ENDOGENOUS KNOWLEDGE AND LOCAL PERCEPTION ON *JATROPHA CURCAS* IN CENTRAL AFRICAN REPUBLIC

TOUCKIA[1] Gorgon Igor, [2]YONGO Olga Diane, [1]DEGUENE Bruce, [1]WABOLOU Francois, [3]KOKOU Kouami

ABSTRACT

Jatropha curcas L. (Euphorbiaceae) is a plant with different kind of use. The particular importance of this plant is its ability to adapt to the effects of climate change and to solve energy crisis. The aim of this study is to contribute to a better understanding of local knowledge and local perception on this plant in Central African Republic (CAR). Surveys were conducted in ten (10) divisions of CAR and one thousand people of different age groups, genders and ethnic groups were interviewed. A Factorial Correspondence Analysis (FCA) is used to calculate the variability between different ethnic groups, the uses and the most used parts of the plant. In CAR, 30.3 % of persons named this plant Kada whereas 25.8 % named Kadandoro. Cuttings (84.5 %) are the most recurrent used as seedlings. The plant is more used in traditional therapy (72.7 %). Banda, Ngbandi and Nzakara, tribes used the plant as a living fence Gbaya, Sara and Oubanguien tribbes, preferentially used it in traditional medicine. Mboum tribe used it lessly as windbreaks and anti erosion. The leaf (44. 9 %) and the sap (20.6 %) are the most used parts of the plant. The most cited pathology is cough (21.6 %). In traditional therapy, other plants such as, 35 % *Citrus limon* and 16 % *Cymbopogon citratus,* were associated in the preparation of mixtur with *J. curcas*.

Key words: *Jatropha curcas*, endogenous knowledge, local perception, Central African Republic.

RÉSUMÉ

Jatropha curcas (Euphorbiaceae), est une plante à usage multiple à laquelle une importance particulière est accordée, à cause des effets de changements climatiques et la crise énergétique. L'objectif de cette étude est de contribuer à une meilleure connaissance des savoirs endogènes et de la perception locale en Centrafrique sur cette ressource. Des enquêtes ont été réalisées dans dix préfectures de Centrafrique et mille personnes de différentes tranches d'âges, des deux sexes et de différents groupes ethniques ont été interrogés. Une Analyse Factorielle de Correspondance a permis de mesurer la variabilité entre les différents groupes ethniques, les utilisations et les organes les plus utilisés. Kada avec 30,3 % et Kadandoro avec 25,8% sont les noms locaux les plus utilisés. Le bouturage avec 84,5 % est le mode de semis le plus récurrent. La plante est plus utilisée en thérapie traditionnelle avec 72,7%. Les groupes ethniques Banda, Ngbandi et Nzakara utilisent plus la plante comme haie vive. Les Gbaya, Sara et Oubanguien l'utilisent préférentiellement en médecine traditionnelle. Les Mboum l'utilisent faiblement comme brise vent et anti érosif. La feuille avec 44,9 % et la sève avec 20,6 % sont les parties de la plante les plus utilisées. La pathologie la plus citée est la toux avec 21,6 %. En thérapie traditionnelle, d'autres plantes dont *Citrus limon* avec 35 % et le *Cymbopogon citratus* avec16 % sont associées dans la préparation des mixtures avec le *J.curcas*.

Mots clés : *Jatropha curcas*, connaissance endogène, perception locale, République Centrafricaine.

[1] Institut Supérieur de Développement Rural (ISDR), Université de Bangui, BP : 909, Mbaïki, Centrafrique.
[2] Laboratoire de Biodiversité Végétale et Fongique, Faculté des Sciences, Université de Bangui, BP 908, avenue des Martyrs. Bangui, Centrafrique.
[3]Laboratoire de Botanique et Ecologie Végétale, Faculté des Sciences, Université de Lomé, 1 BP : 1515 Lomé 1, Togo.
Correspondant : igortouckia@hotmail.fr

INTRODUCTION

Jatropha curcas L. (Euphorbiaceae) which French name's Jatropha, is a plant originated from Central America currently widespread throughout tropical Africa (Prasad et al., 2000; Qin et al., 2005; Gasol et al, 2007. ; Kaushik et al., 2007). It is a very hardy plant that grows even in the tough conditions (Achten et al., 2008). It is commonly used in the tropics as a defensive protection against animals or to demarcate the belongings (Domergue and Pirot, 2008). Its seeds contain oil which is used as biofuel (Jongshaap et al., 2007). Residues of seed are also known as seed meal, are used as organic fertilizer (Henning, 2002). The oil extracted from the seeds is also used to make local soap, which is an income generating activity for women in rural areas (Zahawi, 2005; Madlener et al., 2006). The different parts of the plant are also used in traditional medicine to treat a number of diseases (Assogbadjo et al., 2008). Given to the energetic independence and climate challenge, a particular focus is laid on *J. curcas* (Parawira, 2010). Among the potentially useful crops to supply the essential raw material for biofuel production, that *J. curcas* generates more and more interest into various development agencies in tropical and subtropical regions (Daudet, 2011). The plant is not consumed by livestock because it contains highly toxic substances (Makkar et al., 1997).

