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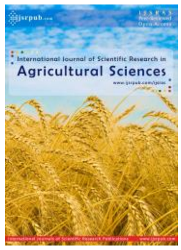
International Journal of Scientific Research in Agricultural Sciences, 3(3), pp. 073-083, 2016
Available online at http://www.ijsrpub.com/ijsras
ISSN: 2345-6795; ©2016; Author(s) retain the copyright of this article
http://dx.doi.org/10.12983/ijsras-2016-p0073-0083



Full Length Research Paper

Socio-Economic Importance, Abundance and Phytochemistry of *Jateorhiza palmata* (Lam.) Miers a Medicinal Plant in Nsanje, Malawi

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Received 07 June 2016; Accepted 16 August 2016

Abstract. *Jateorhiza palmata* (Lam.) Miers is a plant of high commercial value at national and international spheres. This study was conducted to determine the socio-economic importance, abundance and phytochemistry of *J. palmata* in Matandwe Forest Reserve, Nsanje, Malawi. The study revealed eight traditional medicinal uses of *J. palmata* roots. These include: de-worming; treat abdominal pains; fontanelle; hydrocele; heals wounds; stops vomiting; anti-snake bite; and increases male prowess. Communities earn income ranging US$17.71 to US$206.48 per annum. The phytochemical composition of roots constituted of saponins, tannins, anthocyanins and terpenoids. The chemical composition varied amongst sites. This is an area that requires further studies to establish the cause of chemical differences. The density of *J. palmata* was 15±5 plants per hectare which translate into 52.7 kg of merchantable dry product. Approximately 60 tonnes of dry root products are traded from the area annually. This indicates that about 1138.5 hectares of the reserve is required to sustain trade annually. The wild population cannot sustain current demand. Thus, there is need to investigate silvicultural techniques that could promote domestication. Further research in value addition should be conducted to promote commercialization that can facilitate improved livelihood of rural people. Furthermore, these findings are of great use to pharmaceutical industries for the development of new antimicrobial drugs to address unmet therapeutic needs.

Keywords: abundance, commercialization, domestication, *Jateorhiza palmata*, phytochemistry

1. INTRODUCTION

Medicinal plants play crucial roles in modern drug development, and constitute a prolific source of novel compounds or pharmacophores for ongoing drug discovery programs (Brahmachari, 2013). *Jateorhiza palmata* (Lam.) Miers is a member of the Menispermaceae family (Plant List, 2013). It is a tropical climbing vine which produces large fleshy tuberous roots. The tuber is perennial, but the above ground vegetative part dries in the dry season and resprouts in the rainy season (Otieno et al., 2011). *J. palmata* is known to occur in rain forest and fringing forest, up to 1,500 m altitude (Oyen, 2008; FAO, 1986). It is native in Kenya, Tanzania, Malawi, Zimbabwe, Mozambique, and South Africa (FAO, 1986; Schmelzer and Gurib-Fakim, 2008). The species is also naturised in Ghana, Madagascar, Mauritius, India and Brazil (Schmelzer and Gurib-Fakim, 2008). In Malawi, the plant occurs in a wide range of elevation from 500 to 2,300 m above sea level in a variety of soils (Kambewankako, 2005).

The importance of *J. palmata* to human livelihood is extensively documented (FAO, 1986; Taylor, 2006; Schmelzer and Gurib-Fakim, 2008). *J. palmata* root has a high economic value at national (Kambewankako, 2005; Chithira et al., 2014) and international levels (FAO, 1986; Taylor 2006). The root is the source of the formerly popular medicine, ‘radix calumbae’, sold in Europe from Mozambique and Tanzania (Schmelzer and Gurib-Fakim, 2008). The authors reported that in Tanzania, it is used against snake bite and as a vermifuge, treating hernia and ruptures. In Eastern Africa roots are considered as tonic and treatment for dysentery and diarrhea, whereas in India, they are consumed as a bitter tonic with antipyretic and anathematic properties against gastric irritability and vomiting during pregnancy. In

