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Assessing the toxicity level of some useful mushrooms of Burkina Faso (West Africa)

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ABSTRACT
Objective: The goal of this study is to evaluate the potential risks of intoxication following the ingestion of wild mushrooms.
Methodology and results: This study was carried out on four different species of wild mushrooms including two edible species *Chlorophyllum cf. molybdites* and *Phlebopus sudanicus* and two medicinal ones, *Ganoderma lucidum* and *Phellinus pachyphloeus*. These species were analyzed on their acute toxicity and their LD_{50} were calculated based on dry material. The fresh mushroom weights equivalent to the threshold of the LD_{50} was also evaluated. The fungal species LD_{50} were 695.62 mg/kg; 679.09 mg/kg; 395.19 mg/kg and 1070.79 mg/kg for *P. sudanicus*, *C. cf. molybdites*, *G. lucidum* and *P. pachyphloeus* respectively. By comparing these values to the scale of toxicity from Hodge and Sterner, the extracts of *P. sudanicus, C. cf. molybdites* and *P. pachyphloeus* are classified among the substances slightly toxic while *G lucidum* is classified like toxic substance. The fresh mushrooms values equivalent to the lyophilized used for the species were 2.47 kg; 3.67 kg; 1.22 kg and 7.96 kg respectively for *P. sudanicus, C.* cf. *molybdites, G. lucidum* and *P. Pachyphloeus.*
Conclusion and application of results: By taking a minimum of precautions, these species could be developed on the nutritional and therapeutic level.However, it is necessary to undertake toxicity study on the fresh material and by oral way, form of administration generally recommended by the tradi-therapeutists.
Keywords: wild mushroom, use, toxicity, LD_{50}, Burkina Faso.

RÉSUMÉ
Objectif: L'objectif général de cette étude est d'évaluer les risques potentiels d'intoxication suite à l'ingestion de champignons utiles au Burkina Faso.
Méthodologie et résultats: Cette étude a été effectuée sur quatre espèces de champignons sauvages récoltés au Burkina Faso: Chlorophyllum cf. m*olybdites*, *Phlebopus sudanicus* (espèces comestibles), Ganoderma *lucidum, et Phellinus pachyphloeus* (espèces médicinales). Ces espèces ont été séchées, leur toxicité aiguë et leur DL_{50} ont été calculés. Les poids frais de champignons équivalents au seuil de la DL_{50} ont été également évalués. Les valeurs de la DL_{50} déterminées sont de 695,62 mg/kg; 679,09 mg/kg ; 395,19 mg/kg et 1070,79 mg/kg respectivement pour *P. sudanicus*, *C. molybdites*, *G. lucidum* et *P. pachyphloeus.* En comparant ces valeurs de la DL_{50} à l'échelle de toxicité de Hodge et Sterner, les extraits de *P. sudanicus, C. molybdites* et *P.*

pachyphloeus se classent parmi les substances faiblement toxiques tandis que et *G. lucidum* se classe comme substance moyennement toxique.
Conclusion and application des résultats: En prenant un minimum de précautions, ces espèces pourraient être valorisées sur le plan nutritionnel et thérapeutique. Cependant, il est souhaitable que des études de toxicité soient menées à partir du matériel frais et par voie orale, forme d'administration généralement préconisée par les tradi-thérapeutes.
Mots clés: champignon sauvage, usage, toxicité, DL_{50}, Burkina Faso.

