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ABUNDANCE AND SOCIO ECONOMIC IMPORTANCE OF *Osyris quadripartita* IN SOUTH OMO AND GAMGOFA ZONES, SNNPR, ETHIOPIA

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ABSTRACT

Osyris quadripartita is belongs to the family Santalaceae and known as the East African Sandalwood, indigenous to east Africa. It is an evergreen, dioecious shrub or tree, root hemi parasitic and highly branched. The wood is sold locally and also traded internationally for its essential oil which is used in making perfume. However, its abundance and socio economic importance have not been studied in SNNPR, Ethiopia. Therefore, the objective of this study was to assess the abundance and socio economic importance of *Osyris quadripartita* in South Omo and Gamgofa Zones. Accordingly, the study was conducted in five districts within the two zones. From five districts seven forest areas were selected purposively based on the distribution of *Osyris quadripartita*. The data was collected through vegetation survey, direct observation and local informants' interview.A total of 28 plots were laid and 30 informants' were interviewed.The results of this study showed that in 75% of the areas *Osyris quadripartita* was found abundantly whereas in 25% of the plots *Osyris quadripartita* was found rarely. However, most of the areas that *Osyris quadripartita* found abundantly were protected areas. Furthermore, the plant's poor natural regenerative power from seeds and root suckers, and its being dioecious and root hemi parasitic may threatens the survival of the plant. As a result of these facts the cultivation of the plant should be encouraged.

KEYWORDS: *Osyris quadripartita*, Abundance, rare and socio economic importance.

1. INTRODUCTION

Osyris quadripartite is a synonymy of *Osyris lanceolata*Hochst. &Steud and belongs to the family Santalaceae. It is known as the East African Sandalwood, indigenous to east Africa. It is an evergreen, dioecious shrub or tree up to 7 m tall, root hemi parasitic and highly branched. It is most commonly found in Gallery forest, Juniperus, *Podocarpus*, *Combretum* and *Dodonea* woodland, *Erica* scrub, *Acacia nilotica*, *Commiphora* scrub, on rocky slopes or along the margins of dry forest and degraded woodland; 900 to-2900 m.a.s.l in areas with mean annual rainfall of 600 to 1600 mm. Occurs in most Ethiopian regions, throughout Africa, Southern Asia to China (Herrera, 1988, Ermias Dagne, 2009, Kamondo *et al*., 2014).

Osyris quadripartita is used for its scented wood and to extract essential oil. The wood is sold locally and also traded internationally for its essential oil. The wood is over-exploited in parts of its range despite legal protection. Its numbers have been greatly reduced by overexploitation of its roots, which is the source of an expensive essential oil. It is also used as traditional medicine to treat cancer (Oloo, 2012, Kamondo *et al*., 2014, Abiyu Enyew *et al*., 2014).

Osyris quadripartita has recently entered the international market as a substitute of the traditional sandalwood oil originally sourced from Asia and Australia. The oil is useful in perfumery, pharmaceutical and religious practices. The limited supply, coupled with high demand and escalating prices of sandalwood oil from the traditional source countries have led to exploitation of the East African sandalwood as a preferred alternative. This has shifted the trade to the East African sandalwood leading to over exploitation of the species in the range States. The exploitation of *Osyris quadripartita* from Africa could soon drive the species to extinction unless proper control measures are put in place to regulate international trade in the species (Oloo, 2012, CITES, 2013,)

The Ethiopian Biodiversity Institute (EBI) is responsible to conserve, sustainably utilized and fair and equitable sharing of benefit from the utilization of genetic resources. EBI is the nationwide mandated authority through ABS directorate playing the practical role of the Nagoya protocol on Access and Benefit sharing of genetic resources and associated traditional knowledge. Ethiopia has the officially permitted outline for the implementation of the ABS. The laws concerning the national Access and Benefit Sharing framework are

proclamation on Access to genetic Resources and Community Knowledge and Community Rights (Proclamation No 482/2006) and Regulation 169/2009). Based on these frameworks, the country has been implementing the access and benefit sharing objective of the CBD.