Europe, *J. palmata* is still used as a laxative herbal mixture. Kambewankako (2005) reported its pharmacological uses that include cure for many stomach ailments, treatment of snake bite, treatment against tumors, increasing blood level, increasing body immunity, remedy for headaches, treatment for colon cancer, remedy for chronic sores, remedy against nausea, restoring fertility in barren couples, remedy against coughs, treatment against sexual transmitted diseases, treatment for tuberculosis and remedy for cholera and malaria. Traditional uses in Malawi, is in form of dried root pieces, powder, pills/tablets, fresh pieces of roots and concoction (Kambewankako, 2005). The numerous reported traditional uses show the potential commercial value of the plant and the need for understanding its chemistry and silvicultural management.

Greenberg and Irwin (2005) reported that *J. palmata* is a crop of high commercial value to substantially increase household income of rural producers. In Malawi, *J. palmata* is exported but there is no proper documentation of the trade (Chithira et al., 2014). The success of commercialization of plants requires a clear understanding of the demand and production systems (Akinnifesi et al., 2008). Overexploitation of *J. palmata* is a serious concern in biodiversity (Kambewankako, 2005). Sustainable utilization of the resource will require in-depth understanding of its socio economic importance and abundance in areas where it is occurring.

J. almata is an important commercial high value plant in the area of Traditional Authority Malemia, Nsanje district. Rural communities harvest and process roots which are sold to middle traders who in turn sell to Trans-Globe Company, that exports it to Europe where it is made into useful drugs. Due to uncontrolled trade, the species is under threat of extinction.

Despite long history of use in folk medicine in Nsanje, there is no documentation of *J. palmata's* chemistry and usage in the area. The knowledge is important to promote value addition and commercialization. Sustainable use of natural resources requires understanding of the resource base. Further studies on plant biology are pertinent if domestication is envisaged as major mechanism of ensuring sustainable production. Knowledge in phytochemistry is fundamental in development of new drugs and diversification of products. The specific objectives of the study were (1) to determine socio-economic contribution of the plant in Nsanje; (2) to assess the abundance of the species in the area; and (3) to determine the photochemical composition of the roots from different management blocks (sites) in Matandwe Forest Reserve.

2. MATERIALS AND METHODS

2.1. Study Site

The study was conducted from July to September 2014 in Matandwe Forest Reserve (16° 55' S and 35° 16' E) in Nsanje district, at an elevation of 61 m above sea level. The site has a mean annual rainfall of 750 mm, falling between January and April. The temperatures can reach up to 52°C and alluvial soils are preponderant in the area (Hardcastle, 1978). The reserve covers an estimated area of 26204 hectares (Chithira et al. 2013).

2.2. Data Collection

2.2.1. Socio-economic importance of *J. palmata*

The socio-economic data was collected by administering questionnaires to 89 respondents. The study area had a total population of 220 households. The data was collected using a standard structured questionnaire with multiple-choice and open-ended questions administered through face-to-face interviews. Purposive sampling (Tongco, 2007) was employed to identify respondents in villages adjacent to Malemia and Mbangu Co-management blocks, which are near Matandwe Forest Reserve. Targeted respondents were heads of the households and in their absence, the most senior members were interviewed. The blocks were selected because people in these areas are actively involved in using roots for medicinal purpose and selling it to middle traders who ultimately sell to Trans-Globe Company in Blantyre (one of the commercial cities in Malawi). Respondents were asked on socio-demographic characteristics, traditional medicinal uses of *J. palmata* roots, economic contribution of *J. palmata* roots trade, level of harvesting and selling of *J. palmata* roots, and *J. palmata* roots collection frequency.