INTRODUCTION

Non Timber Forest Products (NTFPs) play an important role for thousands millions of rural Africans as source of food, fodder, construction materials, beverages, and drugs (Malaisse, 2010). In tropical African context, wild edible mushrooms range among the most valuable food resources with a remarkable nutritional and socio-economical importance (Buyck 1994; De Kesel *et al.* 2002; Ducousso *et al.* 2003; Yorou *et al.* 2002; Härkönen *et al.* 2003; Eyi-Ndong *et al.* 2011; Koné *et al.* 2012). Mushrooms represent one of the world's greatest untapped resources of nutrition and palatable food of the future. They are an excellent source of antioxidants and have been found effective against heart diseases, cancer, cholesterol reduction, stress, insomnia, asthma, allergies, obesity and diabetes (Wani *et al.* 2010). Edible mushrooms are the richest source of proteins and are suitable for human consumption by providing a great source of dietary fibre. Mushrooms are a good source of vitamins, which help human body. For the whole tropical Africa, Rammeloo and Walleyn (1993) and Walleyn and Rammeloo (1994) have reported over 300 edible and medicinal fungi. Yorou *et al.* (2014) reported conservation estimates of 70 edible species from West Africa. Still, because of the cultural background, the diversity of useful fungi greatly varies from one country to another and even within ethnic groups of the same country (Yorou & De Kesel 2002, Codjia & Yorou 2014). The Malawians recognize and consume 60 different species of mushrooms (Morris 1984). Buyck (1994), Buyck & Nzigidahera (1995) recorded 32 edible species for Western Burundi whilst Pegler and Piearce (1980) reported about 15 to 25 species in Zambia. The Tanzania people use about 50 fungal species as food (Härkönen *et al.* 2003). In a similar way, Eyi-Ndong *et al*. (2011) described over 60 edible species from Central Africa. According to recent surveys, the diversity of wild useful fungi may overcome 70 species in Western Africa (De Kesel *et al.* 2002; Bâ *et al.* 2010; Yorou *et al.* 2014). Wild mushrooms have sometime bad reputation of causing intoxications due to consumption of misidentified mushrooms. Discrete fungi poisoning and toxic fungi have been investigated in few tropical African countries (Heim, 1936, 1940; 1963; Oso 1975, 1977, Holden 1970; Ogundana, 1979; Adewusi *et al.* 1993). At the other hand, taxonomic confusions between native fungal species and introduced species followed by fungi poisoning have been frequent in some eastern and western Africa (Heim 1978; Morris 1984; Härkönen *et al.* 1993). Though rarely recorded in the national statistics of the death causes, fungi poisoning occur inconspicuously within rural communities as the consequence of misidentification (Yorou & De Kesel, 2002). The edibility, along with additional ethnomycological information of a given species is acquired and transmitted orally to next generations in a dogmatic way. Consequently many misidentifications leading to fungi intoxications may occur. Because of the known toxicity of certain mushroom species, there is an important need to study the toxicity of some species whose food and therapeutic values were previously shown in Burkina Faso (Guissou *et al.* 2008). The ultimate goal is to evaluate the potential risks of intoxication following their ingestion. Specifically, we are aiming at assessing the acute toxicity of both useful mushrooms before they disappeared to ascertain the edibility or toxicity of indigenous mushrooms. The goal of this study is to evaluate the potential risks of intoxication following the ingestion of wild mushrooms.

MATERIALS AND METHODS

Justification of the species choice: The investigated material consists of four mushroom species: *Phlebopus sudanicus (photo 1), Chlorophyllum* cf. *molybdites (Photo 2)*, *Phellinus pachyphloeus* (Photo 3) *and Ganoderma lucidum.* These species were selected among many species known in Burkina Faso because of their food and medicinal uses and their availability in natural area. *Chlorophyllum* cf. *molybdites* and *Phlebopus sudanicus* are used in the food of some local populations in Burkina Faso (Guissou 2005). *Ganoderma lucidum* and *Phellinus pachyphloeus* are traditionally used as therapeutic for the cure of diseases. They were most frequently met on the displays of the herbalists. *Ganoderma lucidum* is used to cure cardiac diseases and the pains of spleen while *P. pachyploeus* is used against stomachache and hemorrhoids according to information collected from traditional healers (Guissou 2005).

Photo 1: *Chlorophyllum cf molybdites*

Photo 2: *Phlebopus sudanicus*

Photo 3: *Phellinus pachyphloeus*

Photo 4: ***Ganoderma lucidum***

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studied specimen belong to the division Basidiomycota, sub-class Agaricomycetideae; the two edible species to the order Boletales. *Chlorophyllum molybdites is classified in the family Agaricaceae and P. sudanicus in the* Boletinellaceae. G. lucidum is a Ganodermataceae while Phellinus pachyphloeus is Hymenochaetaceae.

