary is formed by the crater highlands and the rift valley. An arm called the Western Corridor stretches west to Lake Victoria. The northern boundary is formed by the Isuria Escarpments and Loita Plains in Kenya (Marealle et al., 2010). Serengeti Ecosystem is situated between latitudes 1° 28’ and 3° 17’ S and longitudes 33° 50’ and 35° 20’ E (Kideghesho, 2006). In the Western Corridor of the Serengeti National Park, illegal hunting

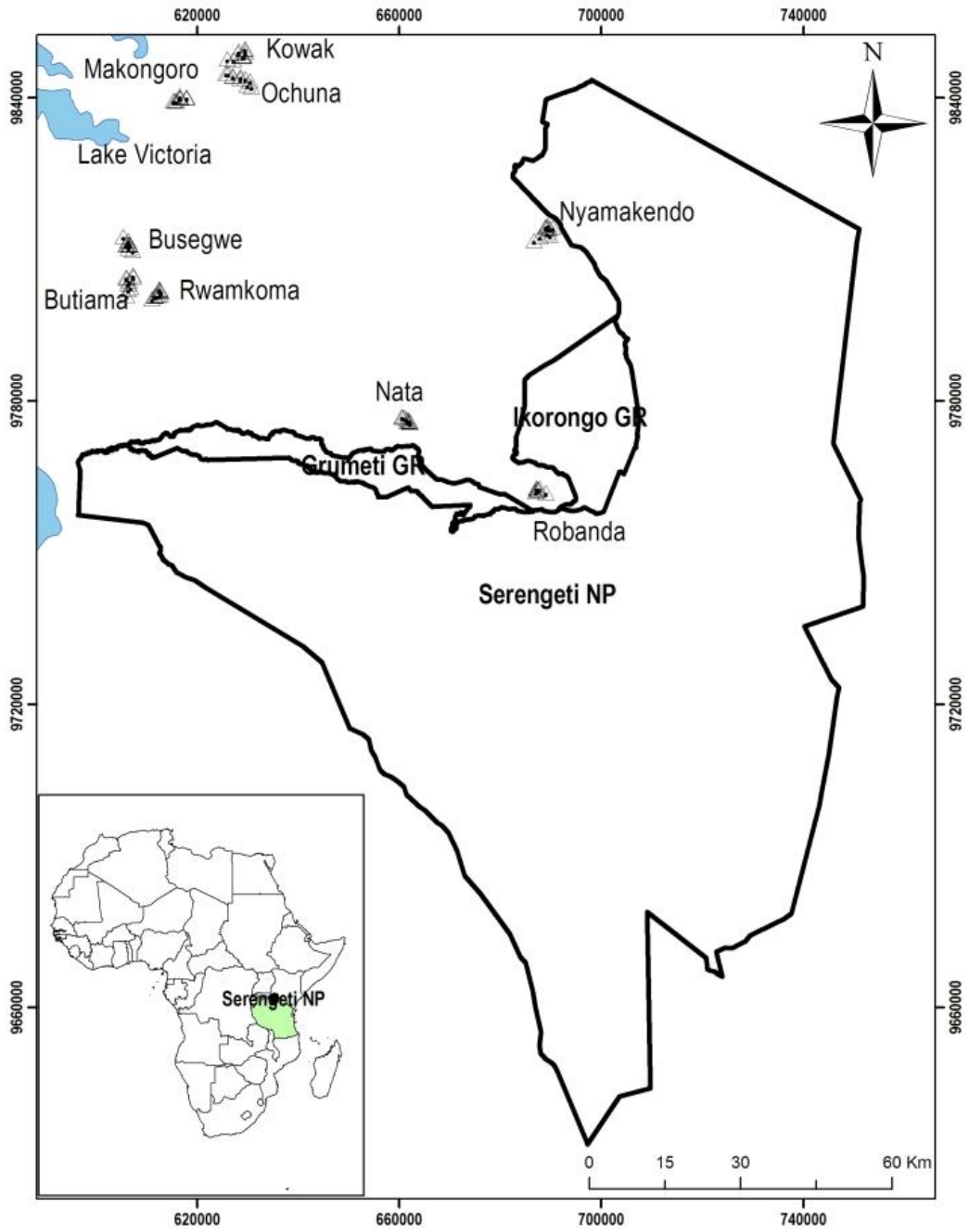

Figure 1. Map of study area showing Serengeti National Park, Grumeti and Ikorongo Game Reserves, Lake Victoria and the surveyed villages (Robanda, Nyamakendo, Nattambisso ,Butiama, Busegwe, Rwamkoma,Ochuna, Makongos and Kowak).

