Traditional methods of harvesting termites used as poultry feed in Burkina Faso

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Abstract

Termites are commonly used by smallholder farmers in West Africa to feed their poultry. A survey was carried out among poultry farmers in Burkina Faso to gather knowledge on the traditional methods used to obtain termites for poultry feed, to assess which termite genera are collected with which techniques and evaluate prospects for optimising and improving the collection and trapping methods. Data were collected among 1100 poultry farmers in eight regions of Burkina Faso on the harvesting techniques, the termite species and their local names as well as on the use of residues. After the interviews, termite samples were collected with the farmers and identified in the laboratory. At least five termite species were found. Species of the genera *Odontotermes*, *Trinervitermes* and *Macrotermes* are commonly given to chickens and guinea fowls whereas a *Cubitermes* species is sometimes used to feed guinea fowls. Two categories of methods are used to obtain termites, the direct collection by breaking termite mounds and the trapping of termites in containers filled with organic matters. The harvesting method varies with the termite genus, the region and the season. Different techniques with various types of containers and organic matters are used in the country and these techniques should be tested and compared to recommend the most efficient ones. The enhancement of termite trapping methods and their integration in poultry feed have the potential to significantly improve traditional poultry farming in Burkina Faso.

Keywords Indigenous knowledge · Termites · Insects as feed · Burkina Faso · Termite harvesting methods

Introduction

Insects are eaten, at least occasionally, by two billion people on earth (Van Huis et al. 2013; Meyer-Rochow and Chakravorty 2013). Termites are particularly nutritive and, in Africa, they are among the most consumed insects (Kinyuru et al. 2009; Lavalette 2013). They are also traditionally used to feed poultry in many West African countries such as Togo, Ghana, Benin and Burkina Faso, in particular in smallholder farming systems in which farmers hold a few scavenging chickens and guinea fowls (Hardouin 2003; Chrysostome et al. 2009; Diawara 2013; Sankara et al. 2018;

Boafo et al. 2019). Farmers collect them either by breaking termite mounds or by trapping them using various methods (Kenis et al. 2014). However, harvesting termites becomes challenging when high quantities are needed to feed a larger flock or to increase the proportion of protein feed in the diet. The abundance of termites varies with seasons and regions and, in recent years, termite populations have decreased, forcing harvesters to walk increasingly long distances to collect the necessary amount to feed their poultry. Consequently many farmers stop feeding their poultry with termites, without finding alternative protein sources (Farina et al. 1991; Kenis et al. 2014; Sankara et al. 2018). Thus, the development of sustainable methods to collect, harvest and store termites is needed to ensure that traditional poultry farmers can provide protein feed to their birds without affecting the environment and local biodiversity (Dao 2016; Ouedraogo 2016; Boafo et al. 2019). In a recent study, Sankara et al. (2018) first assessed the use and knowledge of termites in poultry nutrition in Burkina Faso and analysed the factors influencing this use. Surveys showed that 78% of the farmers from Burkina

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Faso use termites to feed their poultry at least occasionally, but the practice is in decline and strongly varies among regions and provinces. Among the reasons for not using termites, the most common were the unavailability of termites followed by the lack of time and the lack of knowledge of trapping technique. This study complements that of Sankara et al. (2018) by describing and analysing the techniques traditionally used to collect and trap termites, assessing which termite genera are collected with which techniques and discussing prospects for optimising and improving the collection and trapping methods.

Material and methods

Study area

The study was carried out in eight of the 13 regions of Burkina Faso: Centre Ouest, Plateau Central, Nord, Est, Sahel, Centre Sud, Cascades and Hauts-Bassins (Fig. 1). These cover over 60% of the country and represent the three eco-climatic zones of Burkina Faso: These are, from North to South (Sankara et al. 2018):

- (1) The Sahelian zone (regions Sahel and part of Nord), situated approximatively north of the 13°30' parallel is

defined as a zone experiencing 350–600 mm precipitations that are irregular and unevenly distributed over time and space. Temperatures often reach 40 °C, especially in the hot dry season.

- (2) The North Sudanian zone, or Sudano-sahelian zone (Centre Ouest, Plateau Central, Est and part of Nord and Centre Sud) is situated approximatively between the 11°30' and 13°30' parallel, where average annual precipitations vary between 600 and 900 mm.
- (3) The South Sudanian zone (Hauts Bassins, Cascades and part of Centre Sud) is situated approximatively south of the 11°30' parallel. It receives from 900 to 1300 mm precipitations annually. This zone experiences milder temperatures.

