BirEx JOURNAL
Budapest International Research in Exact Sciences
Medical, Biological, Argiculture, Engineering
Science and other related areas
e-ISSN : 2655-7827
p-ISSN : 2655-7835
http://www.bircu-journal.com/index.php/birex

Dynamics of dry matter, organic matter and crude protein in the leaves of four varieties of *Brachiaria brizantha* at the vegetative stage, under the ecological conditions of Kisangani in the DRC

Maurice D. Ngakpa[1], Roger-Lafleur M. Musalizi[2], Jean-Pierre N. Mukandama[2], Joseph I. Saile[1], Colette A. Masengo[3], Ngbolua Koto-te-Nyiwa[3]*

[1]*Institut Facultaire des Sciences Agronomiques de Yangambi, BP 1232 Kisangani, République démocratique du Congo*
[2]*Université de Kisangani, République démocratique du Congo*
[3]*Mention de Sciences de la Vie, Faculté de Sciences et Technologies, Université de Kinshasa, Kinshasa, République Démocratique du Congo*
jpngbolua@unkin.ac.cd

Abstract: *The present work aimed to evaluate the variation of dry matter, organic matter and crude protein in the vegetative phase of four varieties of Brachiaria brizantha (Xaraes, Piata, Marandu and Locale) in forage cultivation. After field experimentation in a complete random block system, and laboratory analyses, the results obtained show that the dry matter content increases from the beginning tillering stage to the end tillering stage and varies according to variety. The highest dry matter content is recorded in the local variety at the end tillering stage. The crude proteins content also varies depending on variety and phenological stage, the protein contents are higher at the full tillering stage in the varieties Xaraes (17.34%), Locale (15.8%) and Marandu (14.2%), while the Piata variety reaches its highest protein content from the beginning tillering stage (13.8%). Overall, the Xaraes variety is more protein-rich, its average protein content in the vegetative phase is 15.3%. Thus, the Xaraes variety is economically more interesting than the others, protein being the most expensive component in livestock feed. This is why this variety would be indicated to be popularized with a view to large-scale exploitation in the Kisangani region. However, additional bromatological analyzes are necessary before any decision.*

Keywords: *Brachiaria brizantha, variety, phenological stage, dynamics, dry matter, organic matter, crude proteins*

I. Introduction

The Democratic Republic of Congo (DRC) is an exceptional biogeographical region in Africa and one of the world's reservoirs of biodiversity, including grazed ecosystems (Asimonyio *et al.*, 2015; Badjedjea *et al.*,2015; Baelo *et al.*,2016; Ngbolua *et al.*,2014; Kambale *et al.*, 2016). Natural pastures play an important role in feeding livestock in tropical regions (Yameogo *et al.*, 2013). To this end, determining the nutritional value of available forage species is a necessity in the Kisangani region with a view to setting the carrying capacity of forage areas and improving the productivity of ruminant livestock.

Forage resources in the Kisangani region are dominated by a few grasses of which nutritional value, despite their hardiness and adaptability, has not yet been assessed at the various phenological stages of the vegetative phase. In fact, it is well established that in the tropics at medium and low altitudes, grasses of the

DOI: https://doi.org/10.33258/birex.v6i2.7818
[redacted]

Budapest International Research in Exact Sciences (BirEx) Journal
Volume 6, No 2 April 2024, Page: 96-103
e-ISSN: 2655-7827 (Online), p-ISSN: 2655-7835 (Print)
www.bircu-journal.com/index.php/birex
email: birex.journal@gmail.com

Brachiaria genus are renowned for their forage capacity (Klein *et al.*, 2014). However, the ignorance of the variation in the nutritional value of these plants is said to be at the root of the forage crisis in Kisangani livestock farms. Hence the need to assess the evolution of their nutrients in forage crops.

Knowledge of nutrient evolution in varieties at different growth stages of these forage species is essential for determining maximum stocking rates for pastures, with a view to sustainable use of forage areas. It is within this framework that the present work was initiated, with a view to assessing the dynamics of dry matter, organic matter and crude protein in four varieties of *Brachiaria brizantha*, a grass (Poaceae) perfectly adapted to the ecological conditions of Kisangani. Knowledge of these elements is essential for the composition of balanced ruminant feed rations (Rivière, 1978).