has been highest around densely populated areas (Holmern et al., 2002; Loibooki et al., 2002). Local communities in Serengeti are not allowed to hunt and there is no open market for wild meat (Ndibalema and Songorwa, 2007). But IUCN (1998), reported that the utilization of bushmeat was found to represent the largest economic value of wildlife, far exceeding legalized hunting, tourism or trophy values in Tanzania. Increased human populations, expansion of agricultural areas, illegal hunting and excessive trophy hunting have been identified as major threats to sustainable conservation (Bohne, 2008). The human population in the area is estimated to be over two million (URT, 2002a). The area is diverse in terms of ethnicity with over 20 tribes, the major tribes being Ikoma, Sukuma, Kurya, Ikizu, Natta, Isenye, Zanaki, Zizaki, Ngoreme, Luo, Taturu and Jita (URT, 2002b). The major livelihood strategies pursued by these tribes are cultivation (largely maize, cassava, millet and sorghum for food and cotton for cash) and livestock husbandry (cattle, goats and sheep). Although most people are subsistence farmers, there are some ethnic differences

in economic activities that include fishing, livestock rearing, game meat hunting, and trading (Loibooki, 1997; Loibooki et al., 2002)

The Western part of Serengeti - the focus of this study - is ecologically significant as a buffer zone for Serengeti National Park (SNP) and a corridor for wildlife species migrating between Serengeti and Maasai Mara in Kenya. These species include some 1.4 million wildebeest, 0.2 million zebra, and 0.7 million Thompson's gazelle (Norton-Griffiths, 1995). The seasonal availability of herbivores due to animal migration affects bushmeat prices that are almost halved when the wildebeest migration arrives in village areas (Holmern et al., 2002). Much of the meat is then preserved in a form of pieces (swahili: 'kimoro'- sundried bushmeat) that permits storage and trading in markets locally or far away from the sources (Kaltenborn et al., 2005). In the Serengeti ecosystem the common large herbivore species usually utilized for bushmeat include wildebeest (*Connochaetes taurinus*), Cape buffalo (*Syncerus caffer*), impala (*Aepyceros melampus*), zebra (*Equus burchelli*), eland (*Tragelaphus orxy*), Thomson gazelle (*Gazella thomsonii*), Grant gazelle (*G. granti*) and giraffe (*Giraffa camelopardalis*). Other species include topi (*Damaliscus korrigum*), kongoni (*Alcelaphus buselaphus*), warthog (*Phacochoerus aethiopicus*), waterbuck (*Kobus ellipsiprymnus*), bush buck (*Tragelaphus scriptus*) and ostrich (*Struthio camelus*) (Campbell and Hofer, 1995; Hofer et al., 1996; Holmern et al., 2004; Mduma et al., 1998). An estimates of the number of hunted wildebeest vary annually from 40,000 (Mduma, 1996) to 118,000 animals (Campbell and Hofer, 1995).

Data collection techniques

The data were collected throughout the year from January 2010 to January, 2011. Sampling included nine selected villages along a gradient of distance from the park. The selection was done in such a way that three villages were located within 10 km distance from the protected area (Robanda, Nyamakendo and Nattambisso - closest) and the other six villages, three for each distance within 40 km (Butiama, Busegwe and Rwamkoma - intermediate) and 80 km from the protected area (Ochuna, Makongos and Kowak – far away). Data for the bushmeat preferences were collected through different techniques including; key informant survey, group discussions, meat taste experiments and questionnaires. The questionnaire interviews were conducted from January to December, 2010 and covered a total of 459 households who were randomly selected from the village and sub-village registers for interview. We interviewed household heads or their wives or resident adults (≥ 18 years old). The villages and sub-villages were picked based on a random-systematic selection. In terms of gender 36.2% of the interviewed respondents were females and 63.8% were males for a questionnaire survey and 46.7% of the respondents were females and 53.3% were males for meat test experiments, reflecting a gender consideration but not balanced. The data were collected by the main researcher, a research assistant, and field assistants conversant with the village and households, languages, and culture. The questions were both close-ended and open-ended aimed at extracting the respondent's opinion in an open minded atmosphere. The questionnaire addressed socio-demographic variables, bushmeat utilization, type of processed meat preferred mostly (fresh boiled, sundried and smoky dried) and wild animal species preferred mostly for the bushmeat in the area. Also, wild animal species preferred mostly from the list of four animals (topi, wildebeest, impala and zebra) based on different processing methods.. Meat taste experiments were done in January, 2011 in three villages randomly selected from the nine above described villages (Mwakatobe et al., submitted). Meat from three wild animal species (wildebeest, impala and zebra) and cattle (used as a control) were first sundried, then chopped into approximately the same sized small pieces and cooked using the same recipe for subsequent human taste. Meat taste experiment was done by using sundried meat only. The selection of wild animals species used in the questionnaire and meat taste experiment based on the list of mostly preferred wild animals for bushmeat in an area reported by different authors and animals which were accessible through quota for legal hunting (Campbell and Hofer, 1995; Hofer et al., 1996; Holmern et al., 2004; Mduma et al., 1998). Beef meat was used as the commonly consumed domestic alternative protein source (Nyahongo, 2007). A number of people of different age, sex and tribes were invited to taste the meat. In case of tribes, recorded tribes were grouped into two; hunter tribes (Ikoma and Zanaki) and non-hunters tribes (Sukuma, Nyaturu, Luo, Kurya, Jita) for analysis. Hunter tribes can be defined as communities that rely primarily on hunting wild animals (bushmeat) for their dietary protein. Each respondent was asked to rank by using number 1 to 4 his/her preference on whose meat was tasted (1) Prefer most, (2) Prefer (3) Moderately prefer and (4) Do not prefer. Also, animal species tested were evaluated by using hedonic factors namely appearance, smell, taste, marbling and chewability to find out if might have impacts on sundried meat preferences. We recorded the responses from the taste persons in data sheets for subsequent analyses. In the meat taste experiments, a total of 225 persons were randomly given pieces of sundried and cooked sundried bushmeat of wildebeest, impala, zebra and beef to taste and identify the species which resulted in 900 tested cases (Mwakatobe et al., submitted).