Maps of the climatic zones and details of the vegetation and agricultural practices in the zones and regions are found in Dembele (2010). Further data on the climate of regions included in this study are found, e.g., in INSD (2014).

Survey on the use of termites in poultry farming in Burkina Faso

A total of 1100 poultry farmers in 32 villages in 25 provinces of the eight regions were selected. One hundred households

Fig. 1 Percentages of poultry farmers using the collection method, the trapping method, both methods and not collecting termites in the eight surveyed regions

were chosen from one village in Haut-Bassins and Cascades whereas, in the six other regions, 30 farmers were selected in each of the five villages per region. The list of villages and provinces is listed in Sankara et al. (2018). The choice of provinces and villages was based on the number of inhabitants, the accessibility and the proportion of poultry farmers in the localities. Inside each province, the villages with the highest number of inhabitants were chosen (INSD 2008). But, to ensure geographic diversity in the samples, they were also selected on different roads. Farmers were randomly selected from lists provided by the Village Development Committees.

In the 1100 households, the farm manager was interviewed individually from 22 May 2015 to 16 July 2015. Direct, face-to-face interviews were conducted by two Master students who understand and speak the local languages of the different villages. The survey was made with a semi-structured questionnaire and was part of a large participatory research carried out in the framework of the project IFWA (see acknowledgements) that assessed the poultry farmers' perceptions for production and use of termites as poultry feed in Burkina Faso. Socio-demographic data of the surveyed farmers and their perception on the use of termites as poultry feed are described in Sankara et al. (2018). This paper specifically describes the answers that were given to the questions on the present practices to gather termites for poultry feed (Table 1). Interviews also included open questions and discussions, in particular on the management of residues of termite collection and trapping.

After each interview, farmers were asked to show the termites that they usually collect, either from termite mounds or

from traps set up around the farm. When available, samples were collected and placed in 70% ethanol for identification in the laboratory. The identification to the genus or species level, were made using identification keys such as Bouillon and Mathot (1965, 1966), Sands (1965), Ruelle (1970) and Williams (1966). However, most West African termite species are difficult to identify (Korb et al. 2019) and, thus, in most cases, identifications were made only to genus level.

Statistical analyses

The data collected during the surveys were first entered into a Microsoft Office's Excel table and then transferred to the IBM SPSS 20 software environment. This software has been used to calculate the percentages of poultry farmers who do not collect termites, those who use collection method, those who use trapping method and those who use both methods by region. The frequencies of use of the container and substrate types were calculated and the Pearson's chi-square test was used for the comparison of percentages.

Results

1- Collection methods

Methods to collect termites can be classified into two categories: Direct collection of termites from their mounds and trapping of termites in containers. Direct collection implies the partial destruction of termite mounds. Techniques vary with

Table 1 Survey questionnaire on the use of termites by small poultry farmers in Burkina Faso

Survey record N° _____	Date of Survey
Investigator's name	
Region	
Contact details of enquired person	
Do you use termites in the poultry feed? Yes () No ()	
If yes, which ones and what are their vernacular names?	
How do you provide termites:	
Wild collection of termites mounds: ()	
Attraction and catching in container: ()	
Which species of termites (vernacular name or description) and describe the collecting methods of the different species:	
Type of container and used substrates (also describe in detail the assembly scenario of containers):	
Are there other types of termites in your village which you do not use in poultry farming?	
Yes () No ()	
If yes, which ones and why don't you use them	

the termite genera. Small mounds of *Trinervitermes* and *Cubitermes* can be dug out with a hoe or a pickaxe. Mounds are collected in the morning between 6 am and 9 am because, later in the day when the sun is shining, termites go in the subterranean part of the nest. Mound pieces are placed in a bag or basket and termites are given to the fowls two or three times a day. According to the farmers, such type of termite collection is mostly practiced in the rainy season. Termites of the genus *Macrotermes*, which construct large mounds, are rather collected by making holes (usually about 50 cm deep) in the lateral part of the mound, and by inserting branches and leaves of various trees and bushes in the hole. Tree species include, among others, *Guiera senegalensis* J.F. Gmel., *Diospyros mespiliformis* Hochst. Ex A.DC., *Piliostigma tonningii* (Schumacher.) Milne-Redh, *Piliostigma reticulatum* (DC.) Hochst. and *Parinari curatellifolia* Planch. Ex Benth. Three to four hours later, the branches and leaves, with termites on them, are removed, placed in containers and brought back to the farm.