Previous works claim that *J. curcas* is unique one of plant from energy crops (Achten et al., 2008, Domergue and Pirot, 2008, Henning, 2002). Its use for biofuel production could be for major interest to compensate for the energy shortages, accelerate the reduction of greenhouse gas emissions from carbon neutral and contribute to increasing farmers' income (Openshaw, 2000). In several African countries such as Mali, Burkina Faso, Senegal, fight against poverty projects and energy independence in rural areas are based on the cultivation of this plant (Gado, 2011). Under proof of progress in this sector, the Global Exchange for Social Investment (GEXSI) in the report of its study commissioned by WWF, amounted to almost 900 000 ha planted with Jatropha spaces on all continents which at least 120 000 in Africa (Gado, 2011).

The Central African Government, in its fight against climate change policy aims at promoting biofuel production. *J. curcas* is therefore, as such, the selected plant and is the most appropriate plant to be valued among the potential plants. It is a plant that grows throughout the territory and does not come into competition with other crops. Because, it is not eatable. Many studies have been conducted on *J. curcas* in other African countries (Henning, 2002; Assogbadjo et al., 2008; Ahoton et al., 2012, Minengu, 2014), but in the Central African Republic, many aspects remain to be done in the research on *Jatropha* because the knowledge is still at low level. Since the different way of use differ according to the resources, region, gender, sex and ethnic groups (Belem et al., 2008; Camou-Guerrero et al., 2008), it is essential to valorize *J. curcas*, to conduct investigations by an ethnobotanical assessment in order to collect data on the uses and the perception of rural populations of Central African Republic.

Thus, the purpose of this work is to contribute to a better understanding of indigenous knowledge on *J.curcas* in Central African Republic and measure the level of acceptability or the perception of the populations about its introduction into the agricultural system in a context of recession land that requires the practice of agroforestry.

MATERIAL AND METHODS

1. Choice of survey localities

The study was conducted in the Central African Republic in ten (10) selected divisions at random among the sixteen (16) in the country (Figure 1). It takes into account four out of the five climate zones of the country. In the sampled divisions, from 1 to 4 towns were chosen randomly for investigations and in each municipality 3 or 4 villages are selected randomly.

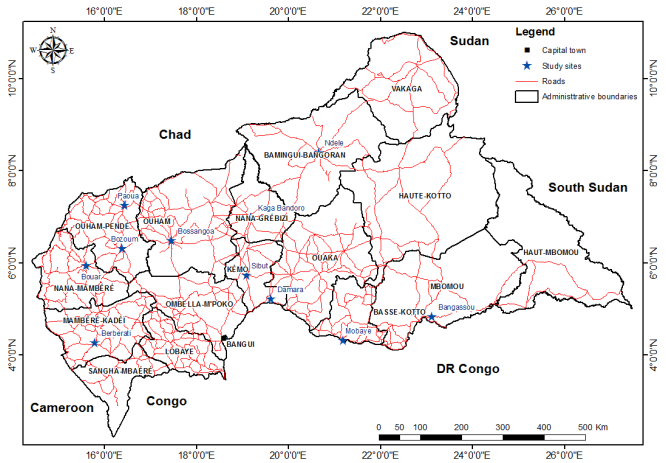

Figure1: Cities surveyed in Central African Republic

2. Data collection

Surveys were conducted between April and May 2013 and June 2014. One thousand people from different age groups of both sexes and of different ethnic groups were interviewed. In each sampled village, surveys were conducted by selected enumerators based on different ethnic groups of both sexes and of different age categories. Individual and/or group interviews have been made on the basis of open questions, indirect and direct, in the vernacular. The information collected concerned the age of the respondents, the ethno-pharmacological data such as local names, used parts of plants, plants associated in values, knowledge about cultivation methods and the perception of the population on the valuation of culture as bioenergy. In this study, the young person is the one whose age is below 30 years, the adult is the person whose age ranges from 30 to 60 years old and the old one is he/she who above 60 (Assogbadjo et al., 2009).

3. Statistical analysis

Data were processed according to ethnic groups, gender and different age groups. They were analyzed using the Software <SPSS for windows> Version 16. The Factorial Correspondence Analysis (ACF) was performed using the software XLSTAT 2008 and the Excel Spreadsheet was used for the realization of some graphics.