This study aims to test the hypothesis that *B. brizantha* varieties behave differently in terms of dry matter, organic matter and crude protein content at different phenological stages of their vegetative phases. The interest of the present work is obvious, as it will enable us to select the best B. brizantha variety for large-scale extension in Kisangani.

II. Research Methods

2.1. Study area

The trial was carried out in Kisangani on the IFA concession and at the Mugbamboli farm, located 20 km from the town center on the old Buta road (Fig. 1). The geographical coordinates of the Mugbamboli farm are: altitude: 403 m above sea level; latitude: 00° 37' 54.1" North; longitude: 25°17'50.5" East. Those of the IFA, taken at the center of the experimental field by GPS GAMIUM MAP 625, are as follows: longitude: 25° 09' 52.8'' E; latitude: 00° 30' 48.9'' N; altitude: 370 m.

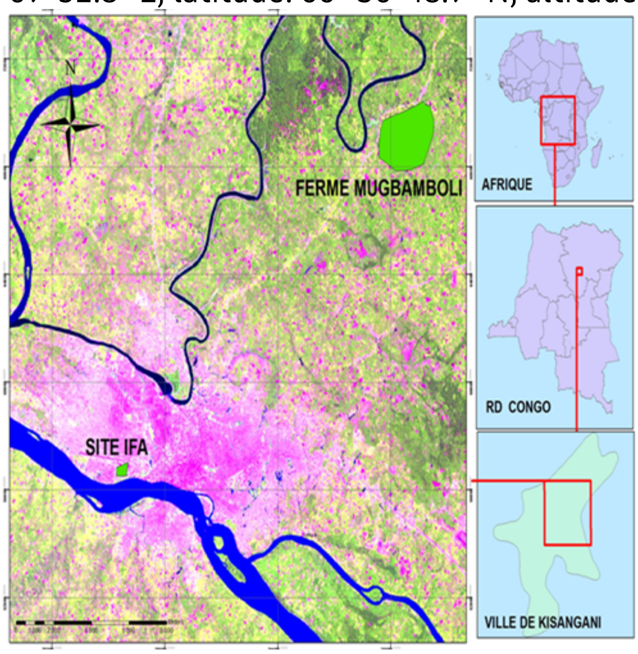

Figure 1. *Geographical location of the IFA site and the Mugbamboli farm*

The Kisangani region belongs to Köppen's Af climatic type. This is a humid

tropical climate with an average temperature of over 18°C in the coldest month and a monthly rainfall of over 60 mm in the driest month (Goffaux, 1990). The annual rainfall pattern shows a double periodicity. The main and secondary maxima are in October and May respectively, while the main and secondary minima are in January and July respectively. Air humidity is fairly high. The monthly average is around 77% to 82%. The city of Kisangani is watered by two river systems: the Congo River and the Tshopo River. Mugbamboli Farm is drained by
the Tshopo River and by two streams that flow into it: Ngenengene and Mugbamboli.

The soils of Mugbamboli farm have the general characteristics of soils in the Kisangani region. The bedrock is made up of sandstone systems (red sandstone, schist and quartzite), while the overburden is formed of clay-sandstone layers (red clay, collateral sandstone). These soils belong to the Lindian system (Upper Precambrian) and have the general characteristics of the soils of the central basin. They are generally acidic (pH around 4.5) and poor in primary minerals (Van Wambeke and Evrard, 1954). In addition, it should be noted that the Congo phytogeographical classification proposed by Ndjele (1988), places the entire Kisangani region, including our experimental sites, in the Central-Eastern Maïko district of Wildeman's central forest sector, Congolese domain, Guineo-Congolian region (White, 1979). Lejoly *et al* (1988) classify the forests of the Kisangani region as equatorial evergreen rainforests.

2.2 Plant material

The plant material used in this study consists of four varieties of *B. brizantha* at different phenological stages.

2.3 Methods

a. Preliminary experiments

The preliminary experiment involved seed acquisition and multiplication. Seeds of the Piata and Xaraes varieties came from Brazil, while the Marandu variety was obtained from INERA NIOKA in DRC. The local variety was found and harvested at kilometre point 22 of the old Buta road (Tshopo Province/RD Congo), on a site where a Belgian settler had attempted to raise cattle in colonial times. *B. brizantha* varieties were planted in a seedbed and propagated by stump shattering. The material was prepared by splitting the stumps, followed by dressing and pralining the resulting splinters.

b. Experiments

The dynamics of dry matter, organic matter and crude protein of *B. brizantha* varieties were studied in the field in a complete randomized block design. The nutrient content of the leaves of four B. brizantha varieties (Xaraes, Piata, Marandu and Locale) from this set-up was determined at three stages of the vegetative phase (beginning tillering stage, corresponding to two-week-old seedlings; full tillering stage, corresponding to 4-week-old seedlings; and end tillering stage, corresponding to 6-week-old seedlings).