In the trapping method, the first stage is to search for signs of termites such as mud sheeting and runways on the ground. These are usually found at sites with plant debris or dead animals, and can be spotted through the characteristic soils associated with termite tubes. Then, the soil is scraped with a hoe and a trap is placed on the soil. The trap consists of a container, overturned and filled with humid organic matter. The trap is placed in the morning (6–8 am) or in the evening (around 6 pm) and covered with foliage or pieces of fabric to protect it against the sun. Termites are collected in the following morning (6–7 am) or two days later. The organic matter, full of termites, is placed in another container and brought to the farm. If the pot is small and the quantity of organic matter is limited, the collection has to be made the following day otherwise termites will eat the whole content and leave the container. Larger containers can remain for two or more days. A variant of the method consists in placing the organic matter, e.g. cow dung, without container, on the termite nests and tubes, and collect the matter with termites by hand the

following day. The trapping technique is used with termites of the genera *Macrotermes* and *Odontotermes*.

Both techniques are used in all investigated regions, but their respective use varies with regions (Pearson's chi-square = 59.060; df = 7; $P < 0.001$). The trapping technique is more practiced than the direct collection technique in the regions Nord (81.3% of farmers said they trap termites at least occasionally) and Cascades (84.0%). In the other regions, the direct collection is more commonly used. It is in the region Est that the trapping technique is practiced the least (19.4%) (Fig. 1).

Discussions with farmers revealed that the pieces of termite mounds collected in the field for termites are recycled to build chicken runs, granaries or terraces in the farm year. Mixed with cow dung, they are also used to plaster walls to consolidate houses. Baits in the trapping containers, after the poultry has extracted termites, are thrown in the fields or in the vegetal garden as compost.

2- Termite genera used as poultry feed in Burkina Faso

In the survey, at least four termite genera were collected and cited as poultry feed, under various local names (Table 2):

- *Trinervitermes* species build small mounds (Fig. 2) and are used by poultry farmers to feed chickens, guinea fowls and turkeys. At least two undetermined species were found in samples collected with farmers.
- *Odontotermes* species (Fig. 3) build more often found in subterranean nests. Their presence is noticed by the damage they do to vegetal debris. They are given mainly to chicks. The specimens examined from farmers' traps could not be identified to the species level.
- *Macrotermes* species build large termite mounds (Fig. 4) and are used to feed chickens, guinea fowls and turkeys, mostly at the adult stage. Two species have been identified in the samples: *M. bellicosus* (Smeathman) and *M. subhyalinus* (Rambur).

Table 2 Names of termites in four local languages

	Region of Centre-Ouest		Region of Hauts-Bassins	All regions
	Gourounsi (Lele)	Gourounsi (Nouni)	Bwaba	Moore
<i>Trinervitennes</i> sp.	Tichou	Fiou	Banloo	Tembeko Tembeto Tembegdo
<i>Odontotermes</i> sp.	Tchon	Fiou nonnon	Banloo	Mogodo
<i>Macrotermes</i> sp.	Tchoo	Fiou kiou	Too	Yaoré
<i>Cubitermes</i> sp.	Tichou N'djendjoulou	Fiou ipouè	Komidendembê	Tembek sablega Tembek Pibri

Fig. 2 Mounds and soldier of *Trinervitermes*

- *Cubitermes* species build characteristic mounds (Fig. 5) and at least one species is occasionally used for poultry feed. Some farmers said that they are given to guinea fowls but are toxic to chicken when given in high quantities.

In the North and Sahel regions, only termites of the genera *Odontotermes* (Fig. 3) and *Macrotermes* (Fig. 4) used as

poultry feed. In the other regions, all four general were collected. In addition, samples collected with farmers also contained some *Microtermes* sp. and *Coptotermes* sp. but it was not clear whether these are used regularly as feed (Fig. 6).

3- Baits and material used to trap termites

The frequency of organic matter used as baits in the containers to trap termites vary with regions (Pearson's chi-square =

Fig. 3 Termites of the genus *Odontotermes*

Fig. 4 Mounds and soldiers of *Macrotermes* spp.

257.589; $df = 28$; $P < 0.001$). Baits that are used include: cow dung, mango stones, maize crop residues, other cereal crops and other plant debris (e.g. dead wood). Table 3 shows the frequency of utilisation of the baits in the different regions. Cow dung is more used than the other baits in most regions. Plant debris has been frequently cited in all regions and is a major bait in the Cascades and Est Regions. Mango stones are

used mainly in Cascades, Centre Ouest and Nord, but not at all in some other regions. Maize residue is a major bait in Hauts-Bassins.

Containers used in the trapping technique are mostly old containers that are not suitable for daily domestic uses. These are mainly calabashes, terra cotta pots (locally named « canaris »), metal boxes (empty cans of tomato, coffee, milk

Fig. 5 Mounds and soldier of *Cubitermes* sp.