Ethiopia has immense biodiversity with actual or potential value and intends to share the benefits arising out of the utilization of these genetic resources. Hence, an Agreement was made Between the Ethiopian Biodiversity Institute and DOCOMO OIL PLC, on Access to, and Benefit Sharing of *Osyris quadripartita* to produce Essential oil (light, middle, heavy fractions of *Osyris quadripartita*), cosmetic compounds, perfumery and aromatic compounds, food and flavor ingredients in South Omo and Gamgofa Zones, SNNPR, Ethiopia. The user (DOCOMO OIL PLC.) has agreed to pay license fee, upfront and a royalty payment to the provider that arises out of the utilization of the genetic/biological resource. Moreover, the Provider shall have the right to ascertain the sustainability of the genetic resource/biological resource at any time and the user agreed to utilize the genetic resources in a sustainable manner and not to over exploit.

Ethiopia is lucky to be gifted with rich biodiversity and traditional knowledge that could pioneer successful bio-prospecting. However, the abundance and socioeconomic importance of most of the genetic resources in general and *Osyris quadripartita* in particular are not well studied and unknown. Accordingly, an assessment was carried out to study the abundance and socio economic importance of *Osyris quadripartita* so as to keep up the sustainable utilization of the plant (*Osyris quadripartita)* in selected forests of South Omo and Gamgofa Zones, SNNPR, Ethiopia.

2. MATERIALS AND METHODS

2.1. Description of the study area

DebubOmo (or "South Omo") is a Zone in the Ethiopian Southern Nations, Nationalities and Peoples' Region (SNNPR). Debub Omo is bordered on the south by Kenya, on the southwest by the Ilemi Triangle, on the west by Bench Maji, on the northwest by Keffa, on the north by Konta, Gamo Gofa and Basketo, on the northeast by Dirashe and Konso, and on the east by the Oromia Region. The administrative center of Debub Omo is Jinka. This zone is named for the Omo River, a river that flows south into Lake Turkana on the western side. Mago National Park and Tama Wildlife Reserve are located at the eastern bank of Omo river (UNDP-EUE Report, 1996).

GamoGofa is a Zone in the Ethiopian SNNPR. It is named for the Gamo and Gofa peoples, whose homelands lie in this Zone. GamoGofa is bordered on the south by the Dirashe special woreda, on the southwest by Debub Omo and the Basketo special woreda, on the northwest by Konta special woreda, on the north by Dawro and Wolayita, on the northeast by the Lake Abaya and on the southeast by the Amaro special woreda. The administrative center of GamoGofa is Arba Minch. The Lake Chamo is located at the southeastern part of GamoGofa just south of Lake Abaya. The Nechisar National Park is located between these two lakes (Vaughan, 2003).