RESULTS

1. Ethnic groups

The various ethnic were regrouped into seven big groups. The Banda group includes the Banda, the Langbachi and the Ngbougou. Gbaya the group that is the most representative in this study with a proportion of 25. 3 % (Figure 2), includes the Gbaya, the Mandja, the Ali and the Gbanou. The Mboum group brings together the Karé, the Tali and the Pana. The Ngbandi group is made up of the Yakoma and the Sango. The Sara group consists of the Kaba, the Dagba and the Goula; the Nzakara group is constituted of the Nzakara and the Zande. And finally the Oubangian group brings together the Ngbaka, the Bolaka, the Gbanziri and the Monzombo.

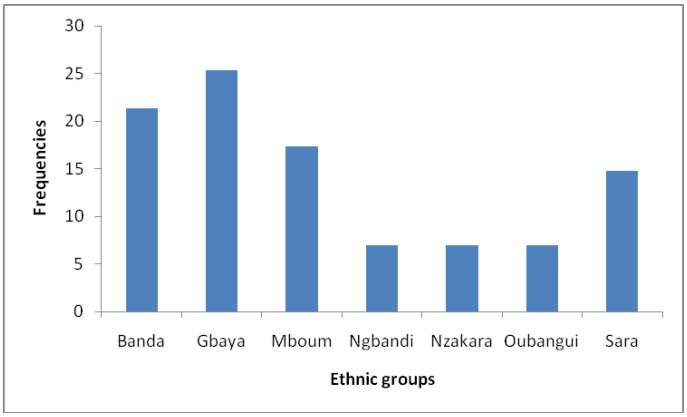

Figure 2: Proportion of respondents belonging to different ethnic groups

2. Local names

From the seventeen (17) cited vernacular names of *J. curcas* in the different localities, Kada with 30.3% usage rate, followed by Kadandoro (25.8%) and by Kadamonon (12.5%) are the most used while Ziguizila, Zenga, Ndounda, Ndérévona, Kpoyongo, Colcoladji and Amchour are hardly used (Figure 3).

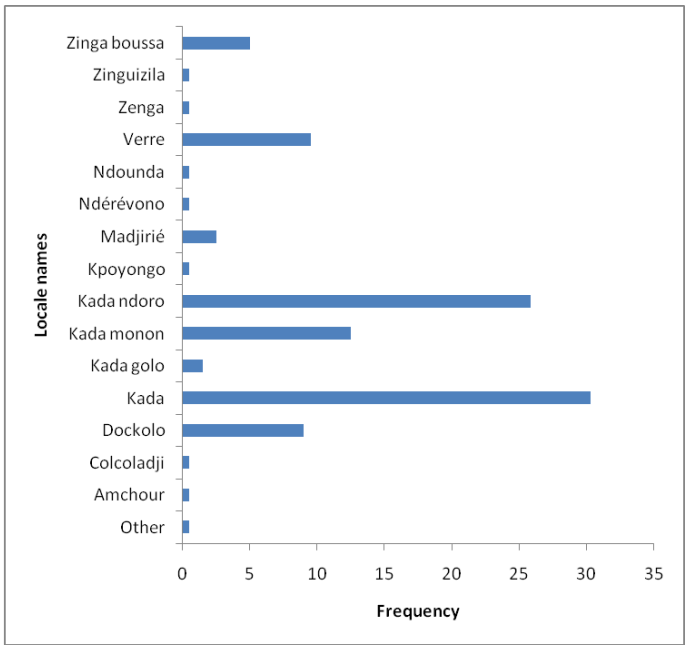

Figure 3: Frequency of the use of the different local names *of J.curcas* in CAR.

3. Planting methods

Cuttings are the most used mode of seeding with 84. 5% followed by direct seeding with 14% and very few users practice cultivation by transplanting (1.5%) (Figure 4).

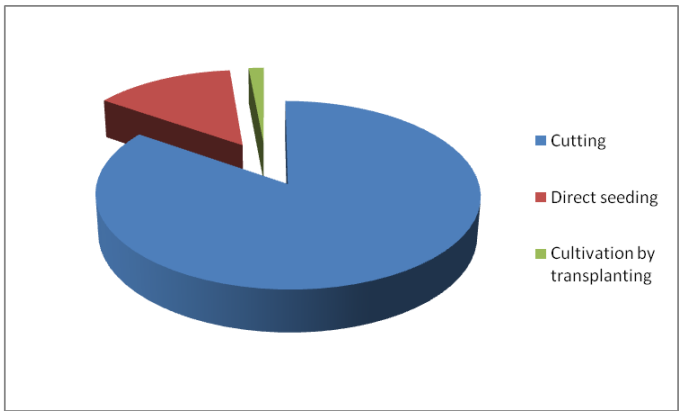

Figure 4: Planting modes of *J. curcas*

4. Different uses of *J.curcas* by ethnic groups

The first two axes F1 and F2 of the AFC (Figure 5) explain 74.90% of the total variability. The first axis F1 contributes to 52.78% and 22.12% in the second.