2.2.2. Abundance of *J. palmata*

T-square sampling procedure was employed to access the abundance of *J. palmata* (Krebs, 1999). In each block (Malemia and Mbangu villages), random points were located and at each random point two distances were measured; first the distance X_i from the random point (O) to the nearest plant (P), secondly, the distance (Z_i) from the plant (P) to its nearest neighbour (Q) with the restriction that the angle OPQ be more than 90° as shown in Figure 1 (Krebs, 1999). Population density was calculated using the formula adopted from Byth (1982):

$$N_T = \frac{n^2}{2\sum(x_i)\left[\sqrt{2\sum(z_i)}\right]}$$

Where: N_T = Estimate of population density; n = Sample size; x_i = Distance from random point i to nearest organism; z_i =T-square distance associated with random point i

To estimate the productivity (kgs/ha) of dry *J. palmata* roots available in the Forest Reserve, five plants from each block were dug and the roots from each plant were weighed separately on a scale. Mean weight of the roots per block was calculated. The roots from each plant were cut into small discs and air dried under shade at room temperature. The roots were weighed every five days until constant weight was reached. The moisture content was calculated using the following formula:

$$MC = \frac{w_1 - w_2}{w_1}\ x\ 100$$

Where: MC was the moisture content in percentage, W_1 was the initial fresh weight and W_2 was the final weight of the roots after drying (Desch and Dinwoodie, 1997). To calculate the mean moisture content of the roots, the sum of the moisture contents of five plants was divided by 5 (number of plants). The mean dry weight was multiplied by number of *J. palmata plants* per hectare and this was multiplied by hecterage of Matandwe Forest Reserve to obtain the total productivity.

2.2.3. Phytochemical analysis of *J. palmata* roots

J. palmata roots from three sites (Mbangu, Chididi and Nyachilenda) were brought to Mzuzu University Chemistry Laboratory for phytochemical screening. Phytochemical screening was carried out using standard qualitative methods (Harbone 1998; Sofowora 1993; Trease and Evans 2002). Presence of anthraquinones, terpenoids, flavonoids, tannins, alkaloids, anthocyanins, saponins was tested following the procedure described below.

2.2.3.1. Saponins

An infusion (5 %) was prepared by macerating dried powdered plant material (1g) in distilled water (20 ml). This was left to stand for 24 hours and the extract was filtered using Whatmann filter paper No. 1. The filtrate (10 ml) was transferred into a 160 x 16mm test tube and was shaken vigorously for 10 seconds. If foam persisted for 10 minutes it was taken as an evidence for the presence of saponins (Sofowora, 1993).

2.2.3.2. Flavonoids

An infusion of the powdered plant material (5 g) in distilled water (50 ml) was prepared and left to stand for 24 hours. A solution of hydrochloric acid, methanol and water (1:1:1) (0.5 ml) was added to the filtrate followed by addition of some few magnesium turnings (3 pieces, 0.1 cm long). Absence of pink, red or magenta colour was taken as an indication for the absence of flavonoids (Trease and Evans, 2002).

2.2.3.3. Alkaloids

A test for the presence of Alkaloids was done using Dragendorff and Mayer’s reagents (Harbone, 1973). Powdered root material (5g) was macerated in 5% (v/v) hydrochloric acid (aq) solution (50 ml) for 24 hours (Wink et al., 1995). Two portions of the filtrate (1 ml each) were treated with 10 drops of Dragendorff and Mayer’s reagent separately. Red orange and cream white precipitates indicated the presence of alkaloids by Dragendorff and Meyer’s tests, respectively (Harbone, 1973).

2.2.3.4. Terpenes/Terpenoids

Dry powdered root material (1 g) was macerated in diethyl ether (20 ml) in a stoppered conical flask (50 ml) for 48 hours. A portion of the filtrate (10 drops), in a porcelain crucible was dried to dryness in a water bath followed by the addition of concentrated sulphuric acid (10 drops). The colour produced was recorded. Another portion was treated the same but starting with the addition of acetic anhydride followed by 10 drops of concentrated sulphuric acid (Finar, 1975). Appearance of green, blue, pink to purple colours indicated the presence of sterols (green to blue), and /or terpenoids (red, pink to purple) (Santosh et al., 2013).

2.2.3.5. Tannins

An infusion (5 %) was prepared by macerating the powdered root material (1g) in distilled water (20 ml) and was left to stand for 24 hours. A portion of the filtrate (2 ml) was treated with 10 drops of 0.5 M. aqueous ferric chloride solution (Sofowora, 1993). A blue- black, green or blue-green precipitate indicated presence of tannins (Trease and Evans, 2002).