Statistical analyses

Statistical analyses were conducted using Statistical Package for Social Sciences (SPSS, 17). Multiple responses were used to test for preferences of local communities around protected areas on different processing methods of sundried bushmeat and reasons for the preference. Chi-square tests were applied to tests for the differences in the independent variables: chewability, smell, taste, marbling and appearance if might influences species preference of sundried bushmeat. Also, correlation coefficients were used to test the relationship between the same independent variables.

RESULTS

Bushmeat preference based on processing methods

Generally, the majority of respondents (84.8%, n = 459) claimed to have tasted bushmeat before and were aware of bushmeat (86.9%, n = 459). Sundried bushmeat was most frequently preferred by the respondents (49.5%, n = 459), followed by boiled (37.2%, n = 459), and smoked bushmeat (13.3%, n = 459) - (Table 1). The main reason for the preference of sundried bushmeat according to respondents was good taste, easy accessibility, chewability, good smell, not oily, and easy to cook (Table 2).

Preference on individual species of sundried meat

Respondents mostly showed a general tendency of preference for sundried beef meat over other sundried bushmeat in terms of chewability (Pearson Chi-Square; $\chi^2 = 64.4$, df = 12, n = 897, P < 0.001, Table 3), smell (Pearson Chi-Square; $\chi^2 = 98.6$, df = 12, n = 899, P < 0.001, Table3), and taste (Pearson Chi-Square; $\chi^2 =$

Table 1. Percentages of various processing methods of bushmeat the questionnaire respondent's preferred (only 366 out of 459 respondents).

Village	Processing methods of bushmeat			Total
	N (%)			
	Fresh	Sundried	Smoked meat	
Robanda (within 10 km from PA)	29 (64.4)	13 (28.9)	3 (6.7)	45 100
Nattambisso (within 10 km from PA)	21 (42.9)	28 (57.1)	0 (0)	49 (100)
Nyamakendo (within 10 km from PA)	9 (27.3)	19 (57.6)	5 (15.1)	33 (100)
Butiama (within 40 km from PA)	25 (73.5)	6 (17.7)	3 (8.8)	34 (100)
Busegwe (within 40 km from PA)	11 (33.3)	18 (54.6)	4 (12.1)	33 (100)
Rwamkoma (within 40 km from PA)	9 (25.0)	21 (58.3)	6 (16.7)	36 (100)
Makongos (within 80 km from PA)	14 (34.2)	16 (39.0)	11 (26.8)	41 (100)
Kowak (within 80 km from PA)	15 (31.9)	20 (42.6)	12 (25.5)	47 (100)
Ochuna (within 80 km from PA)	3 (6.3)	40 (83.3)	5 (10.4)	48 (100)
Total	**136 (37.2)**	**181 (49.5)**	**49 (13.3)**	**366 (100)**

Table 2. Reasons for preferred sundried bushmeat process.

Reasons for preference	N	% total	Ranking
Good taste	443	65.1	1
Easy accessibility	130	19.1	2
Chewability	64	9.4	3
Good smell	18	2.6	4
Not oily	17	2.5	5
Easy to cook	8	1.2	6
Total	**680**	**100**	

The overall number of respondent exceeded 459 the total number of respondents due to multiple responses.

Table 3. Species preferences of sundried meat based on sensory evaluation.

Hedonic taste factor	Species of Sundried meat	Ranking of preferences of sundried meat				
		N (%)				
		Prefer very much	Prefer	Moderately prefer	Do not prefer	Total
Chewability	Wildebeest	75 (34.4)	101 (46.3)	31 (14.2)	11 (5.0)	218 (100)
	Impala	90 (38.7)	103 (44.4)	34 (14.7)	5 (2.2)	232 (100)
	Zebra	63 (33.5)	86 (45.7)	34 (18.1)	5 (2.7)	188 (100)
	Beef	91 (41.9)	101 (46.5)	19 (8.8)	6 (2.8)	217 (100)
Smell	Wildebeest	91 (41.0)	91 (41.0)	36 (16.2)	4 (1.8)	222 (100)
	Impala	99 (42.6)	96 (41.6)	24 (10.8)	12 (5.2)	231 (100)
	Zebra	66 (31.9)	83 (40.1)	31 (15)	27 (13.0)	207 (100)
	Beef	115 (52.8)	86 (39.4)	13 (6.0)	4 (1.8)	218 (100)
Taste	Wildebeest	87 (39)	105 (47.1)	25 (11.2)	6 (2.7)	223 (100)
	Impala	93 (40.1)	104 (44.8)	29 (12.5)	6 (2.6)	232 (100)
	Zebra	57 (27.5)	95 (45.9)	36 (17.4)	19 (9.2)	207 (100)
	Beef	108 (49.5)	92 (42.2)	17 (7.8)	1 (0.5)	218 (100)

Table 3. Contd.