It appears that ethnic groups namely Banda Ngbandi and Nzakara use mostly the plant as a protection against wandering animals, and for the manufacture of local soap. In addition, these groups also use the plant in traditional medicine, and hardly as residential fence. The Gbaya, the Sara and the Oubangien groups preferentially used the plant in traditional medicine and then as residential fence, while the ethnic group Mboum uses it as windbreaks. The Sara meanwhile use it as anti-erosive and means of protection against evil spells. Among the eight types of uses identified in this study, it appears that *J.curcas* is more used in traditional medicine (72.7%) and then as fence (15%).

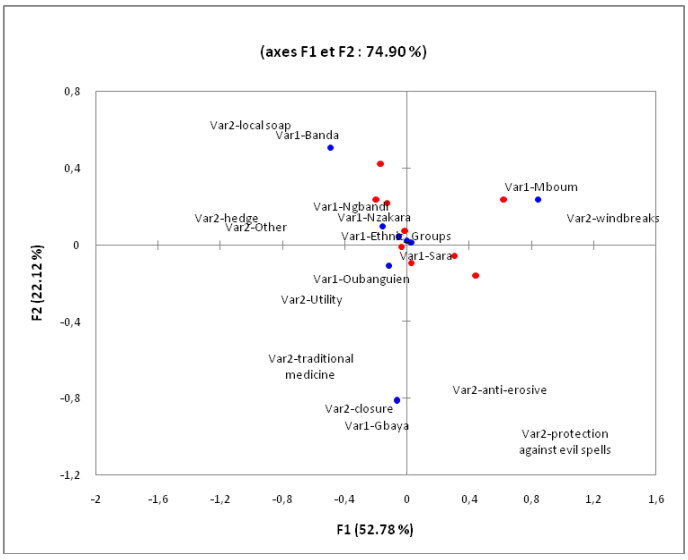

Figure 5: Links between the different uses of *J. curcas* and ethnic groups

5. Organs used regarding ethnic groups

ACF performed to study the variability between organs and ethnic groups (Figure 6) shows that the first two F1 and F2 axes explain 81.25% of the total variability. The first axis F1 contributes to 66.69% and the second at 14.56%. Out of the different parts of use, the Sara, the Nzakara and the Ngbadji groups use mostly the sap while the Oubangien, the Banda and the Mboum use the leaf. However the Mboum, out of leaf, use also the seeds, the bark and the stem.

The Gbaya in turn, make use of the leaves, the roots and also the rod. Among the different used parts of the plant by the different ethnic groups, the leaf, with 44.9 % frequency of use is the most used, followed by 20.6% with the sap.

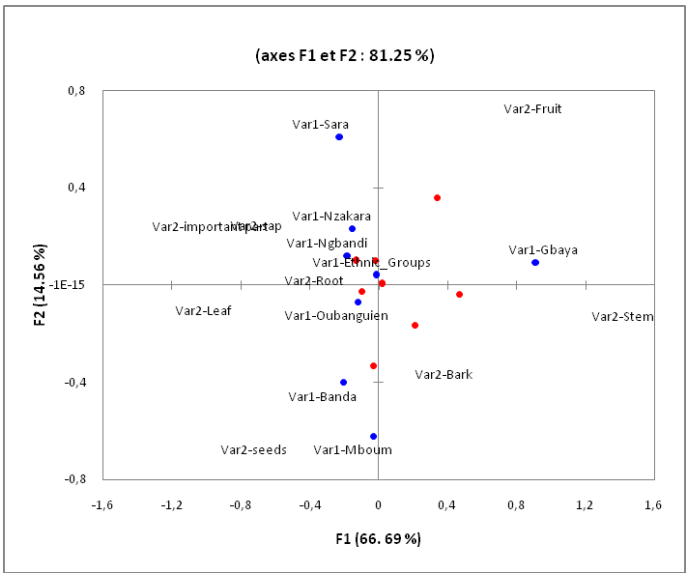

Figure 6: Different parts of *J. curcas* used by ethnic groups

6. Diseases and symptoms treated regarding ethnic features

The data analyse by ACF showed, The ACF performed shows with the first two axes, 72.73% of the information recorded on diseases and symptoms treated with Jatropha by the different ethnic groups. The first axis contribute to 52.22% and the second at 18.51% (Figure7).

The Gbaya and the Mboum used mostly Jatropha plant in

the treatment of malaria, typhoid fever, diarrhea, jaundice, of parasitosis and gonorrhea. Nzakara, Banda, Ngbandji and Sara used mostly Jatropha plant, to treat conjunctivitis, otitis, influenza, skin disease, while Oubanguiens use it for tooth decay, stomach aches and cough.

Out of all the diseases treated, comes first the wound (26.3%), followed by cough (21.6%), and then typhoid fever and dermatosis with 10.06 % and 10% respectively.