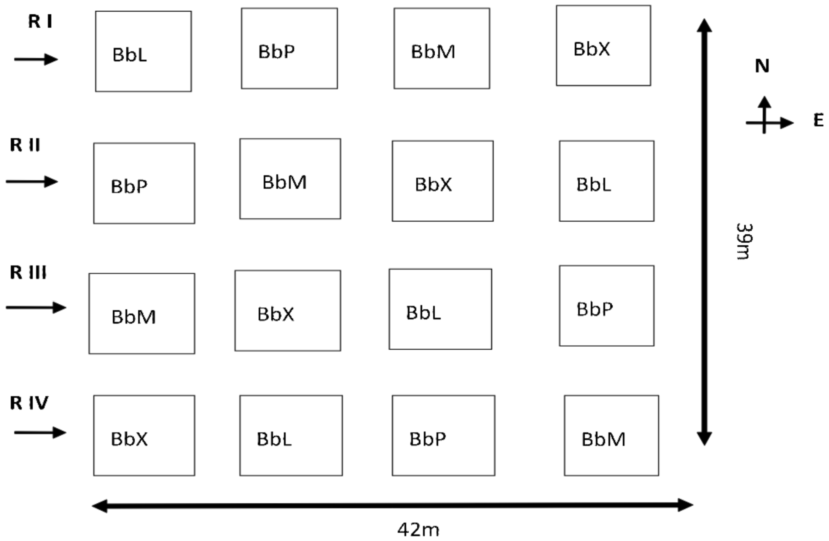

Figure 2. *Experimental layout of 4 complete randomized blocks*

Legend: BbL, BbP, BbM and BbX are respectively the plots containing the Locale, Piata, Marandu and Xaraes variety of *Brachiaria brizantha*. RI, RII, RIII and RIV are the repetitions.

c. Determining nutrient dynamics

To estimate nutrient dynamics in the leaves, the regrowth was mown with a machete at various stages of the vegetative phase, then stripped of leaves. Leaf aliquots were taken and sent to the IFA laboratory for analysis. Dry matter content was determined by oven-drying at 105°C to constant weight in accordance with ISO 6496 (1999); organic matter content was determined by oven-calcination in accordance with ISO 5984 (2002), while crude protein was obtained by determining total nitrogen using the Kjeldahl method, followed by application of the 6.25 coefficient specified for forage in accordance with FAO (2016).

2.4. Data analysis

Nutrient contents were expressed as a percentage, then subjected to analysis of variance (ANOVA) using Statistica version 8 software. Fisher's LSD test was used for comparison of means.

III. Results and Discussion

The table below gives the dry matter, organic matter and crude protein contents of four *B. brizantha* varieties at the three phenological stages of the vegetative phase.

Table 1. Dry matter, organic matter and crude proteins contents of four *B. brizantha* varieties at the three phenological stages of the vegetative phase.

Phenological stages	Varieties											
	Xaraes			Piata			Marandu			Locale		
	DM (%)	OM (%)	CP (%)	DM (%)	OM (%)	CP (%)	DM (%)	OM (%)	CP (%)	DM (%)	OM (%)	CP (%)
BT (2W)	21,6	92,0	14,8	21,9	93,0	13,8	20,7	90,5	11,6	20,8	93,0	14,6
FT (4W)	24,3	90,0	17,3	25,8	91,0	13,4	21,4	89,5	14,2	21,9	91,0	15,8

ET (6W)	27,9	89,5	13,9	27,6	90,5	12,3	25,5	89,0	12,7	30,0	89,5	12,8
Mean	24,6	90,5	15,3	25,1	91,5	13,2	22,5	89,7	12,8	24,2	91,2	14,4

Legend. BT: beginning tillering; FT: full tillering; ET: and tillering; W: week; DM: dry matter; OM: organic matter; CD: crude proteins.

The ANOVA showed significant differences between varieties, between phenological stages and between varieties and phenological stages ($p < 0.05$). These differences are presented in the figures below.