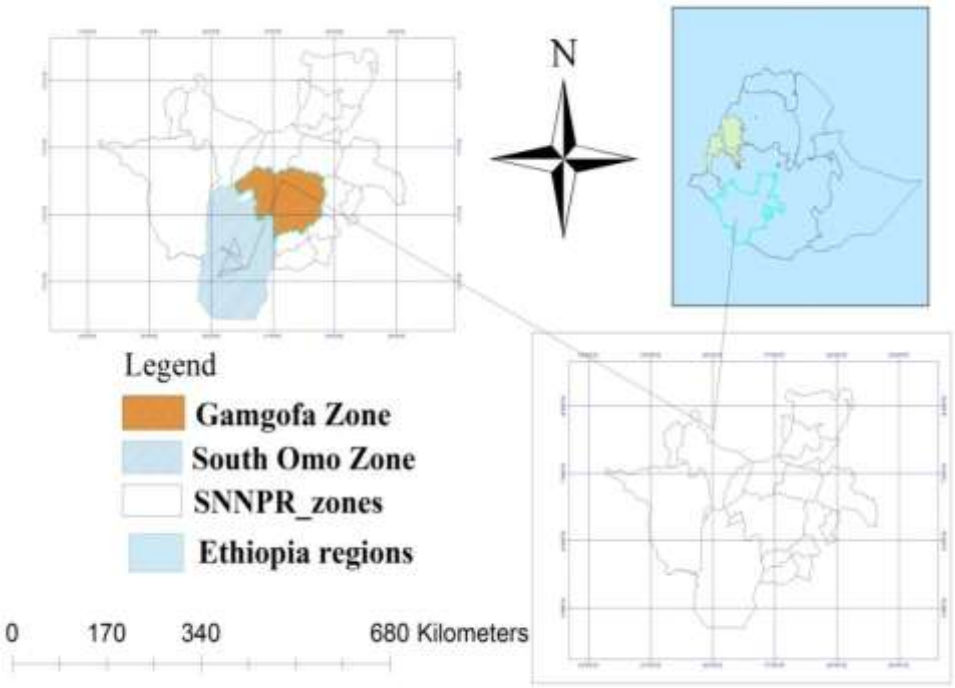

Figure 1: Administrative Map of the study Areas.

2.2. Methods of data collections

The study was conducted in two zones; - South Omo and Gamgofa Zones. From the two zones the study was conducted only on five representative districts. Accordingly, Benatsemay, Hamer, South Ari, Arbaminch Zur and Bonke were selected to conduct this assessment study. From five districts, seven forest areas were selected. The study districts were selected purposively based on the abundance and distribution of *Osyris quadripartite*.

Vegetation survey: within 7 forest areas 28 plots were laid to obtained quantitative data.The forest patches were selected by the help of informants or found during our random assessment. A total of 28, 20x20 plots were sampled and within each plot the number of *Osyris quadripartita* present was counted so that abundance could be determined.The sampling method was based on Systematic Random sampling techniques using one transect line. Two consecutive plots were separated from each other by 100 m. In each plot, the number of *Osyris quadripartita* was recorded and the associated species also recorded and identified.

Moreover, Semi-structured interview, group discussion and direct field observation data collection methods were employed for primary data collection. Secondary source of data was obtained from the agricultural office of the districts, from different books, journals and research article. A total of 30 respondents were selected purposively to the semi structured interview. Respondents were selected with the help of district extension agents based on the knowledge on *Osyris quadripartita.*

4. RESULT AND DISCUSSIONS

The result of this study indicated that in 75% of the explored areas (seven forest areas, a total of 28 plots) *Osyris quadripartita* was found abundantly whereas in 25% of the areas, *Osyris quadripartita* was rarely found. However, most of the areas that *Osyris quadripartita* abundantly found were protected areas. Similar study by LeulKidane Woldemichael *et al*, (2010) in Tigray region indicated that *Osyris quadripartita* was one of the dominant species in the study areas.

4.1. Abundance of *Osyris quadripartita in* selected forest of South Omo Zone

In South Omo Zone four forest areas was purposively selected based on the information obtained from the key informants (Kure forest, Ezaama, Bora and Shankokelema/Buska forest). In these forest sites a total 13 plots/ quadrats were laid, of these in 53.8% of the plots *Osyris quadripartita* was abundantly found and in 46.2% of the plots, *Osyris quadripartita* was rarely available. In more than half of the explored areas *Osyris quadripartita* was abundantly found. Moreover, out of the 13 quadrats in one plot, sapling was greater than trees, in four plots saplings > trees >seedlings, in three plots only trees were found, in another one plot, tree was greater than seedling and in four plots only seedlings and saplings were found. This might be indicated that the regeneration status of *Osyris quadripartita* in explored forest areas of South Omo zone was fair. The result of similar study by Abiyou Tilahun *et al.*, (2015) indicated that the regeneration status of *Osyris quadripartita* was fair in that particular study area.

Moreover, *Osyris quadripartita* has good coppicing abilities. Based on direct observation during the study individual harvested plant has the potential to produce 4_7 another plants. This could also be indicated that the utilization of this plant by the company (DOCOMO OIL PLC) will not be the fear for the conservation and sustainable utilization of the plant rather it could be means of conservation and sustainable utilization (Fig 2). Furthermore, because of the money obtained from the sale of the plant, the societies give due emphasis to the plant and conserve very well.