Table 1: Characteristics of the mushroom species

Species	Systematic position	Local name (Mooré)	Use	herbarium Number and site of collection
Phlebopus sudanicus	Basidiomyceta Agaricomycetideae *Boletales* Boletinellaceae	Karpinta Kidlingou	Edible	Guissou K.M.L. 227 Bala
Chlorophyllum cf. molybdites	Basidiomyceta Agaricomycetideae *Boletales* Agaricaceae	Goundou	Edible	Guissou K.M.L. 435 Bala
Ganoderma lucidum	Basidiomyceta Agaricomycetideae *Polyporales* Ganodermataceae	Tiig-lalem Tiig-landgo Raog-goundou	Medicinal	Guissou K. M. L. 179 ; Ouagadougou
Phellinus pachyphloeus	Basidiomyceta *Hymenochaetales* Hymenochaetaceae	Wed-fiiré	Medicinal	Guissou K. M. L. 88 Ouagadougou

Specimen sampling, identification and conservation: The protocol of De Kesel et *al.* (2002) was followed for specimen collecting and conservation. Mushroom samples were collected during the raining season in Parc bangre-weogo of Ouagadougou and in the reserve of hypopothamus pound of Bala. Morphological features were recorded using fresh materials that were afterward dried using a propane gas field dryer during 48 hours according to De Kesel (2001). The fungal specimens were collected carefully as outlined in Guissou (2005). Macroscopic characters such as shape, colour, spores deposition, taste, size and ecological characteristics of the samples were recorded. *Phlebopus sudanicus* and *Chlorophyllum* cf. *molybdites* were collected in the Reserve of Biosphere of the Pond in Hippopotamus of Bala (western part); *P. pachyphloeus* was collected at the experimental station of Farakoba and G *lucidum* at the University of Ouagadougou. Microscopic examination, description and identification of fungal species were performed according to Guissou (2005). Identifications were made based on macro and microscopic characters using keys of identification relevant to the literature by the first author.

Evaluation of the acute toxicity: Hundred twenty-five (125) g of powder of each species are put to macerate in 500 ml of distilled water. After agitation during 24 hours, the extract is filtered on centrifuged absorbent cotton with 2000 tours/minute during 15 minutes. The extracts are then lyophilized, afterward dried and the yields of extraction were calculated:

Yield (%) = weight of lyophilized x100/ initial weight of mushroom powder.

The method adapted from Litchfield and Wilcoxon (1949) were used for acute toxicity assessment on mice weighting between 25 g and 30 g. The toxicological study aims at determining the 50% lethal dose (LD50). It consists in evaluating the amount, which kills 50% of the animals in experiment according to the cumulated standardized method of Trevan (1927) and Hodge and Sterner (1980). Mice were obtained from the International Centre for Research Development of Animal Rearing in Humid Zones (CIRAD) in Bobo-Dioulasso (Burkina Faso) for the experiment. During the test, mice were stored in laboratory conditions with natural light and ambient temperature at 25-30°C. They were fed by granules containing 20% proteins and water ad libitum. For each species, six groups of six mice each were used including five groups receiving five different concentrations and one untreated control group that received distilled water. For this, animals of each group were receiving a specific dose of the extract to be tested and distilled water by intraperitoneally injection using

syringe. After pretests in each mushroom extract, the following doses have been administrated:

- 250, 500, 1000, 1250 and 1500 mg / kg body weight for *P. sudanicus* and C. cf *molybdites;*
- 150, 250, 500, 1000, 1250 and 1500 mg / kg body weight for *G. lucidum*;
- 500, 1000, 1250, 1500 and 2000 mg / kg body weight for *P. pachyphloeus*.

Assays were performed in quadruplicate for each dose. T*hen, all mice w*ere observed systematically during 72 hours. The general behaviour of the mice was observed. The toxicological effect was assessed by the median lethal dose value (lethal Dose 50 or LD50) estimated from the regression of log-probit mortality rate. The scale of Hodge and Sterner (1980) were used to characterize the safety level of each mushroom extract (table 2).

Table 2: Scale of toxicity according to Hodge and Sterner

Class of toxicity	**LD50 (rat, mouse) mg/kg**
Extremely toxic	<1
Very toxic	1 à 50
Fairly toxic	50 à 500
Slightly toxic	500 à 5000
Practically not poison	5000 à 15000
Relatively without danger	>15000

The lethality of mice was estimated as a percentage of deaths observed for each extract dose. SPSS (version 10.0.5) for Windows (95, 98 and NT) was used to determine the values of DL1, DL5, LD50, DL95 and DL99 and the relative ratios DL5/LD50, LD50/DL95 and DL5/DL95 by mean of the probit analysis.