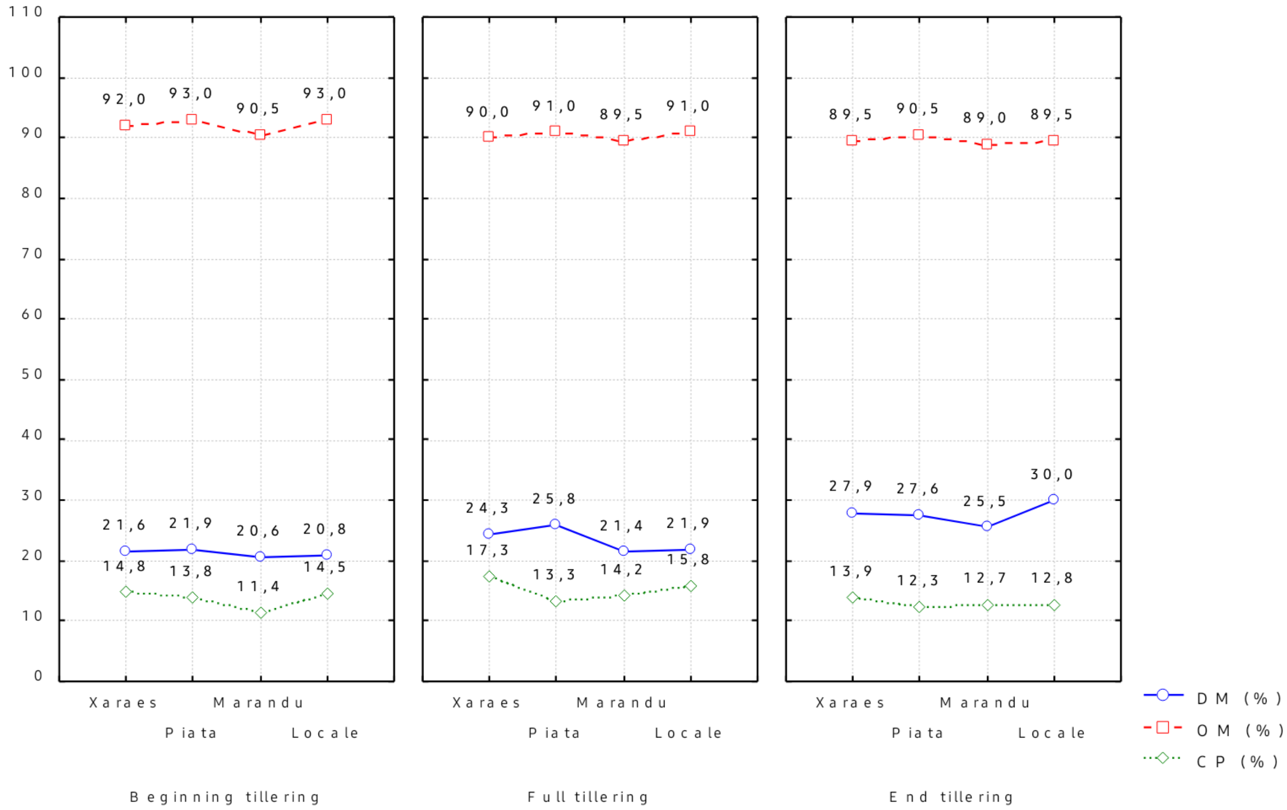

Figure 3. *Phenological stages of different varieties used*

Comparison of means using Fisher's LSD test enabled us to classify varieties at different phenological stages with regard to dry matter, organic matter and crude protein content, in descending order as follows:
At early tillering:
For dry matter: Piata (21.9) > Xaraes (21.6) > Locale (20.8) =Marandu (20.7)
For organic matter: Piata (93) = Locale (93) > Xaraes (92) > Marandu (90.5)
For crude proteins : Xaraes (14.8) = Locale (14.6) > Piata (13.8) > Marandu (11.6)
At full tillering:
For dry matter: Piata (25.8) > Xaraes (24.3) > Marandu (21.4) > Locale (21.9)
For organic matter: Piata (91) = Locale (91) > Xaraes (90) > Marandu (89.5)
For crude protein: Xaraes (17.34) > Locale (15.8) > Marandu (14.2) > Piata (13.35),
At late tillering
For dry matter: Locale (30) > Xaraes (27.9) > Piata (27.6) > Marandu (25.5)
For organic matter: Piata (90.5) > Xaraes (89.5) = Locale (89.5) > Marandu (89)
For crude protein: Xaraes (13.9) > Locale (12.8) = Marandu (12.7) = Piata (12.3).