Figure 2: Coppicing capability of *Osyris quadripartite.*

Table 1: *Osyris quadripartite* Exploration sites in South Omo Zone.

No.	Exploration sites	Districts	Zone/ Region	Altitude	Latitude	Longitude	Average number of *Osyris* per plot	Present/ Absent	Status	Remark
1.	Kure Forest(plot1)	South Ari	South Omo	1392m.a.s.l	$05^0$47'30.3'' N	$036^0$28'17.1'' E	13	Present	Abundance	Sapling > Tree
2.	Kure Forest(plot2)	South Ari	South Omo	1280m.a.s.l	$05^0$47'26.0'' N	$036^0$28'39.0'' E	18	Present	Abundance	Sapling > Tree > Seedling
3.	Kure Forest (plot 3)	South Ari	South Omo	1260m.a.s.l	$05^0$47'25.4'' N	$036^0$28'30.3'' E	7	present	Rare	Only Trees
4.	Kure Forest(plot 4)	South Ari	South Omo	1234m.a.s.l	$05^0$47'02.2'' N	$036^0$27'15.3'' E	25	present	Abundance	Sapling > Tree > Seedlings
5.	Kure Forest(plot 5)	South Ari	South Omo	1152m.a.s.l	$05^0$47'02.2'' N	$036^0$27'15.3'' E	20	Present	Abundance	Trees > Seedlings
6.	Kure Forest(plot 6)	South Ari	South Omo	1178m.a.s.l	$05^0$47'04.8'' N	$036^0$27'18.1'' E	2	Present	Rare	Only two male
7.	Kure Forest(plot 7)	South Ari	South Omo	1153m.a.s.l	$05^0$47'02.9'' N	$036^0$27'15.5'' E	3	Present	Rare	Only Trees
8.	Ezaama	Benatsemay	South Omo	1391m.a.s.l	$05^0$27'24.0'' N	$036^0$37'39.7'' E	15	Present	Abundance	Only Seedlings
9.	Bora	Benatsemay	South Omo	1325m.a.s.l	$05^0$22'20.0'' N	$036^0$35'32.0'' E	3	Present	Rare	Only Seedlings
11	Shankokelema(Buska forest)	Hamer	South Omo	1179m.a.s.l	$05^0$11'39.8'' N	$036^0$34'12.0'' E	3	Present	Rare	Only Saplings
	Shankokelema(Buska forest)	Hamer	South Omo	1180m.a.s.l	$05^0$11'38.3'' N	$036^0$34'11.8'' E	8	Present	Rare	Only Saplings
12	Shankokelema(Buska forest)	Hamer	South Omo	1177m.a.s.l	$05^0$11'37.4'' N	$036^0$34'12.5'' E	10	Present	Abundance	Saplings>Tree> Seedlings
13	Shankokelema(Buska forest)	Hamer	South Omo	1180m.a.s.l	$05^0$11'41.2'' N	$036^0$34'11.1'' E	11	Present	Abundance	Saplings>Tree> Seedlings

4.2. Abundance of *Osyris quadripartita* in selected forest of Gamgofa zone

In Gamgofa zone, three forest areas was purposively selected based on the information obtained from the key informants (Genta Meche,Shara ,and Waso/Durbe forest).In these three forests a total of 15 plots were laid, out of 15 plots in 93.3% of the areas *Osyris quadripartita* was abundantly found and only in 6.7% of the plots, *Osyris quadripartita* was rarely found. In these areas the plant was matured but stunted. In the majority of the plots (10 plots out of 15) only trees and sapling were found (Trees > Saplings), in four plots seedlings, saplings and trees were found in which seedling ≤ saplings < trees and in one plots only seedling and sapling was existed (seedlings < saplings).This could be indicated that the plant was not appropriate to harvest for extraction of oil during the exploration time. Moreover, the explored areas were protected and area closures (Table 2).

Table 2: *Osyris quadripartita* Exploration sites in Gamgofa Zone.