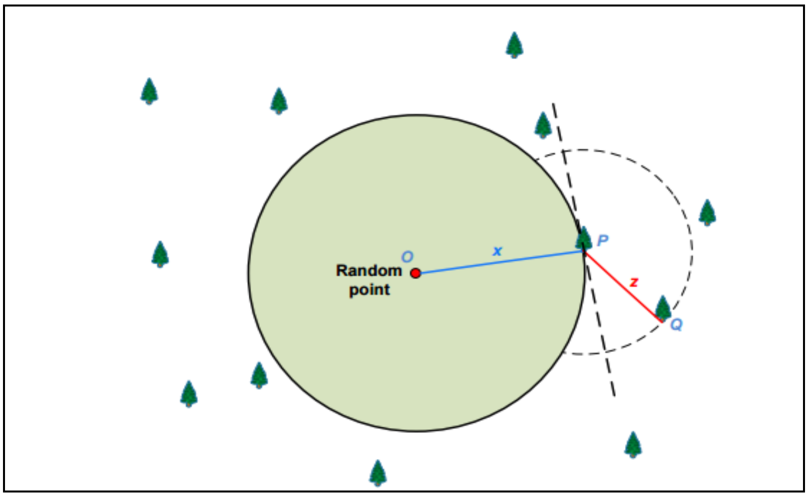

Fig. 1: T- square methodology for plant abundance assessment (Adopted from Krebs, 1999)

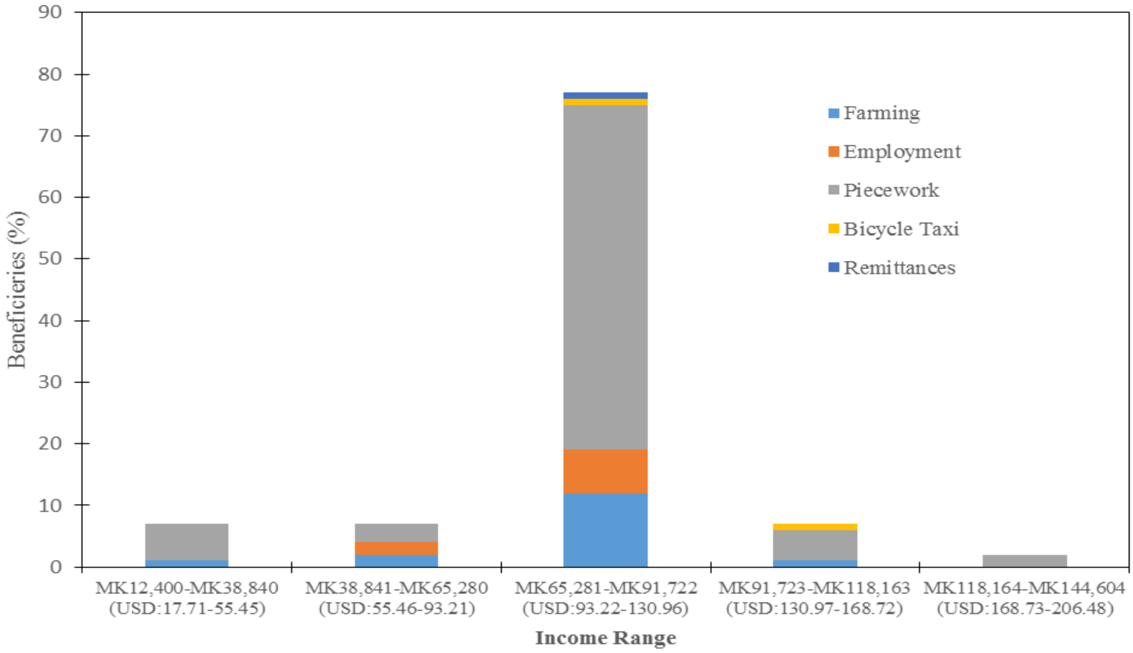

Fig. 2: Estimated income that communities get from the sales of *J. palmata*

Note: *The Malawi Kwacha (MK) to USD conversion is based on the official middle exchange rate released by the Reserve Bank of Malawi on 30th May, 2016 [MK700.34 = $1.00]* (RBM, 2016)