Fig. 6 Termite genera used as poultry feed per region in Burkina Faso. Regions where *Macrotermes* and *Odontotermes* are collected, Regions where *Macrotermes*, *Odontotermes*, *Cubitermes* and *Trinervitermes* are collected, Regions not surveyed

powder, etc.) and plastic containers (e.g. cut plastic barrels or gas tanks) (Table 4). The frequency of containers' types varies with regions (Pearson's chi-square = 398.915; df = 28;

$P < 0.001$). Canaris are used everywhere but metal boxes are more commonly used in Centre Ouest and Plateau Central. Calabashes and plastic containers are not much used. In

Table 3 Frequency of organic matters used in the containers to trap termites in the different regions, expressed as percentage of all citations. Most farmers have cited several organic matters

Regions	Cow dung %	Plant debris %	Mango stones %	Residues of other cereals %	Residue of maize crop %	Number of farmers trapping termites	Number of substrates' citations
Cascades	30,7a	32,6a	21,8ab	1,1c	13,8b	85	261
Centre Ouest	48,4a	23,2ab	19,4b	3,2c	5,8c	77	155
Centre Sud	48,0a	11,7d	7,6d	14,6c	18,1b	82	171
Est	54,3a	41,3a	0,0b	0,0b	4,3b	29,	46
Hauts-Bassins	47,1a	9,8c	2,0c	2,0c	39,2b	50	102
Nord	48,1a	26,6b	16,9b	4,2c	4,2c	122	237
Plateau Central	76,8a	7,2b	0,0b	5,8b	10,1b	55	69
Sahel	60,0a	22,5b	2,5c	2,5c	12,5b	29	40

Values in the same line followed by the same letters and not significantly different at 0.05 level

Table 4 Frequency of containers' types used for trapping termites in the different regions, expressed as percentage of all citations. Some farmers have cited several containers' types

Regions	Calabash	Terra cotta pot	Metal box	Plastic container	No container	Number of farmers trapping termites	Number of containers' citations
Cascades	0b	97,6a	0b	2,4b	0b	85	85
Centre Ouest	3,8c	35,4b	57,0a	0c	3,8c	77	79
Centre Sud	0c	55,6a	34,7a	9,7b	0c	82	124
Est	0c	43,8b	0c	9,4c	46,9a	29	32
Hauts-Bassins	0b	100a	0b	0b	0b	50	50
Nord	2,4c	64,8a	25,6b	0c	7,2c	122	125
Plateau Central	5,6c	11,1b	77,8a	1,9c	3,7c	55	57
Sahel	0c	22,6b	12,9c	16,1c	48,4a	29	31

Values in the same line followed by the same letters and not significantly different at 0.05 level

Sahel and Est Regions, about half of the farmers said that they do not use containers and directly apply the baits, mostly cow dung, on termite nests and tubes. This technique is not much used in the other regions (Table 4).

Discussion

Collection methods

This survey showed that two categories of methods are abundantly used to collect termites in all investigated regions, the direct collection from termite mounds and the trapping of termites in containers. The same categories of method have recently been described from Ghana as well (Boafo et al. 2019). Direct collection is easy but has two drawbacks. Firstly, termite mounds are not always easily available and collectors, often children, sometimes have to walk very far to collect termites (Kenis et al. 2014). Secondly, these methods are not sustainable because they may destroy the termite nests, which play an important role in the functioning of African soil ecosystems. Even when the colony is not directly destroyed, digging holes favours the attack of predators such as ants. Hardouin (2003) had noticed this issue and therefore suggested to favour the trapping methods, which had already been described by Farina et al. (1991), Chrysostome (1997) and others. At first view, the trapping method is more difficult to implement because it requires material and time for preparation of the traps. However, traps can be placed around the farm without destroying the nests and even inconspicuous nests that are identified by mud tubes and holes in the soil are suitable. This method could be improved by finding the best technique, including the most efficient organic matters, the best containers and the most appropriate timing and sites for exposing the traps.