Determination of the weight of the fresh mushrooms being equivalent to the threshold of the LD50 : The weight of fresh mushroom can be used to appreciate the quantities of the fresh mushroom consumed that can be dangerous for human being. One of the objectives of this study is to demonstrate if the studied species are toxic for human. For this, the quantity of fresh mushrooms that is equivalent to the threshold of the LD50 was evaluated. The equivalent of the weight of fresh mushroom (FW) to the threshold of the LD50 is calculated by the following relation:

$FW = 100^2\ WL/rr'$,

with PW= fresh weight of the sample; WL = weight of the lyophilized; r = yield of lyophilized; r' = % of the dry weight of mushroom. Data were analyzed using SPSS comparison test (ONE WAY ANNOVA). Statistical significance was assessed at $p<0.05$.

RESULTS

Extract yields: The extract yields are represented in table 3. *Phlebopus sudanicus* presents a high yield (31.82%) followed by *Chlorophyllum* cf. *molybdites* (16.8%). The therapeutic species record a poor yield compared to the edible ones.

Table 3: Extract yields

Fungal species	**Initial weight of the sample (g)**	**Weight of the lyophilisat (g)**	**Yield (%)**
Phlebopus sudanicus	125	39,77	31,82
Chlorophyllum cf. *molybdites*	125	21	16,8
Ganoderma lucidum	125	6	4,8
Phellinus pachyphloeus	125	2,87	2,3

Acute toxicity of the species: The signs of mice observed during the toxicity study start at amount of 250mg/kg body weight for all the fungal species. The following signs were observed: immobilization; sleepiness, regrouping; reduction of the locomotors activity and a significant sudation of the mice. Figure 1 present the mortality of the mice (%) according to the dose of each mushroom species extract.

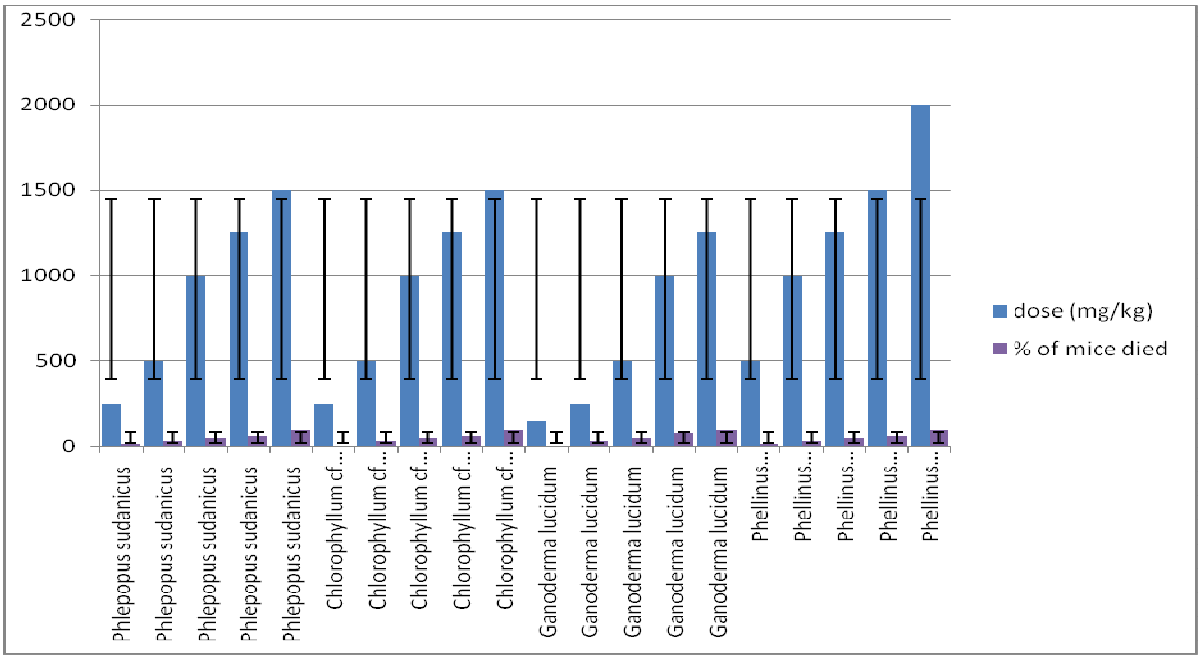

Figure 2: mortality of mice (%) according to the dose (mg/kg) of mushroom extract