Appearance	Wildebeest	98 (46.7)	80 (38.1)	24 (11.4)	8 (3.8)	210 (100)
	Impala	113 (51.1)	74 (33.5)	24 (10.9)	10 (4.5)	221 (100)
	Zebra	78 (39.4)	65 (33.0)	35 (17.7)	20 (10.1)	198 (100)
	Beef	107 (51.2)	84 (40.2(	14 (6.7)	4 (1.9)	209 (100)

The overall number of respondent exceeded 459 the total number of respondents due to multiple responses.

92.2, df = 12, n = 900, P < 0.001, Table 3). However, appearance (Pearson Chi-Square; χ^2 = 44.7, df = 12, n = 897, P < 0.001, Table 3) was different, here beef ranked second after sundried impala meat. All over, beef was the most preferred sundried meat, followed by sundried impala and then sundried wildebeest meat. Sundried zebra meat was least preferred among all four sample of meats tested.

The correlation coefficients between hedonic evaluation factors (appearance, smell, taste, marbling and chewability) of the panel who tested sundried bushmeat were highly significant (all P < 0.01; Table 4). Thus, the same person tended to prefer the different taste methods with same frequencies. In the further analyses, therefore, we averaged preferences on hedonic evaluation factors tested.

There was a statistically significant difference in how respondents liked different bushmeat by their mean score beef being the most preferred (beef, Mean = 1.7, ± SD = 0.536; impala, Mean = 1.8, ± SD = 0.644; wildebeest; Mean = 1.9, ± SD = 0.632; and zebra, Mean = 2.1, ± SD = 0.752) (F = 15.1, P < 0.001).

When questionnaire respondents were asked on meat preferences of four animal species (Topi, wildebeest, impala and zebra) processed differently from three distances categories meat preferences differed significantly (sundried meat - Pearson Chi-square: χ^2 = 1.1, P < 0.001; boiled meat - Pearson Chi-square: χ^2 = 1.1, P < 0.001; smoky meat - Pearson Chi-square: χ^2 = 62.2, P < 0.001; Table 5). Sundried bushmeat of wildebeest was mostly preferred in close and intermediate village categories while sundried bushmeat of impala was mostly preferred in far away villages. In case of boiled and smoky bushmeat, wildebeest meat was mostly preferred in closes villages only and impala bushmeat was mostly preferred in intermediate and away villages. Also, when asked which kind of sundried bushmeat generally they preferred they responded that they mostly preferred sundried bushmeat of wildebeest followed by impala, zebra and rabbit (*Syvilagus palustris)*. Other preferred sundried bushmeat were buffalo, klipspringer (*Oreotragus oreotragus)*, eland, hippopotamus (*Hippopotamus amphibius*), hartebeest *(Alcelaphus buselaphus),* elephant *(Loxodanta africana)* and topi (Table 6).

Factors affecting preference of sundried meat

There was a significant (F = 14.8, P < 0.001) difference in average mean scores of bushmeat preference between hunter tribes (Mean = 1.9, ± SD = 0. 627) and non- hunter tribes (Mean = 1.8, ± SD = 0.696), as well as the distance of the villages from SNP (F = 15.9, P < 0.001); Busegwe (Mean = 2.0, ± SD = 0.639), Robanda (Mean = 1.9, ± SD = 0.587) and Ochuna (Mean = 1.7, ± SD = 0.714). Other demographic variables as gender and age classes did not influence the preference significantly (males; Mean = 1.9, ± SD = 0.653; females; Mean = 1.8 ± SD = 0.665; F = 3.2, p =

Table 4. Correlation coefficients (in percentages) between hedonic evaluation factors at Spearman's rho tests; (all P < 0.01).

Hedonic evaluation factor	Appearance	Smell	Taste	Marbling	Chewability
	Correlation coefficient (n)				
Appearance	1.000 (838)	0.637 (836)	0.567 (838)	0.393 (837)	0.478 (833)
Smell	- -	1.000 (878)	0.638 (878)	0.401 (873)	0.444 (870)
Taste	- -	- -	1.000 (880)	0.442 (875)	0.58.2 (872)
Marbling	- -	- -	- -	1.000 (875)	0.438 (867)
Chewability	- -	- -	- -	- -	1.000 (872)

Table 5. Meat preferences of four animal species processed differently by the members from three distances categories.

Animal species / Village	Topi	Wildebeest	Impala	Zebra	Total	Pearson Chi- Square
	N (%)					
Closest villages	31 (25.2)	40 (32.5)	18 (14.6)	34 (27.6)	123 (100)	
Intermediate villages	3 (3.0)	43 (43.4)	41 (41.4)	12 (12.5)	99 (100)	$\chi^2 = 1.1$, $p < 0.001$
Far away villages	8 (6.0)	40 (26.9)	53 (39.5)	34 (25.5)	135 (100)	
Closest villages	37 (28.9)	39 (30.5)	37 (28.9)	15 (11.7)	128 (100)	
Intermediate villages	4 (4.1)	29 (29.9)	52 (53.9)	12 (12.4)	97 (100)	$\chi^2 = 1.1$, $p < 0.001$
Far away villages	6 (4.5)	43 (32.1)	62 (46.3)	23 (17.2)	134 (100)	
Closest villages	28 (25)	33 (29.5)	32 (28.6)	19 (17)	112 (100)	
Intermediate villages	8 (9.2)	27 (31.0)	40 (46)	12 (14.3)	87 (100)	$\chi^2 = 62.2$, $p < 0.001$
Far away villages	10 (7.4)	40 (29.4)	61 (45.1)	25 (18.4)	136 (100)	

Table 6. Ranking of species by respondent based on preference.