2.2.3.6. Anthraquinones

The powdered root material (2 g) was moistened with 10 % (v/v) hydrochloric acid (aq) solution and macerated in chloroform- ether (25:75) (1 ml) for 24 hours. The filtered extract (1 ml) was treated with 10 % Sodium hydroxide (aq) solution and the mixture was shaken. Pink, red or violet colour in the lower phase (Sodium hydroxide) indicated the positive test for anthraquinones (Sofowora, 1993).

2.2.3.7. Anthocyanins

An infusion (5 %) was prepared by macerating powdered root material (1g) in distilled water (20 ml). Hydrochloric acid (2 M HCl) (aq) solution (5 ml) was added to the filtrate and heated in a water bath for 30 minutes (Harborn, 1973). Pink, red to brown precipitates indicated the presence of anthocyanins.

2.3. Statistical Analysis

Data obtained were subjected to the Statistical Package for Social Scientists (SPSS) version 16.0. On socio-economic data cross tabulations were done and chi-square (X^2) was used to establish the associations between variables by percentages and frequencies. The Chi-square (X^2) test was used because of its ability to analyse enumerative data. Student t-test was done to determine the significant differences on mean stocking density, fresh weight per plant, dry weight per plant and moisture content between the two management blocks at 0.05 significant level.

3. RESULTS

3.1. Socio-demographic characteristics of respondents

The respondents mean age was 35.5±4.5 years. Majority of the respondents were females (53.9 %), and most of the respondents (82.0 %) were married. Most of the respondents (76.4 %) had undergone formal education, with the majority (57.3 %) having attained primary education, few (1.1 %) had post-secondary education and the remainder attaining secondary school level of education. Majority of the respondents (71.9 %) depends on piecework as a source of income (Table 1).

3.2. Socio-economic importance of *J. palmata*

3.2.1. Traditional uses of *J. palmata*

Summary of the traditional uses of *J. palmata* root in Nsanje are presented in Table 2. The results indicate that eight medicinal uses of the roots were reported. The major uses were for de-worming (71.9 %) and treatment of abdominal pains (60.7 %). The other uses were minor ranging from 3.4 to 41.6 %.

3.2.2. Economic contribution of *J. palmata*

The results on economic contribution of *J. palmata* are given in Figure 2. There were significant (X^2=163.3; P<0.001) differences in income generated from *J. palmata* root trade based on occupation. The income ranged from MK12,400.00 (USD17.71) to MK144,604.00 (USD206.48) from the lowest to the heights earner. More income was generated in the range of MK65,281.00 (USD93.26) to MK91,722.00 (USD130.97) with those employed as pieceworkers earning much than any other group. (Note: *The Malawi Kwacha (MK) to USD conversion is based on the official middle exchange rate released by the Reserve Bank of Malawi on 30th May, 2016 [MK700.34 = $1.00]* (RBM, 2016).

Table 1: Socio-demographic characteristics of respondents

Variable	Frequency (f)	Percentage (%)
Age of Respondents (Years)		
21 - 30	26	29.2
31 - 40	36	40.5
41 - 50	18	20.2
>50	9	10.1
Gender		
Male	41	46.1
Female	48	53.9
Marital status		
Married	73	82.0
Single-separated	2	2.3
Single-divorced	1	1.1
Single-widowed	11	13.5
Single-never married	1	1.1
Education		
None	21	23.6
Primary	51	57.3
Secondary	16	18.0
Tertiary	1	1.1
Source of Income		
Farming	14	15.7
Employment	8	9.0
Piece work	64	71.9
Bicycle taxi	2	2.3
Remittances	1	1.1

3.2.3. Levels of harvesting and selling of *J. palmata* roots

The level of harvesting and selling of *J. palmata* roots was strongly associated (X^2=36.492; P<0.001) with land holding size of the respondents (Table 3). All respondents (100 %) who harvested and sold <1 ton of *J. palmata* roots had large land size of 1-2 ha. Respondents with small land size (<1ha) for cultivation harvested and sold 5.0-6.9 ton of dried root.