This comparison shows that

a. The local variety is richer in dry matter at the late tillering stage (30 % DM), while at the full and early tillering stages, the Piata variety is better (25.8 % and 21.9 % DM respectively);

b. The Piata variety produces more organic matter at the early and late tillering stages (93 % and 90.5 % OM respectively), while at the full tillering stage the Piata and local varieties (91 % OM each) are the best;

c. The Xaraes variety produces more protein at the early, full and late tillering stages (14.8 %, 17.34 % and 13.9 % CP respectively), while the local variety is only better at the early tillering stage (14.6 % CP).

As a result, the Xaraes variety at full tillering is better suited to feeding ruminants with high protein requirements, particularly young growing animals and dairy cows. In terms of dry matter requirements, all these varieties at the phenological stages studied fall within the ideal range of dry matter content (20 – 30 % dry matter) defined by Dowel and Urdaneta (1975).

As for organic matter, the contents observed in all varieties at different phenological stages show that crude ash contents (100% - % organic matter) vary little with variety, but decrease slightly from early tillering to late tillering. These values remain between 7 and 12.5%, as found by Rivière (1978) in *B. brizantha* grown dry in the Sudano-Guinean climatic zone, with rainy seasons ranging between 6 and 7 months. The organic matter contents recorded at the various phenological stages (in the varieties under study) are satisfactory, insofar as the energy of the forage comes solely from the components of organic matter, notably carbohydrates, lipids and proteins. Ensmiger and Olentine (1978) state that young grass with an organic matter content of around 80% can achieve an energy value of around 0.70 UF. In view of this consideration, all the phenological stages tested in our varieties will more than cover the energy requirements of ruminants, which are estimated, according to Boudet (1975), at 0.60 UF and over 0.60 UF respectively for good-quality and excellent forage.

For the whole vegetative phase, comparison of the averages enabled us to classify the varieties for the parameters studied as follows:

For dry matter content: Piata (25.1) > Xaraes (24.6) > Locale (24.2) > Marandu (22.5);

For crude protein content: Xaraes (15.3) > Local (14.4) > Piata (13.2) > Marandu (12.8);

For organic matter content: Piata (91.5) > Locale (91.2) > Xaraes (90.5) > Marandu (89.7).

This comparison shows that the Piata variety is richer in dry matter and organic matter, while the Xaraes variety is higher in crude proteins. Both varieties therefore have a high forage potential. However, the emphasis will have to be placed on in-depth bromatological analysis of the dry matter of these two varieties with high agropastoral potential in order to guarantee their sustainable use in the ecological conditions of Kisangani.

IV. Conclusion

In this study, we determined the dry matter, organic matter and crude protein content of the regrowth of four *B. Brizantha* varieties, at three stages of their vegetative phase. Dry matter, organic matter and crude protein content varied with variety and phenological stage. Dry matter content increases from beginning tillering to end tillering and varies by variety. The highest dry matter content is recorded for the local variety at the end tillering stage. Crude protein content also varies according to variety and phenological stage, with protein content highest at full tillering in the Xaraes (17.34%), Locale (15.8%) and Marandu (14.2%) varieties, while the Piata variety is richest in protein at beginning tillering (13.8%). The Xaraes variety is the most protein-rich, its average protein content in the vegetative phase being 15.3%. Xaraes is therefore economically more attractive than the other varieties, since protein is the most expensive component of livestock feed. For this reason, this variety would be well suited to being popularized for large-scale exploitation in the Kisangani region. However, further bromatological analysis is required before any decision can be taken.

References

Asimonyio J.A., Kambale K., Shutsha E., Bongo G.N., Tshibangu D.S.T., Mpiana P.T., Ngbolua K.N. (2015). Phytoecological Study of Uma Forest (Kisangani City, Democratic Republic Of The Congo). Journal of Advanced Botany and Zoology, V3I2. DOI: 10.15297/JABZ.V3I2.01, 2015.

Asimonyio J.A., Ngabu J.C., Lomba C.B., Falanga C.M., Mpiana P.T., Ngbolua K.N. (2015). Structure et diversité d'un peuplement forestier hétérogène dans le bloc sud de la réserve forestière de Yoko (Ubundu, République Démocratique du Congo). International Journal of Innovation and Scientific Research, 18(2):241-251.