Most preferred species' sundried meat	N	%	Ranking
Wildebeest *(Connochaetus taurinus)*	228	26.6	1
Impala *(Aepyceros melampus)*	205	23.9	2
Zebra *(Equus burchelli)*	111	13.0	3
Rabbit (*Syvilagus palustris)*	79	9.2	4
Buffalo *(Syncerus caffer)*	73	8.5	5
Topi (*Damaliscus korrigum)*	55	6.4	6
Klipsringer *(Oreotragus oreotragus)*	42	4.9	7
Eland *(Taurotragus oryx)*	22	2.5	8
Hippopotamus (*Hippopotamus amphibius*)	20	2.3	9
Hartebeest *(Alcelaphus buselaphus)*	17	2.0	10
Elephant *(Loxodanta africana)*	4	0.5	11
Total	**856**	**100**	

The overall number of respondent exceeded 459 the total number of respondents because of multiple responses.

Table 7. Linear regression Coefficients with the general taste of sundried meat as dependent variable with Village, sample specimen, gender, age class and tribes as independent variables.

Model		Unstandardized coefficient		Standardized coefficients	t	P
		B	Std. error	Beta		
1	(Constant)	2.288	.108		21.104	.000
	Village	-.156	.040	-.193	-3.884	.000
	Sample specimen	-.040	.020	-.068	-2.048	.041
	Gender	.015	.048	.012	.321	.748
	Age class	-.016	.024	-.022	-.666	.505
	Tribe groups	.006	.066	.004	.091	.927

0.072; age classes; < 20 years; Mean = 1.9, ± SD = 0.618; 21 – 40 years; Mean = 1.9, ± SD 0 =713; 41 -60 years Mean = 1.9, ± SD = 0.652, and > 60 years; Mean = 1.8, ± SD = 0.580; F = 0.4, P = 0.737).

A linear regression coefficient analysis indicated that both the distance of the village from SNP (t = -3.884, p < 0.001) and type of sample specimen (t = -2.048, p = 0.041) tested as independent variables, contributed statistically significantly to the amount of variation in bushmeat preferences. However, other independent variables as gender, age class and tribe (Table 7) did not contribute significantly to the variation in average bush meat preference (Table 7).

In case of preferences on the sample specimen of sundried meat (type of sundried meat tested) the same trend was observed as above. There was a significant (F = 16.3, P < 0.001) amount of variation in average mean scores between hunter tribes (Mean = 2.0, ± SD = 0. 597) and non- hunter tribes (Mean = 1.7, ± SD = 0.633); as well as the distance of the villages from SNP (Busegwe; Mean = 2.1, ± SD = 0.633; Robanda; Mean = 1.9, ± SD = 0.538, and Ochuna; Mean = 1.7, ± SD = 0.638; F = 11.1, p < 0.001). The differences between demographic variables such as gender and age classes were very small and insignificant (males, Mean = 2.9, ± SD = 0.619; female, Mean = 1.8, ± SD = 0.634; F = 5.0, P = 0.260; age classes; < 20 years; Mean = 1.9, ± SD = 0.0.625, 21 – 40 years; Mean = 1.9, ± SD = 0.705; 41 -60 years Mean = 1.9, ± SD = 0.576, and > 60 years ; Mean = 1.7, ± SD = 0.424;. F = 0.596, P = 0.618).

DISCUSSION

Preference of bushmeat based on processing methods

Our results suggest that sundried bushmeat was most frequently preferred by respondents followed by boiled bushmeat while smoked bushmeat was the least preferred type of bushmeat. The reasons for the preference of sundried bushmeat are in line with the findings of other authors. It is cheaper than domestic meat in rural areas, so it is particularly accessible to poor households (Loibooki, 1997). It is .used as life-saving reserves in times of food shortage and hunger (FAO, 1997; Hofer et al., 2000; Kaltenborn et al., 2005;

Kideghesho et al., 2007; Loibooki et al., 2002; Mfunda and Røskaft, 2010). Also, hunters prefer the sundried meat in the bush due to the fact that in the tropical countries sun is usually available. Dried meat can be easier transported from protected areas which are usually far from the villages and accessible in the distant villages. On other hand boiled or smoked meat requires the hunters to take the fresh meat to villages which is costly and will not go far before the meat rot. Finally, it has distinct taste and aroma, and it retains little or no fat (FAO, 1997). According to Holmern et al. (2002), its' availability depends mainly on animal migrations, which necessitate preservation of enough meat for sale and for consumption in times of hunger. Sundried bushmeat can be stored and traded in the local markets or far away from the sources (Kaltenborn et al., 2005).