3.2.4. Frequency of *J. palmata* roots collection

Summary of the results on frequency of *J. palmata* roots collection are presented in Table 4. The results revealed that there was no significant (X^2=9.639; *P*=0.29) difference between family source of income and frequency of *J. palmata* root collection. Respondents engaged in farming were the most active in harvesting *J. palmata* followed by those who were employed.

3.3. Abundance of *J. palmata*

The mean stocking density, fresh weight and dry weight of tubers per plant, and the moisture content results are presented in Table 5. The results show that there were no significant (*P*>0.05) differences on mean stocking density, fresh weight and dry weight of tubers per plant, and the moisture content between the two management blocks. The mean stocking density of *J. palmata* for Matandwe Forest Reserve was 15±5 plants per hectare.

3.4. Phytochemical screening

Summary of the results on phytochemical analysis are presented in Table 6. The results revealed the presence of saponins, tannins, anthocyanins and terpenoids *in J. palmata* root. *J. palmata* root from Chididi showed strong presence of saponins, terpenoids, tannins and anthocyanins while samples from Mbangu and Nyachilenda showed weak to moderate presence of these phytochemicals. Roots from all sites did not contain alkaloids, flavonoids and anthraquinones.

Table 2: Traditional medicinal uses of *J. palmata* in Nsanje, Malawi

Use	Frequency (f)	Percentage (%) (n=89)
As a de-wormer in children	64	71.9
Treatment of abdominal pains	54	60.7
Treatment of fontanelle	37	41.6
Treating and healing wounds	21	23.5
Increases male prowess / aphrodisiac properties	14	15.7
Treating hydrocele in men	11	12.4
Stops vomiting	7	7.9
Anti-snake bite	3	3.4

Table 3: Quantity *of J. palmata* sold and household Land holding capacity

Land holding sizes (ha)	Quantity of *J. palmata* used or sold (tons/yr)			
	< 1 ton	1-2.9 tons	3-4.9 tons	5-6.9 tons
<1	0%	57.10%	89.40%	100%
1-2	100%	42.90%	11.80%	0%

X^2 = 36.492; *P*<0.001

4. DISCUSSION

4.1. Socio economic importance

4.1.1. Traditional uses of *J. palmata*

Results have shown that *J. palmata* is an important medicinal plant in Nsanje, Malawi. Most of the uses reported by respondents in this study have been reported by other researchers such as, Kambewankako (2005) who reported that in Ntcheu, Mwanza and Mangochi districts of Malawi, *J. palmata* roots are used to increase male prowess, treat snake bite and as a remedy against cholera. The author further reported that the plant can also treat tumors, increasing blood level, increasing body immunity against diseases, remedy for headaches, treatment for colon cancer, remedy for chronic sores, remedy against coughs, treatment for sexually transmitted diseases, and remedy for malaria. In Mozambique *J. palmata* root is reported to be useful in treating cholera, diarrhoea and nausea (Anonymous, 2005) while in Tanzania, the plant is also useful in de-worming, treating snake bites, and as a remedy against vomiting during pregnancy (Otieno, 2011). Similarity in uses of the plant reported depicts the potential the root has for medicinal purpose. In addition, there is potential to develop numerous pharmaceutical products that widen the variety of high quality merchandise synthesized from the roots. High quality products will fetch good prices enabling rural communities to generate adequate income to improve their livelihood. What is remaining is to identify the chemistry of the roots responsible for treatment of different ailments.