Badjedjea B.G., Akuboy B.J., Masudi M.F., Asimonyio J.A., Museu K.P., Ngbolua K.N. (2015). A preliminary survey of the amphibian fauna of Kisangani eco-region, Democratic Republic of the Congo. Journal of Advanced Botany and Zoology, V3I4.DOI: 10.15297/JABZ.V3I4.01.

Baelo P., Asimonyio J.A., Gambalemoke S., Amundala N., Kiakenya R., Verheyen E., Laudisoit A., Ngbolua K.N. (2016). Reproduction et structure des populations des Sciuridae (Rodentia, Mammalia) de la réserve forestière de Yoko (Ubundu, RD Congo). International Journal of Innovation and Scientific Research, 23(2):428-442.

Boudet G. (1975). Manuel sur les pâturages tropicaux et les cultures fourragères (2ième édition), Institut d'Elevage et de Médecine Vétérinaire des Pays Tropicaux, République française, Ministère de la coopération, 254 pp.

Duthil, J. (1967). La production fourragère. J.-B. Balliere & Fils, Editeurs. 19, rue Hautefeuille - Paris-VIe, 373 pp.

Ensminger M.E. and Olentine C.G. (1978). Feeds and nutrition complete. The Ensminger Publishing Compagny 3699 East Sierra avenue clovis, California 93612. USA. 1417 p.

FAO (2016). Assurance qualité pour les laboratoires d'analyse d'aliments pour animaux. Manuel FAO de Production et Santé Animales No. 14, Rome.

Rivière, R. (1978). Manuel d'alimentation des ruminants domestiques en milieu tropical (2e édition), République française, Ministère de la Coopération Imprimerie JOUVE, 17, du Louvre ,75001 Paris, 527p.

Goffaux J. (1990). Notions de climatologie. Centre de Recherches Pédagogiques, Kinshasa (RD Congo).

ISO 5984 (2002). Animal feeding stuffs – Determination of crude ash. Geneva, Switzerland.

ISO 6496 (1999). Animal feeding stuffs – Determination of moisture and other volatile matter content. Geneva, Switzerland.

Kambale J.-L.K., Shutsha R.E., Katembo E.W., Omatoko J.M., Kirongozi F.B., Basa O.D., Bugentho E.P., Yokana E.I., Bukasa K.K., Nshimba H.S., Ngbolua K.N. (2016). Etude floristique et structurale de deux groupements vegetaux mixtes sur terre hydromorphe et ferme de la forêt de Kponyo (Province du Bas-Uele, R.D. Congo). International Journal of Innovation and Scientific Research, 24(2);300-308.

Lejoly J., Lisowski S., Ndjele M. L. (1988). Les plantes vasculaires de la Sous-Région de Kisangani et de la Tshopo. Catalogue informatisé. Doc. Polycopié Fac. Sc., ULB.

Dowel M.C., Urdaneta, A.E. (1975). Intensive systems for beef production in the tropics. Journal of Animal Sciences, 41(4):1228 – 1237

Ndjele M.B. (1988). Les éléments phytogéographiques endémiques dans la flore vasculaire du Zaïre. Thèse de doctorat ULB, Laboratoire de Botanique Systématique & Phytothérapie, 1988.

Ngbolua K.N., Ngemale G.M., Konzi N.F., Masengo C.A., Gbolo Z.B., Bangata B.M., Yangba T.S., Gbiangbada N. (2014). Utilisation de produits forestiers non ligneux à Gbadolite (District du Nord-Ubangi, Province de l'Equateur, R.D. Congo): Cas de Cola acuminata (P.Beauv.) Schott &Endl. (Malvaceae) et de Piper guineense Schumach. &Thonn.(Piperaceae). Congo Sciences, 2(2):61-66.

Van Wambeke A., Evrard C. Notice explicative de la carte des sols et de la végétation du Congo belge et du Ruanda-Urundi. 6. Yangambi : planchette 1 : Weko, A et B. Bruxelles : Publication INEAC, pp. 1-23 ; 1954.

Yameogo G., Kiema A., Yelemou B., Ouedraogo L. (2013). Caractéristiques des ressources fourragères des pâturages naturels du terroir de Vipalago (Burkina Faso). International Journal of Biological & Chemical Sciences, 7(5) :2078-2091.