With a dose of 250 mg/kg of *P. sudanicus* extracts, 16.67% of the mice died after 72 hours. None of the mice survived (100% mortality) at the concentration of 2000 mg/kg at the same period. All investigated mice were able to support 250 mg/kg of extracts of *C.* cf. *molybdites*. At the opposite, 1250 mg/ kg of extracts of *C. molybdites* killed all animals (100% mortality) after 48 hours. Whilst we record no mortality of mice with 150 mg/kg of *G. lucidum*, all mice were killed with 1250 mg/kg of extract after 48h. As far as *Phellinus* is concerned, 500 mg/kg extract killed 16.67% of mice. After 72h, no mice can survive with a dose of 2000 mg/kg. Ki-deux tests showed a significance difference between the species and the administrated doses (p=0.022). A significant difference was obtained between the fugal species and the percentage of mice died (p= 0.001). The lethal doses values calculated are presented on table 4. ANOVAs test confirmed the significant difference between mushroom species, their doses and the percentage of mortality.

Table 4: Lethal doses values (mg/kg) of the studied species

Species	LD 01	LD50	DL99	Index of safety LD99/DL01)
Phlebopus sudanicus	83,15	695,62	5819,45	69,99
Chlorophyllum cf. *molybdites*	195,99	679,09	2352,94	12,01
Ganoderma lucidum	69,97	395,19	2232,1	31,90
Phellinus pachyphloeus	255,46	1070,79	4488,30	17,57

LD50 are 695.62; 679.09; 395.19 and 1070.79 mg/kg for *P. sudanicus*, *C molybdites*, *G lucidum* and P. *pachyphloeus,* respectively. In the same order, index of safety are 69.99, 12.01, 31.90 and 17.57. According to the scale of toxicity of Hodge and Sterner (1980), *P. sudanicus, C.cf molybdites* and *P. pachyphloeus* are classified among the substances slightly toxic while *G. lucidum* is indexed as toxic. The high index of safety (see table 4) of the species demonstrated that we can use them in the human health benefits such as food and medicine.

Mushroom fresh weight evaluation equivalent to the lyophilized of the species: The quantities of fresh mushrooms equivalent to the lyophilized used for the species are presented on table 5. For an example, we obtained the following data: 2.47kg; 3.67kg; 1.22kg and 7.96 kg respectively for *P. sudanicus, C.* cf *molybdites, G. lucidum* and *P. Pachyphloeus.* It means that one should use such quantities of fresh mushrooms for unique dose consumption to reach the LD50. In the study area, these quantities surpassed the daily consumption of individual villager.

Table 5: Fresh weights evaluated and equivalent of the LD50 of the species

Species	LD50 (mg/kg)	Dry weight (%)	Quantity of lyophilized (g)	Equivalent dry weight (g)	Fresh weight (kg)
P. sudanicus	844	7.5	59.1	185.8	2.47
C. cf. *molybdites*	750	8.5	52.5	312.5	3.67
G. lucidum	499.8	59,5	34.9	727.1	1.22
P. pachyphloeus	1190.3	45.5	83.3	3621.7	7.96