4.1.2. Economic importance of *J. palmata*

Developing countries rely greatly on plants for medicine and income generation (Malla et al., 1995). This study has shown that pieceworkers and farmers are the major beneficiaries of *J. palmata* trade at grass root level. This could be due to less income realized by these groups of people in the society and the plant act as a safety net. However, communities may maximize benefits from the trade once middle traders are excluded from value chain. Middle traders tend to offer low farm gate price compared to what they get from Trans-Globe Company.

4.2. Abundance of *J. palmata*

The results showed that the density of *J. palmata* in Matandwe Forest Reserve is 15±5 plants per hectare. Present results are similar to what Chithira et.al. (2013) reported of 16±4 *J. palmata* plants per hectare. The results are considered low abundance /density (Krebs, 1999). Consequently, such density may not sustain the huge international trade demand. To worsen the situation communities, harvest all the tubers from the plant. Such modes of harvesting kill the plant. Cunningham (1993) reported that such non-scientific collection methods affect growth and occurrence of plants. There is need to teach communities the best way to harvest the roots without killing the entire plant. Presently there is scanty information on sexual reproduction of the plant. This is an area that requires further studies if domestication is envisaged to enhance production. It was observed that farmers are investigating vegetative propagation through planting whole roots. This seems is not sustainable way of growing the plant at commercial level. Thus, there is need to carry out studies in vegetative propagation that farmers can use for artificial regeneration at large scale. Due to lack of awareness about harvesting, and marketing, this valuable medicinal plant species may disappear altogether, causing economical as well as ecosystem imbalances (Kates et al., 2005).

Table 4: Family source of income and *J. palmata* collection frequency

Family source of income	Collection frequency for *J. palmata* (days/week)		
	Daily	**2-3 days**	**4-6 days**
Farming	82.1%	50.0%	70.2%
Piece work	7.1%	0.0%	7.0%
Employment	3.6%	50.0%	21.0%
Remittances	3.6%	0.0%	1.8%
Bicycle taxi	3.6%	0.0%	0.0%

$X^2 = 9.639$; P=0.29

Table 5: *J. palmata* abundance, weight and moisture content

Block name	Plant/ha	Fresh weight/plant (kg)	Dry weight/plant (kg)	Moisture content (%)
Mbangu	18±5	17.02±4.61	3.51±0.56	80±2
Malemia	13±6	15.15±3.04	3.53±0.45	76±5
P-value	0.526	0.791	0.937	0.219
Grand Mean	15±5	16.17±3.63	3.52±0.51	77±4

Note: Mean values are followed by standard deviation of the mean

Forestry Research Institute of Malawi records show that 60 tons of *J. palmata* roots are being exported each year (Chithira et al., 2013). Exporting of *J. palmata* roots from Nsanje started 7 years ago. This could imply that 420 tons have been removed from this forest. The quantity translates to 7,969.6 hectares of plants have been cleared of the plant. The plant thrives only in river streams of the forest reserve. It is doubtful if large population still exists that can sustain the international trade. It could be postulated that artificial regeneration is required to enhance productivity that can sustain the huge market demand. Thus research in reproductive biology of the plant should be conducted. Information generated will be used in the silvicultural management of the plant.

Table 6: Phytochemical screening results of *J. palmata* extracts

Name of compound	Sample collection site		
	Mbangu	**Chididi**	**Nyachilenda**
Alkaloids	-	-	-
Flavonoids	-	-	-
Saponins	++	+++	+
Anthraquinones	-	-	-
Anthocyanins	+	+++	++
Tannins	+	+++	++
Terpenoids	++	+++	+

+++= Strongly positive, ++ = mildly positive, + =Weakly Positive, - = Negative

4.3. Phytochemical screening of *J. palmata*

The results revealed a large variation in phytochemicals in *J. palmata* root from one locality to another. The variations in the chemistry of plant species may be due to genetic factors, environmental factors or geographical location (Gazim et al., 2010). In the present study, *J. palmata* root samples from Chididi were collected at an elevation of 596 m above sea level while those from Mbangu and Nyachilenda were collected at 160 m and 103 m above sea level, respectively. The chemistry of plants also depends on the season and time of collection/harvesting. However, we further propose that studies should be conducted to unravel the type and source of variation causing differences in phytochemistry in the roots varied with locality.