Preference on individual species of sundried meat

Our overall results show that respondents preferred sundried beef meat over different sundried bushmeat in terms of chewability, smell, and taste. All over, beef was the most preferred sundried meat, followed by sundried impala and then sundried wildebeest meat. Sundried zebra meat was least preferred among all four samples of meat tested. This result is slightly similar to that reported by Nyahongo (2007), overall preference rank in the two-species comparisons was beef, closely followed by topi and impala. Zebra and wildebeest were the least preferred species. This indicates that sundried beef meat has a highly preferred quality in rural communities but accessibility might be a limiting factor. Therefore, our results indicate that local communities have long term experience with beef as it is commonly used as alternative source of protein during the non-hunting season. Also, results from questionnaire respondents indicated that meat preferences of four animal species (Topi, wildebeest, impala and zebra) processed differently from three distances categories meat preferences differed significantly. This indicated that bushmeat preferences of animal species depend on availability of an animal species as sundried, boiled and smoky impala bushmeat was mostly preferred in far way villages. This result agreed with the report of other authors that species of wild animals utilized for bushmeat within particular areas depends largely on availability of species in the local markets (Barnett, 2000; Hoyt, 2004).

Factors affecting preference on sundried meat

The present results show that in the Western Serengeti the distance of the village from SNP and the type of sample specimen were significant contributors towards bushmeat preferences. Similar findings have been previously reported elsewhere by other scientists (Barnett, 2000; Hoyt, 2004; Nyahongo, 2007). Species of wild animals utilized for bushmeat and species selection within particular areas depends largely on location, habitat type and availability of species in the local markets. According to Holmern et al. (2002), bushmeat availability depends mainly on animal migrations, which necessitate preservation of enough meat for sale and for consumption in times of hunger. This indicates that availability of animal species in the market is the major factor for bushmeat species preference. Independent variables as gender, age class and tribe did not contribute significantly to the variation in average bush meat preference. Our results are contrary with findings of other authors who have found that preferences on bushmeat species also varies with differences in tribes' cultures (Fa et al., 2002; Mfunda and Røskaft, 2010; Ndibalema and Songorwa, 2007); and gender (Nyahongo, 2007).

Conclusion

(i) Sundried bushmeat was most frequently preferred by respondents, followed by boiled and the least preferred meat was smoked bushmeat.
(ii) Beef was the most preferred sundried meat, followed by sundried impala and then sundried wildebeest meat.
Sundried zebra meat was least preferred among all four sample of meat tested.
(iii) The distance of the village from SNP and type of sample specimen tested contributed statistically significantly to bushmeat preferences.

RECOMMENDATIONS

We recommend further studies on quality analysis on different processed meat (fresh boiled, sundried and smoked) to check for different nutrients. Also, based on above results on preference on individual species of sundried meat, sundried beef meat was mostly preferred; therefore we do recommend that communities around protected areas who are livestock keepers should be encouraged to process sundried beef meat during good environmental conditions which can be used as reserve in times of food shortage and hunger period. This will help to reduce pressure on illegal bushmeat hunting hence sustainable utilization of wildlife resources. Also, conservation awareness campaigns should not concentrate only to villages which are close to protected areas as far villages serves as market place for bushmeat and they utilize locally available animal species illegally.

ACKNOWLEDGEMENTS

We would like to thank Wildlife Division (WD), Ministry of Natural Resources and Tourism, Tanzania for providing

us with hunting permits. In addition, we would like to thank the Tanzania Wildlife Research Institute (TAWIRI) for granting us permission to conduct this research and together with NTNU for funding the data collection. We are also grateful to Tanzania National Parks (TANAPA) for allowing us to stay and work in Serengeti National Park. Finally, we thank the district and village leaders and our field assistants, all of whom contributed to the completion of this important study.

REFERENCES

Andimile M, Eves HE (2009). BEAN bushmeat fact sheat Katavi National Park field assessment, Tanzania. URL www.bushmeatnetwork.org.

Asibey EOA, Child GS (1990). Wildlife Management for rural development in Sub-Saharan Africa. Unasylva 41.

Barnett R (2000). Food for thought: the utilization of wild meat in eastern and southern Africa. In: Nairobi, Kenya: TRAFFIC/WWF/IUCN.

Bohne A (2008). Wildlife value, trophy hunting and rural development – with illustrations from Tanzania. Conference on International Research on Food Security, Natural Resource Management and Rural Development, University of Hohenheim. p. 6.

Bowen-Jones E, Pendry S (1999). The threat to primates and other mammals from the bushmeat trade in Africa, and how this threat could be diminished. Oryx 33: 233-246.

Bowen - Jones E, Brown D, Robinson EJZ (2003). Economic commodity for environmental crisis? An interdisciplinary approach to analyzing the bushmeat trade in central and west Africa. Area 35: 390-402.

Brown S (2006). West develops a taste for primates. New Scientist 191: 8.