DISCUSSION

The study revealed that *P. sudanicus* and *C.* cf. *molybdites* are slightly toxic. Edible mushrooms have been reported for Burkina Faso (Guissou 2005) and *Phlebopus sudanicus* and *Chlorophyllum molybdites* are two common wild mushrooms in Burkina Faso. An ethnomycological study through 5 ethnics groups showed that knowledge is actively disappearing from one generation to another (Guissou *et al.,* 2008), mostly due to urbanization and modern schooling. Intoxications cases were not mentioned, but the notion of poisonous mushrooms clearly exists within local people (Guissou *et al.,* 2008). *C. molybdites* is a pantropical saprotrophic species that occurs predominantly along roadside and in man-made nitrogen-rich ecosystems (De Kesel *et al.* 2002). As far as *P. sudanicus*, it is a symbiotic species that occurs throughout tropical Africa. It is a putative ectomycorrhizal partner of numerous trees member of genera *Acacia* and *Uapaca* (De Kesel *et al.* 2002). In Burkina Faso however, *P. sudanicus* occurs predominantly in shrubs savannas dominated by *Piliostigma thonningii* (Guissou 2005). Both species have been subject to many debates in numerous papers regarding their edibility. *Phlebopus sudanicus* is reported to cause intoxications in West Africa (Pegler & Rayner, 1969; Morris, 1984). At the opposite, Hariot and Patouillard (1909) reported *P. sudanicus* as an edible species in Congo. Detailed ethnomycological surveys in Burkina Faso (Guissou *et al.* 2005) reported the common consumption, drying and storage of this species by Bobo people. Ducousso *et al.* (2003) mentioned that it is consumed with no major trouble in Senegal. Similarly, the edibility of *Chlorophyllum molybdites* in tropical Africa has been controversially discussed in literature. It is commonly consumed in Burkina Faso (Guissou *et al.* 2008) and in Benin (De Kesel *et al.* 2002). At the opposite, Zoberi (1979) showed that this species is toxic and that its toxicity is due to the presence of an extremely thermolabile and water soluble alkaloid. In Zambia, Pegler and Piearce (1980) mentioned many gastro-intestinal troubles following the consumption of *C. molybdites*. Fasidi and Kadiri (1994) reported the absence of amanitoxin and phalloïdine in *C molybdites*. Both toxins are generally present in mortal species like *Amanita phalloides*. Moreover, these authors showed that the extract of *C molybdites* injected by intra-leather ways did not kill any rat. This depends on the experimental conditions as these authors used fresh extracts, instead of dry extract as we did in this study. In Nigeria, Zoberi (1979) reported that some carpophores of *C. molybdites* are edible while others are poisonous. Later, Stenklyft and Augmentstein (1990) described a severe case of intoxication of a 6-year-old child after consumption of fresh specimens of *C molybdites.* According to the authors, *Chlorophyllum molybdites* causes irritating gastro-intestinal disorders and benign insupportable in the children. Adewusi et al. (1993) demonstrated that some rodents administrated with *C. molybdites* developed some uncontrolled violence that is probably governed by an unknown psychotropic toxin. Zoberi (1979) and Floch *et al.* (1966) showed that this species is toxic and that its toxicity would be due to the presence of an extremely thermolabile and water soluble alkaloid. This argument is supported by Härkönen *et al. 1994* who even suggested that the toxicity of *C. molybdites* is more related to individual sensibility than the specific toxin contained in the specimens. *C. molybdites* is consumed in the neighbouring country Benin as attested by De Kesel *et al.* (2002). These authors argue that Benin more likely hosts an edible physiological type of *C. molybdites*, but that the toxicity may be alleviated through cooking of the specimens, which indeed corroborate with the arguments of Floch *et al*. (1966) and Zoberi (1979). In a similar way, the absence of intoxication reports within populations of Burkinabe could be related to the fact that the mushrooms undergo a great cooking in Burkina Faso before consumption. Moreover, our results suggest that the species becomes toxic for adults only after consumption of at least 3.67 kg of fresh biomass at a time. In general, individual (even daily) consumption is so far lower in many rural areas. Mushrooms are commonly used as sauce supplements (De Kesel *et al.* 2002; Guissou 2005) to accompany starch-rich foods made of cereals like maize, rice, millet, Sorghum and/or rots and tubers. It is quite rare to observe daily consumption of