Rupasinghe et al. (2003) reported that saponins possess hypocholesterolemic and antidiabetic properties, and Sparg et al. (2004) explained that saponins regulate the immune system because some members of the saponins family have been shown to have anti-fungal, antibacterial and anti-inflammatory activity. Tannins are potential toxic agents to fungi and bacteria. According to Sandhu and Heinrich, (2005), tannins possess anti-microbial activity and could be used as food preservatives. With the growing interest to replace synthetic preservatives in food with plants possessing antimicrobial properties, the detection of the presence of tannins in *J. palmata* can be a step forward to reducing use of synthetic food preservatives. The report by the communities in this study that *J. palmata* root is medicinally useful in treating abdominal pains and wounds is scientifically proven. Other researchers (Pereira et al., 2001; Palombo, 2006) reported that tannins are used in treating various diseases in humans, including snake bites, diarrhoea, gastric ulcers and wounds. The detection of terpenoids in the root points out to the many applied uses of the plant's root; terpenoids precursors in human bodies, help to produce steroids like sex hormones such as testosterone (Prior and Cao, 2009). Probably the traditional use of *J. palmata* root as reported by the communities in the present study that the root of *J. palmata* is useful in boosting male prowess could be due to the presence of terpenoids. Anthocyanin pigments have been implicated in a diverse range of health-promoting properties. Earlier researchers have reported this class of compounds to be useful in a number of ways, for example, Lila (2004) reported that Anthocyanins play a beneficial role in visual acuity, treatment of cancer, heart disease and age-related neurodegenerative disorders. In his report Kambewankako (2005) mentioned that *J. palmata* is useful in cancer treatment. Probably the capacity of *J. palmata* to interfere with the process of carcinogenesis is due to the presence of anthocyanins. A report by Lila (2004) concluded that anthocyanin consumption results in improving sharpness of vision through enhancement of rhodopsin regeneration. Reports by Rechner and Kroner (2005) and Wang and Stoner (2008) agree on the role of anthocyanins in lowering the risk of cardiovascular disease. Anthocyanins may protect against age-related neurological disorders, for example the risk of degenerative disorders. Anthocyanins have been credited with the capacity to modulate cognitive and motor function, to enhance memory and to have a role in preventing age-related declines in neural function. Investigations have revealed that this is possible due to the fact that anthocyanins are highly bioavailable in endothelial cells.

Results revealed absence of alkaloids, anthraquinones and flavonoids in *J. palmata* specimen collected from all sites. However, Anonymous (2005) reported their presence in the same roots. The absence of these phytochemicals could be attributed to environmental factors such as light and temperature acting during the plant development (Gazim et al., 2010). He stressed that extreme environmental conditions such as heat stresses in dry seasons, induce massive production of secondary metabolites as a defense mechanism against attack by pathogens as well as to keep off damaging insects and herbivores by producing a repellent ordour and production of bitter juices. This line of reasoning is also supported by Subapriye and Nagini (2005) who isolated 140 compounds from different parts of neem. They reported that the presence of phytochemicals including alkaloids, flavonoids and anthraquinones vary with seasons. They reported high concentrations in dry seasons and low concentrations in cool rainy seasons. Hence, further studies are recommended to determine the effect of season on the phytochemical screening of *J. palmata*.

5. CONCLUSION

The present study has revealed that *J. palmata* holds a greater economic potential in uplifting the quality of life of the rural forest dependent communities of the study area. In the study area *J. palmata* is used as a hunger copping off-farm produce by small scale farmers owning less than a hectare of cultivation land. The findings of this report could be of great use to pharmaceutical industries for the development of new antimicrobial drugs to address unmet therapeutic needs. The abundance of *J. palmata* reported in this work could be useful in establishing sustainable harvest levels of the tuber to ensure its continued availability in the resource base.

ACKNOWLEDGMENT

The authors are grateful to the staff at Nsanje district Forestry Office for the technical assistance and the communities from Malemia and Mbangu for their active participation in the study.

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