Campbell K, Hofer H (1995). People and wildlife: Spatial dynamics and zones of interaction. In: Serengeti II: Dynamics, management and conservation of an ecosystem, eds. ARE Sinclair, P Arcese, pp. 534-570. Chicago, Ill: The University of Chicago Press. Chapman CA, Lawes MJ, Eeley HAC (2006). What hope for African primate diversity? Afr. J. Ecol. 44: 116-133.

Damalu L (2011). Bushmeat issues in Tanzania. A paper presented during ATCB and SCB meeting held in Arusha during June 12th to 16th, 2011. In: Naura Springs Hotel, Arusha Tanzania.

DDresden E (2004) The bushmeat taste, personal reflections within a context of human-animal interactions. Revision 27: 33-41.

Fa JE, Juste J, Burn RW, Broad G (2002). Bushmeat consumption and preferences of two ethnic groups in Bioko Island, West Africa. Human Ecol. 30: 397-416.

FAO (1997). Widlife utilization and food security in Africa. In: Technical Report.

FitzGibbon CD, Mogaka H, Fanshawe JH (1996). Subsistence hunting and mammal conservation in a Kenyan coastal forest: resolving a conflict. In: The exploitation of mammal populations, eds. VJ Taylor, N Dungton, London, UK: Chapmann & Hall. pp. 147-159..

Geist V (1988). How markets for wildlife meat and taste, and the sale of hunting privileges, jeopardize wildlife conservation. Conserv. Biol. 2: 15-26.

Grevengoed S (2001). Mountain gorilla killed and eaten in Rwanda. Press release (June 6, 2001). In: p. 1. Washington, DC: Wildlife Conservation Society.

Hennessey AB (1995). A study of meat trade in Quisso, Republic of Congo. New York: Wildlife Conservation Society.

Hofer H, Campbell KLI, East ML, Huish SA (1996). The impact of game meat hunting on target and non-target species in the Serengeti. In: The exploitation of mammal populations, eds. J Taylor, N Dunstone,. London, UK: Chapman and Hall. pp. 117-146

Hofer H, Campbell KLI, East ML, Huish SA (2000). Modelling the spatial distribution of the economic costs and benefits of illegal game meat hunting in the Serengeti. Natural Resource Modelling 13: 151-177.

Holmern T, Johannesen AB, Mbaruka J, Mkama SY, Muya J, Røskaft E (2004). Human-wildlife conflicts and hunting in the Western Serengeti, Tanzania. In: NINA Project Report. Trondheim, Norway: Norwegian Institute of Nature Reseach. p. 26

Holmern T, Røskaft E, Mbaruka J, Mkama SY, Muya J (2002). Uneconomical game cropping in a community-based conservation project outside the Serengeti National Park, Tanzania. Oryx 36: 364-372.

Homewood K, Lambin EF, Coast E, Kariuki A, Kikula I, Kivelia J, Said M, Serneels S, Thompson M (2001). Long-term changes in Serengeti-Mara wildebeest and land cover: Pastoralism, population, or policies? Proc. Natl. Acad. Sci. USA. 98: 12544-12549.

Hoyt R (2004). Wild meat harvest and trade in Liberia: managing biodivesity, economic and social impacts. In: odi Wildlife Policy Briefing, p. 4.

IUCN (1998). Links between biodiversity conservation, livelihoods and food security; the sustainable use of wild species for meat. In: IUCN Species Survival Commission Occasional Paper, Gland.

Juste J, Fa JE, del val Perez J, Castroviejo J (1995). Market dynamics of bushmeat species in Equartorial Guinea. J. Appl. Ecol. 32: 454-467.

Kaltenborn BP, Nyahongo JW, Tingstad KM. (2005). The nature of hunting around the western corridor of Serengeti National Park, Tanzania. Eur. J. Wildl. Res. 51: 213-222.

Khatun UH (2010). Challenges in conservation of primates; a comparison between Asia and Africa. In: Conservation of natural resources; Some African & Asian examples, eds. E Gereta, E Røskaft,. Trondheim, Norway: Tapir Academic Press. pp. 398-417

Kideghesho J (2008). Co-existence between the traditional societies and wildlife in Western Serengeti, Tanzania: its relevancy in contemporary wildlife conservation efforts. Biodiv. Conserv. 17: 1861-1881.

Kideghesho JR (2006). Wildlife conservation and local land use conflicts in Western Serengeti, Tanzania. In: Department of Biology, Trondheim, Norway: Norwegian University of Science and Technology.

Kideghesho JR, Røskaft E, Kaltenborn BP (2007). Factors influencing conservation attitudes of local people in Western Serengeti, Tanzania. Biodiv. Conserv. 16: 2213-2230.

King S (1994). Utilisation of wildlife in Bakossil and West Cameroon with particular refernce to primates. TRAFFIC Bulletin 4: 63-73.

Loibooki M (1997). People and poaching: the interactions between people and wildlife in and around Serengeti National Park. In: Reading: University of Reading, UK.

Loibooki M, Hofer H, Campbell KLI, East ML (2002). Bushmeat hunting by communities adjacent to the Serengeti National Park, Tanzania: the importance of livestock ownership and alternative sources of protein and income. Envir. Cons. 29: 391-398.

Marealle W, Fossøy F, Holmern T, Stokke BG, Røskaft E (2010). Female-biased sex-ratio in an adult giraffe population leads to female births; Implications for conservation? Wildl. Biol. 16: 419-429.