Termite genera

Four termite genera are commonly used, *Trinervitermes* and *Cubitermes*, which are obtained through direct collection, *Odontotermes*, which is trapped with containers, and *Macrotermes*, which can be collected using both methods. All termites can be collected throughout the year but *Trinervitermes* and *Cubitermes* are more commonly collected in the rainy season, possibly because the mounds are more easily destroyed in that season. In contrast, *Odontotermes* and *Macrotermes* are more commonly trapped with containers in the dry season because, in the rainy season, according to farmers, termite tubes are regularly washed out by the rain and *Odontotermes* nests are less conspicuous. The climate may also explain why *Odontotermes* and *Macrotermes* are collected throughout the country whereas *Trinervitermes* and *Cubitermes* mounds are not harvested in the Sahelian zone (North and Sahel regions), which is the driest area of the country. However, it may also simply be that *Trinervitermes* and *Cubitermes* are less abundant in these regions. Kifukieta et al. (2014) showed that termites' distribution, diversity and abundance vary with climate but also with soil and vegetation types.

While no producer has expressed limitations in the use of *Odontotermes* spp., which can be given *at libidum* for chicks, some issues have been raised regarding the three other genera. *Macrotermes* spp. cannot be given to chicks of less than 2–4 weeks because soldiers can hurt and even kill chicks by biting their throat. Some farmers said that a species of *Trinervitermes* is toxic and only experienced farmers can recognize them, which hampers their use. *Trinervitermes* spp. are toxic through their soldiers that spit toxins (diterpenes and monoterpenes) with their snout and it is possible that the “toxic species” may be species or nests with high proportions of soldiers, or soldiers that produce more toxic substances than others. *Cubitermes* sp. can be used without danger for guinea

fowls and keets but, in large quantities may be toxic to chicken. While the reasons for the toxicity of species of the genera *Trinervitermes* and *Cubitermes* should be further investigated, other authors have mentioned similar issues. For example, in Benin, Chrysostome (1997) reported that a species of the genus *Noditermes* is known for being toxic to poultry, which was confirmed in feeding tests.

In Ghana, Bofo et al. (2019) also mentioned that soldiers of *Trinervitermes* and *Macrotermes* as well as some *Cubitermes* and *Amitermes* species are known to be poisonous or damaging to chicks and provide symptoms for the different termite species. Other termites are reported as poultry feed in Africa and elsewhere. In their review, Figueirêdo et al. (2015) reported over 40 species used as food or feed worldwide. Before the recent studies of Bofo et al. (2019), Sankara et al. (2018) and this study in Ghana and Burkina Faso, hardly anything was known about the use of species of the genera *Odontotermes*, *Trinervitermes* and *Cubitermes* in feed or food. In contrast, *M. bellicosus* and *M. subhyalinus* have been particularly well studied in Africa. They are consumed also by humans in many countries. They are very rich in nutrients, i.e. proteins, vitamins and minerals, and their consumption has been encouraged (Ntukuyoh et al. 2012). Furthermore, their large size allows them to be preserved dry. Sogbesan and Ugwumba (2008) tested *M. subhyalinus* in catfish feed and suggest that it is easier and more profitable to preserve and give them dry than fresh. In Congo, Munyuli and Balezi (2002) showed that dry termites can successfully replace the expensive meet meal commonly used in poultry feed diets.

Baits and material used to trap termites

Various types of containers and contents are used across Burkina Faso to trap termites. The containers are usually old or broken pots and the baits are animal or plant wastes so that this technique does not cost anything to implement. Baits used to trap termites may reflect their local abundance. For example, mango stones are used in the Cascades region, where mango trees are particularly abundant. Cow dung is abundant everywhere and it is the easiest and most commonly used bait to attract termites. In some regions, cow dung is simply placed on the ground. In most cases, however, a container is used, which can be of various sizes and material. Containers need to keep the organic matter at the right humidity and at low temperature, which may be the reason why terra cotta pots are abundantly used, in contrast to plastic containers that tend to heat their content. In a similar survey in Ghana, farmers also advised the use of earthenware as it remains cooler than containers made of other materials (Bofo et al. 2019). They also stated that, to maintain good microclimate for the termites, baited containers can be covered with leaves after placing on termite mounds.

Conclusion

This study allowed us to highlight and describe traditional activities related to the use of termites as poultry feed in rural communities in Burkina Faso. Termites are frequently given to poultry and represent an important source of proteins in traditional poultry farming. In addition, residues of termite mounds and traps are used in construction work and as compost, respectively. While the direct collection through destruction of termite mounds is not sustainable and cannot be recommended, the trapping system with containers and organic matters should be encouraged in villages that are not practicing it. However, more research is needed to improve the trapping and use of termites in poultry feed. Tests should be conducted to assess which containers, baits and techniques of trap exposure are most efficient. Techniques are likely to be different for the different species, which should be all identified to the species level. The effect of intense trapping around farms on termite populations should be studied. Finally, if methods are found to trap termites in high quantity in a sustainable way, the possibility of drying termites and integrating termite meal in poultry diets should be considered.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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