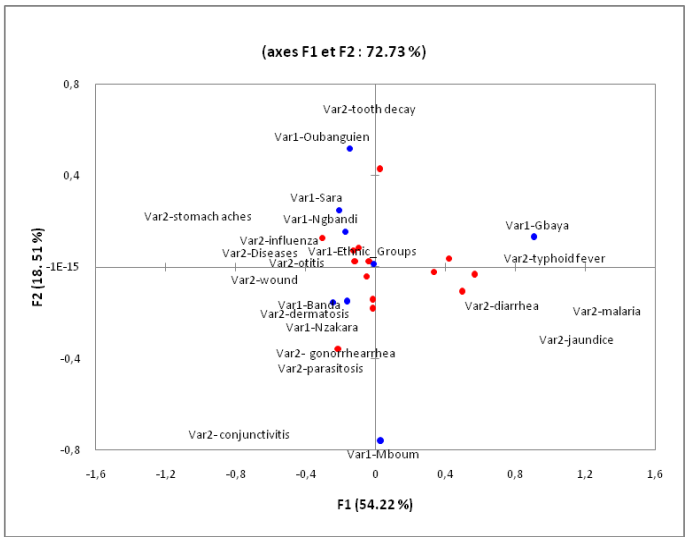

Figure 7: Diseases and symptoms treated by ethnic groups

7. Plants associated with *J.curcas* in traditional medicine treatments

A number of plants are usually associated with Jatropha (*J.curcas*) in traditional medicine treatments. In this study 10 species have been recorded. They include *Spondias dulcis* (Anacardiaceae)*; Annona muricata* (Annonaceae); *Elaeis guinensis* (Arecaceae) *; Dacryodes edulis (*Burseraceae)*; Tamarindus indica* (Caesalpiniaceae); *Cymbopogon citratus* (Poiceae), *Citrus limon* (Poiceae), *Citrus sineensis* (Rutaceae); *Citrus maxima* (Rutaceae); *Lantana camara* (Verbenaceae*)*. Among associated species, the most used is *Citrus limon* (35%), followed by *Cymbopogon citratus* (16%) and *Lantana camara* (12%).

Plant parts associated most commonly used are the leaves (59%) followed by roots (38%). The most common method of preparation is decoction (63%). The oral route is the most used mode of administration (72%).

8. Acceptability intercropped by the population

8.1 Motivations for growing *J.curcas* L.

The awareness of the public on the usefulness of *J. curcas* (90%) facilitates its introduction into the cropping system. The few reasons for their motivation are mainly related to the fact that this plant can be a rural poverty reduction means. The proportion of this population fringe is 33.1%. The proportion of different ethnic groups of population those who believe that *Jatropha*, can contribute to a local energy source is 32.60%. However, the proportion of those who think that this culture will allow them to diversify their cropping system is the lowest with 3.80% (Figure8). Regarding, the use of the plant by ethnic groups according to age, the use as an energy source is the primary reason, all ethnic groups (Figure 8) and the main categories of age (Figure 9); engage in the cultivation of *J. curcas*; then just use as a means to fight against poverty. The proportion of those who perceive the plant as a means of diversification of crops is the lowest (12%)

Regarding the opinion on the acceptability of the introduction of this plant, women are most concerned with a proportion of 80.5% against 76% of men.

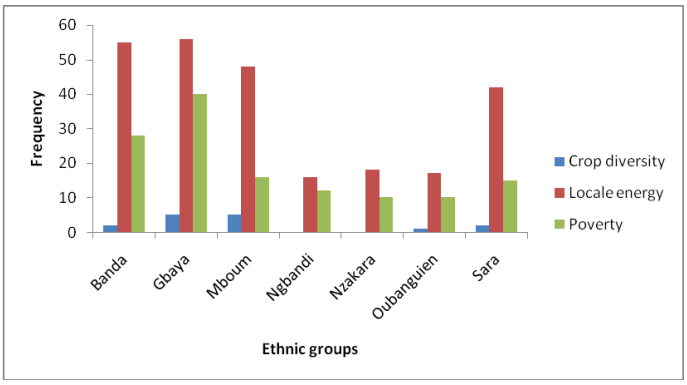

Figure 8: Motivations for growing *J.curcas* by ethnic groups

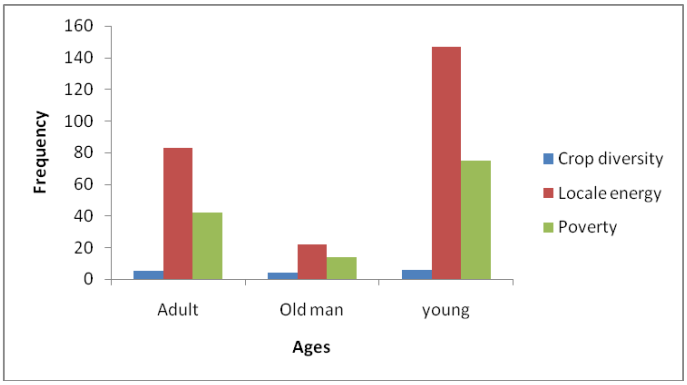

Figure 9: the motivations for growing *J.curcas* depending on the age group.