3.67 kg of *C. molybdites*. For *Phlebopus sudanicus*, the quantity for fresh mushroom equivalent to the threshold is 2.47kg. Though large quantities of this species are commonly harvested and dried under sun (Guissou 2005) and individual consumptions (pers; observations) are lower (<200 g per day) than the toxic value obtained for the species. Our repetitive collection trips revealed that quantities collected by the villagers are just enough for subsistence and individual consumptions over than the 2.47 kg could not be observed. *Ganoderma lucidum* presents the lowest toxicity value of 1.22 kg. Because of its context, direct consumption of *G. lucidum* as food is rare in the West Africa (De Kesel *et al.* 2002; Guissou 2005, Yorou *et al.* 2014). However, the species is commonly used to face numerous human diseases as detailed above. In the West African context, external applications of the flour obtained from dried/or fried fruit bodies is the most common application (pers. observation). However, direct consumption of the species for medicinal purpose is recorded, oral flow of pure and/or mixed (with other ingredients) extracts of *G. lucidum* rarely exceed 1.22 kg by day. In a similar way, the 7.96 kg obtained as toxic threshold for *P. pachyphloeus* is hardly reached by villagers. Though the targeted species present low toxicity levels, further studies must be undertaken in order to assess the toxic status of these species regarding local drying and cooking techniques. It is more likely that the local drying, processing, and cooking techniques influence the toxicity of the species. This is particularly true at least for *C. molybdites* for which there are controversial arguments about its edibility that may be justified by the fact that the species is consumed either fresh or partially and/or fully cooked. In tropical Africa, there are no standard and scientifically sound criteria to detect edible and toxic fungal species. Alternatively, there are very rare (if not at all) studies focusing exclusively the toxicity of mushrooms. Indigenous information about the edibility of wild mushrooms have been developed since time immemorial and transmitted orally from one generation to another (Guissou *et al.* 2008), Yorou & De Kesel 2002). The Nagot people of Benin use criteria such as the colour and taste of the fruit body (Yorou & De Kesel 2002), the ecology of the species in the demarcation between edible and non-edible species (De Kesel *et al.* 2002, Yorou 2000). While white, dirty white to grey colored species are generally regarded as edible, many species with very bright colour (red, yellow and dark) are assumed unsuitable for human consumption, with however, no valid indigenous conclusion about its toxicity. Throughout the whole tropical Africa (Buyck 1994), Härkönen *et al.* 2003, Buyck & Nzigidahera 1995) bruising fruit bodies is also a strong local signal to detect non edible species. According to this criterion, many species member of the Boletales (with numerous highly esteemed species in Europe) are locally rejected. The Nagot people consider species with bitter taste, and strong, unpleasant and repulsing smell (including Lactarius and Russula species) as improper for consumption (De Kesel *et al.* 2002; Yorou 2000). Numerous hypotheses have been suggested for the rapid and costs-free detection of edible fungal species. According to Oso (1975), the toxicity of the mushroom can be tested by application to animals. Oso (1975) argues that the species is safe for human consumption if no major trouble is recorded on the tested animals. In Burundi, Buyck & Nzigidahera (1995) suggested that a mushroom is good for human consumption if it is eaten by the monkeys with no particular troubles. Using animals as toxicity references presents the danger that many animal species may support toxic and/or thermolabile compounds that human organism cannot tolerate. In this study, it is difficult to make a direct link to toxicological effects for human being. Some additional laboratory tests should be done for validation. However, it does give an indication for the toxicity of mushroom. In a similar way, Malawians and Tanzanians recognized a potential species healthy for human consumption when it is colonized by the larvae of insects (Härkönen *et al.* 1994). Still, almost all fleshy mushrooms harbour insects larvae in their fruit bodies regardless of if they are good edible or extremely toxic. Though the toxicity studies are time and budget consuming, it is recommended to undertake laboratory tests to help identify edible and toxic species, but also to detect the LD_{50} of common species in order to avoid fatal intoxications within rural communities. The case of both edible species investigated in this study give strong evidence that they are good edible, but become toxic when huge quantities are consumed. This information's are particularly important in the definition of mushrooms-oriented national food security and health strategies. Toxicity studies are consuming time and budget it is recommended to undertake laboratory tests to help identify edible and toxic species By taking a minimum of precautions, the species could be developed on the nutritional and therapeutic level. However, it is necessary to undertake toxicity study on the fresh material and by oral way, form of administration generally.

CONCLUSION

This is the first study that examines the toxicity of fungal species in West Africa compared to vegetables. This study revealed that LD50 were 695.62; 679.09; 395.19 and 1070.79 mg/kg for *P. sudanicus*, *C molybdites*, *G lucidum* and P. *pachyphloeus,* respectively. *G. lucidum* presents the lowest toxicity value. *P. sudanicus, C. molybdites* and *P. pachyphloeus* are classified among slightly toxic food while *C. molybdites* and *G. lucidum* are indexed as fairly toxic ones. The quantities of fresh mushrooms equivalent evaluated were 2.47kg; 3.67kg; 1.22kg and 7.96 kg respectively for *P. sudanicus, C.* cf. *molybdites, G. lucidum* and *P. Pachyphloeus.* One should use such quantities of fresh mushrooms for unique dose consumption to reach the LD50. Fortunately, in the study area, these quantities surpassed the daily consumption of individual villager. Our results suggest that except *G. lucidum*, the studied species can be used for food or medicine. By taking a minimum of precautions, these species could be developed on the nutritional and therapeutic level.

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