Mduma S (1996). Serengeti wildebeest population dynamics: Regulation, limitation and implications for harvesting. In: Department of Biology, Vancouver, Canada: University of British Colombia.

Mfunda IM, Røskaft E (2010). Bushmeat hunting in Serengeti, Tanzania: An important economic activity to local people. Int. J. Biod. Conserv. 2: 263-272.

Mockrin MH, Bennett EL, La Bruna DT (2005). Wildlife farming: A viable alternative to hunting in tropical forests? In: New York, USA: Wildlife Conservation Society.

Mwakatobe A, E R, Nyahongo JW (submitted) Species identification through the taste of sun-dried bushmeat by local communities near the Serengeti Ecosystem, Tanzania. . subm.

Ndibalema VG, Songorwa AN (2007). Illegal meat hunting in Serengeti: dynamics in consumption and preferences. Afr. J. Ecol. 46: 311-319.

Nelson F (2009). Natural conservationists? Evaluating the impact of pastoralist land use practices on Tanzania's wildlife economy. URL http://pubs.iied.org/pdfs/G02729.pdf.

Nielsen MR (2006). Importance, cause and effect of bushmeat hunting in the Udzungwa mountains, Tanzania: Implications for community-based wildlife management. Biol. Conserv. 128: 509-516.

Norton-Griffiths M (1995). Economic incentives to develop the

rangelands of the Serengeti: Implications for wildlife conservation. In: Serengeti II. Dynamics, management, and conservation of an ecosystem., eds. ARE Sinclair, P Arcese,. Chicago, USA: University of Chicago Press. pp. 506-533

Noss AJ (1998). The Impacts of cable snare hunting on wildlife populations in the forests of the Central African Republic. Conserv. Biol. 12: 390-398.

Noss AJ (2000). Cable snares and nets in Central African Republic. In: Hunting for sustainability in tropical forests, eds. JG Robinson, EL Bennett,. New York: Colombia University Press. pp. 415-429

Nyahongo JW (2007). Depredation of livestock by wild carnivores and illegal utilization of natural resources by humans in the Western Serengeti. In: Department of Biology, Trondheim, Norway: NTNU.

Nyahongo JW, East ML, Mturi FA, Hofer H (2005). Benefits and costs of illegal grazing and hunting in the Serengeti ecosystem. Envir. Cons. 32: 326-332.

Peggy C, Killer DR, Leever MG, White BC (2009). Ethics in action. A case-based approach. Singapore: Wiley- Blackwell.

Rao M, McGowan PJK (2002). Wild meat use, food security, livelihoods and conservation Conserv. Biol. 16: 580-583.

Robinson JG, Bennett EL, eds. (2000). Hunting for sustainability in tropical forests. New York: Columbia University Press. pp. 521-524

Rovero F, Mtui A, Kitegile A, Nielsen MR, Jones TC (2010). Udzungwa Scarp Forest Reserve in crisis. An urgent call to protect one of the Tanzania most important forests. In: p. 35.

Schenck M, Effa EN, Starkey M, Wilkie D, Abernethy K, Telfer P, Godoy R, Reves A (2006). Why People Eat Bushmeat: Results from Two-Choice, Taste Tests in Gabon, Central Africa. Human Ecol. 34 (3): 433 - 445.

Starkey M (2004). Commerce and subsistence: the hunting, sale and consumption of bushmeat in Gabon. In: Cambridge, UK: Fitzwilliam College, Cambridge University.

TRAFFIC (1998). Food for thought: The utilization of wild meat in Eastern and Southern Africa In: ed. R Barett,. IUCN/WWF. p. 37

United Republic of Tanzania URT (2002a). Population and housing census. The National Bureau of Statistics, Dar Es Salaam Tanzania.

URT (2002b). Population and housing censuses. In: ed. Tourism-Department, Dar es Salaam, Tanzania: Ministry of Natural Resources and Tourism. pp. 14.

Wilkie D, Schenck M, Effa EN, Starkey M, Abernethy K, Telfer P, Godoy R, Treves A (2006). Why people eat bushmeat: Results from two-choice, taste tests in Gabon, Central Africa. Human Ecol. 34: 433-445.

Wilkie DS, Carpenter JF (1999). Bushmeat hunting in the Congo Basin: an assessment of impacts and options for mitigation. Biodiv. Conserv. 8: 927-955.

Wilkie DS, Godoy RA (2001). Income and price elasticities of bushmeat demand in lowland Amerindian societies. Conserv. Biol. 15: 761-769.

Wilkie DS, Starkey M, Abernethy K, Effa EN, Telfer P, Godoy R (2005). Role of prices and wealth in consumer demand for bushmeat in Gabon, central Africa. Conserv. Biol. 19: 268-274.

Willcox AS, Nambu DM (2007). Wildlife hunting practices and bushmeat dynamics of the Banyangi and Mbo people of Southwestern Cameroon. 134: 251-261.

Wolanski E, Gereta E, Borner M, Mduma S (1999). Water, migration and the Serengeti ecosystem. Am. Sci. 87: 526-533.