8. 2. Constraints for growing *J. curcas*

Among the population who expresses the doubt about involving Jatropha in their agricultural practices, 64.4 % are demotivated because there is not yet a *J. curcas* seeds sales channel. However 20 % of population states the lack of knewlegde of technical route, oil extraction for biofuel and soap making The reason given by all ethnic groups and the different age groups that can demotivate to engage in the cultivation of *J. curcas* is the absence of seed sales channel

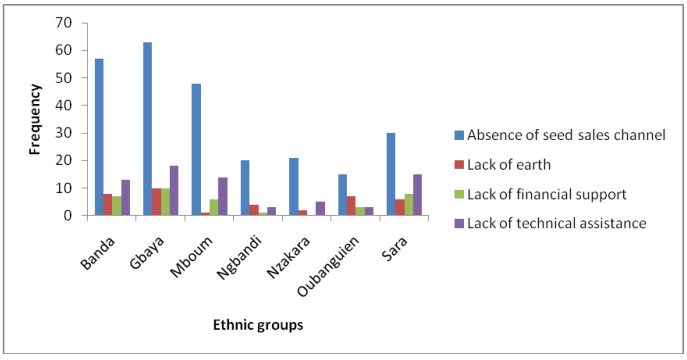

Figure 10: Constraints related to culture based on ethnic groups

(Figure 10 and 11). Lack of technical support is the second reason cited. Figure 9: the motivations for growing *J.curcas* depending on the age group

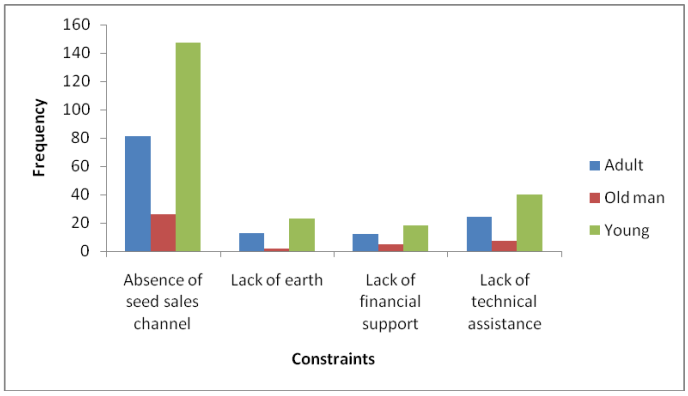

Figure 11: Constraints culture *J.curcas* depending on the age group

DISCUSSION

Among different ethnic groups, *J. curcas* is known under different names, which attest that it is very well integrated cultural perspective within the various study groups. According to Avakoudjo et al. (2013), the denomination by one or more names of the species within the same ethnic group testifies that *J.curcas* is well known by rural people and is used for various purposes. Despite the diversity in the naming, Kada which means bad smelling plant, is the most famous local name known by all ethnic groups of different age groups and both sexes.

. is the multiplication mode most used by the population because it promotes rapid plant growth in the establishment of hedges. People do not see the need to go through the nursery and direct seeding, which not only monitoring, but also gives plants of less rapid growth. Henning (2002) confirms that the cutting of *J. curcas* is known and practiced by traditional societies in the wild to delimit fields. The small part of the population that uses the semi direct and transplanting is that which is aware of the use of *J.curcas* as bio energy and who will want to engage in its culture.

In Central African Republic, although *J. curcas* is known by people of various ethnic groups, both sexes and different age groups it is more used in traditional medicine and then as residential fence. Assogbadjo et al. (2008) also found that in Benin, it is mostly used by local people in traditional medicine (87.50%) and to a lesser extent as close to the demarcation of dwellings (19.83%). In Central African Republic, some uses such as the manufacture of local soap is known only by the Ngbandi and the Nzakara groups. However, different organs of the plant after incineration are used for making soap and not the oil extracted from the seeds as is done in some countries.

The use as bio energy is almost unknown by the public except toa small part that is informed by the media. The leaf is the mostpart of plant used in traditional medecine, particularly to treat cough, typhoid fever, malaria .This is repoted by Gbemavo et al. (2014). The mixtures are generally done with other plants such as leaves of *C. limon, L. camara* and others. This shows that the public is informed about the toxicity of the plant, making it avoid ingesting a large amount of its organs. The seeds are hardly used.

The knowledge about the uses of the different parts of *J. curcas* are almost similar to those cited by Üllenberg (2007); Assogbadjo et al. (2008); Jongschaap et al. (2007); Avakoudjo et al. (2013) and Gbemavo et al. (2014). This confirms the assertion of Domergue and Pirot (2008) that *J. curcas* is a plant well known by local African populations. For Tchatat et al. (2006), eighboring population of Central African forests perfectly knowledgeable not only of the behavior of species in their ecosystem, but also the different uses that they can be put it in use. In traditional therapy, anti malarial properties of *J.curcas*, are indicated by Lakouetene et al. (2009) in their study on the medicinal plants used for malaria in the city of Bangui in CAR. The antiseptic and coagulant properties of the plant have also been reported by several authors (Domergue and Pirot, 2008; Heller, 1996). The use of the plant in the treatment of gonorrhea, jaundice, stomach ache, cough, wound, tooth decay and malaria are also reported in Benin by Assogbadjo and al. (2008) and Avakoudjo et al. (2013).

Informed of the use of *J. curcas* as bioenergy, the population is favorable of its introduction into the culture system due to high oil prices and poverty stressed by the military and political crises which noticeable in Central African rural areas.

According to Gazull (2013), in the South, local valorization biomass to energy is seen as a factor for development and a way to fight against poverty, especially in rural areas. Other motivations mentioned as crop diversification are secondary because the more crucial for the population is bioenergy. Henning (2002), observed that in Mali, traditionally the seeds of *J. curcas* are harvested by women who use them for medical treatments and local soap production. The introduction of *J.curcas* in the agro forestry system would constitute an added value for them. The proportion of the population that sees the plant as a means of diversification of crops is low. This population fringe think that the cultivation of *J curcas* may constitute a necessary extra to take over cash crops including coffee and cotton that since recent decades have fallen into disuse.

The passion to make of *J.curcas* a local energy source, is greater among young people, because they are subject to rural exodus caused by poverty

CONCLUSION

J. curcas is a plant known in the Central African Republic. It is variously used by people of different ethnic groups, different age groups of both sexes. It is used in traditional medicine and then as boundary fence. However, its cultivation for energy reasons as is done in other countries is not yet effective, but many initiatives are on way. The population for traditional care often combines the *J. curcas* to other plant species when the route of administration is oral, this holding account of the toxicity of the plant. The leaf is the most usedwhile various illnesses are treated by the plant. Cough is the most disease cited, followed by the wound. Knowledge about the plant is almost similar to those cited in other parts of Africa. The reason that motivates more people to engage in the cultivation of *J. curcas* is its use as an energy source. However the lack of sales channel and ignorance of the technical route of culture are the causes of reluctance of this population. It would be better for a better valuation of *J. curcas* in rural Central African zones to meet a

number of conditions such as mastery of cultivation technic adapted to the local context, to organize a sales channel and recovery of the seeds and make available farmers financial and technical support.

Acknowledgement

The authors would like to thank the French Government through the Department for Cooperation and Cultural Action of the French Ambassy in CAR for financially supporting this research.

REFERENCES

Achten, W. M .J., Verchot, L., Frankeen, Y.J., Mathijs, E., Singh, V.P., Aerts, R. & Muys B., 2008. *Jatropha* biodiesel production and use. *Biomass and Bioenergy*, 32(12) ,1063-1084.

Ahoton, L. E., Quenum F., Mergeai G., 2011. Evaluation agromorphologique et sélection des meilleures accessions de Pourghère (*Jatropha curcas* L.) introduites au Bénin, *International Journal of Biological and Chemical Sciences,* 5 (4), 1619-1627.

Assogbadjo, A.E., Amadji, G., Glèlè Kakaï, R., Mama, A., Sinsin, B., Van Damme, P., 2009. Evaluation écologique et ethnobotanique de *Jatropha curcas* L. au Bénin. *International Journal of Biological and Chemical Sciences,* 3 (5), 1065-1077.

Avakoudjo, H.G.G., 2013. Evaluation ethnobotanique de *Jatropha curcas* L. au Sud et au Centre-Bénin. THESE Pour l'obtention du diplôme d'Ingénieur Agronome. FASA d'Abomey Calavi Benin. 75 p.

Belem, B., Olsen, S.C., Bellefontaine, R., Guinko, S., Lykke, A.M., Diallo, A. & Boussim, J.I., 2008. Identification des arbres hors forêt préférés des populations du Sanmatenga (Burkina Faso). *Bois et forêt des tropiques*, 298(4), 53-63.

Camou-Guerrero, A., Reyes-García V., Martínez-Ramos M., Casas A., 2008. Knowledge and Use Value of Plant Species in a Rarámuri Community: A Gender Perspective for Conservation. *Human Ecology*, 36, 259–272.

Daudet Medza Mvé, S., Mergeai G., Baudoin, J. P.,Toussaint A., 2011. Culture *in vitro* de *Jatropha curcas* L. *Biotechnol. Agron. Soc. Environ,* 15(4), 567-574.

Domergue, M., PIROT, R., 2008. *Jatropha curcas* L. *Rapport de synthèse bibliographique*. CIRAD, 133 p.

Datinon, B.D., Glitho, A. I., Tamo M. and Amevoin, K. 2013. Perception of Farmers on Seed Production Constraints of *Jatropha curcas* L. (Euphorbiaceae). *Asian Journal of Applied Sciences,* 6,*99-106.*

Gado, A. K., 2011. *Le "système Jatropha" pour l'écodéveloppement au sahel. Master de développement spécialité gestion de l'environnement*, Université SENGHOR d'Alexandrie - (http://www.memoireonline.com) accessed 30/10/2013**.**

Gasol, C.M., Gabarrell, X., Anton, A., Rigola, M., Carrasco, J., Ciria, P., 2007. Life cycle assessment of a Brassica carinata bioenergy cropping system in southern Europe. *Biomass Bioenergy,* 31(8), 543– 555.

Gazull, L. 2013. Les systèmes de production locale de bioénergie : quel impact sur la vie des populations rurales. http://www.cirad.fr/ accessed 18/03/2015.

Gbemavo, C. J. S., Gnangle C. P., Assogbadjo E. A., Glele kakaï L. R., 2014. Analyse des perceptions locales et des facteurs déterminant l'utilisation des organes et des produits du *Jatropha curcas* linn. (Euphorbiaceae) au Benin. *Agronomie Africaine,* 26 (1), 69 - 79.

Henning, R.K., 2002. *Jatropha curcas* in Africa. Assessment of the impact of the dissemination of "the Jatropha System"Global Facilitation Unit for Underutilised Species (GFUUS), Weissensberg, Germany, 49 p.

Heller,J., 1996. Physic Nut *Jatropha curcas* L.: Promoting the Conservation and Use of Underutilized and Neglected Crops. 1. Institute of Plant Genetics and Crop Plant Research, Gatersleben, Germany/International Plant Genetic Resources Institute (IPGRI), Rome, Italy, 66 p.

Jongschaap, R.E.E., Corré, W., Bindraban, P.S and Brandenburg, W.A., 2007. Claims and Facts on *Jatropha curcas* L: Global *Jatropha curcas* evaluation, breeding and propagation program, Plant Research International. B.V, Wageningen, *Report* ,(158), 42 p.

Kaushik, N., Kumar, K., Kumar, S., Kaushik N., Roy S., 2007. Genetic variability and divergence studies in seed traits and oil content of jatropha (*Jatropha curcas* L.) accessions. *Biomass & Bioenergy*, 31, 497-502.

Lakouéténé , D .P., Ndolngar , G ., Berké, B., Moyen, J. M., Kosh komba, E., Zinga, I ., Silla, S., Rasolodimby, J. M., Vincendeau , P ., Syssa Magale, J. L ., Nacoulma Ouedraogo ,O .G., Laganier, R., Badoc, A ., Cheze C., 2009. Enquête ethnobotanique des plantes utilisées dans le traitement du paludisme à Bangui. *Bull. Soc. Pharm. Bordeaux*, 148, 123-138.

Madlener, R, Robledo, C, Muys, B, Blanco, Freja, J.T., 2006. A sustainability framework for enhancing the long-term success of LULUCF Projects. *Climatic Change*, 75(1-2), 241–271.

Makkar, H.P.S., Becker K., Sporer, F., Wink, M., 1997. Studies on nutritive potential and toxic constituents of different provenances of *Jatropha curcas*. *J Agric Food Chem*,45, 3152-7.

Minengu, M. ,J.D., 2014. Etude des possibilités de culture de *Jatropha curcas* L. dans la région de Kinshasa (République Démocratique du Congo).Thèse de Doctorat, Université de Liège – Gembloux Agro-Bio Tech (Belgique), 178 p.

Openshaw, K., 2000. A review of *Jatropha curcas*: an oil plant of unfulfilled promise. *Biomass and Energy*, 19, 1-15.

Parawira, W., 2010. Biodiesel production from *Jatropha curcas*: *Scientific Research and Essays,* 5(14), 1796-1808.

Prasad, C.M.V., Krishna M.V., Reddy C.P., Mohan K.R., 2000. Performance evaluation of non-edible vegetable oils as substitute fuels in low heat rejection diesel engines. *Proceedings of the Institution of Mechanical Engineers, Part D* – J. Auto Eng 214(Part D),181–187.

Qin, W., Ming-Xing H., Ying X., Xin-Shen Z., Fang C., 2005. Expression of a ribosome inactivating protein (curcin 2) in *Jatropha curcas* is induced by stress. *Journal of Biosciences*, 30, 351-357.

Tchatat, M., Ndoye O., 2006. Étude des produits forestiers non ligneux d'Afrique centrale : réalités et perspectives. *Bois et forêts des tropiques*, 288 (2), 27-38.

Üllenberg, A., 2007. *Jatropha* à Madagascar -Rapport sur l'état actuel du secteur GTZ Agresti A, Analysis of categorical data. New York, USA 1990.

Zahawi, R.A. 2005. Establishment and growth of living fence species: an overlooked tool for the restoration of degraded areas in the tropics. *Restoration Ecololy*, 13(1), 92–102.