No.	Exploration sites	Districts	Zone/ Region	Altitude	Latitude	Longitude	Average no. of *Osyris* per plot	Present/ Absent	Status	Remark
1	Bere(Gentameche) 1	ArbaminchZuria	Gamgofa	1650	$06^0$00'37.3''N	$037^0$31'24.5''E	17	present	Abundance	Tees > saplings & 2 male
2.	Bere(Gentameche) 2	ArbaminchZuria	Gamgofa	1630	$06^0$00'35.3''N	$037^0$31'25.0''E	28	present	Abundance	Tees > saplings
3.	Bere(Gentameche) 3	ArbaminchZuria	Gamgofa	1632	$06^0$00'34.6''N	$037^0$31'25.1''E	24	present	Abundance	Tees > saplings
4.	Bere(Gentameche) 4	ArbaminchZuria	Gamgofa	1657	$06^0$01'13.0''N	$037^0$52'27.0''E	11	present	Abundance	Tees > saplings
5.	Bere(Gentameche) 5	ArbaminchZuria	Gamgofa	1672	$06^0$01'25.0''N	$037^0$52'22.0''E	18	present	Abundance	Tees > saplings
6.	Bere(Gentameche) 6	ArbaminchZuria	Gamgofa	1679	$06^0$01'25.2''N	$037^0$52'28.0''E	13	present	Abundance	Tees > saplings
7.	Shara 1	ArbaminchZuria	Gamgofa	1624	$06^0$07'11.0''N	$037^0$32'55.0.''E	14	present	Abundance	Tees > saplings
8.	Shara 2	ArbaminchZuria	Gamgofa	1623	$06^0$07'99.0''N	$037^0$32'92.3.''E	18	present	Abundance	Tees > saplings
9.	Shara 3	ArbaminchZuria	Gamgofa	1619	$06^0$07'21.6''N	$037^0$32'92.7''E	33	present	Abundance	Tees > saplings
10.	Shara 4	ArbaminchZuria	Gamgofa	1617	$06^0$07'11.3''N	$037^0$32'55.6.''E	28	present	Abundance	Tees > saplings
11.	Waso (Durbe) 1	Bonke	Gamgofa	1362	$05^0$00'38.8''N	$037^0$14'16.6''E	24	present	Abundance	Seedlings= saplings< Trees
12.	Waso (Durbe) 2	Bonke	Gamgofa	1392	$05^0$52'23.0''N	$037^0$22'00.3''E	25	present	Abundance	Seedlings= saplings< Trees
13.	Waso (Durbe) 3	Bonke	Gamgofa	1366	$05^0$52'37.8''N	$037^0$22'03.0''E	33	present	Abundance	Seedlings< saplings
14.	Waso (Durbe) 4	Bonke	Gamgofa	1361	$05^0$52'36.0''N	$037^0$21'99.6"E	22	present	Abundance	Seedlings= saplings< Trees
15..	Waso (Durbe) 5	Bonke	Gamgofa	1343	$05^0$52'32.9''N	$037^0$21'99.5''E	8	present	Rare	Seedlings= saplings< Trees

4.3. Associated Species and families with *Osyris quadripartita*

In different Exploration sites, *Osyris quadripartita* was found associated with varieties of plant species. It was mostly occurring with *Euclea racemosa, Combretum molle, Carissa spinarum, Dodonaea angustifolia, Acokanthera schimperi, Myrsine africana, Jasminum abysinica* and Rhus *spp.*(Table 3).

A total of 65 plant species belonging to 33 families were recorded (in overall of 28 plots within seven forest areas) during the current study. Fabaceae accounts the highest 13(20%), followed by Anacardiaceae 4(6.15%), Combretaceae, Euphorbiaceae, Rutaceae and Tiliaceae accounts 3(4.05%) each share the third place among the plant species recorded in the study areas (Table 3).

Osyris quadripartita was associated more with legume plant species; this might be due to the ability of the legume plant species in increasing soil fertility as they have the capacity to fix atmospheric nitrogen through their root nodules. Beside this, legume plants help in increasing diversity of soil flora and fauna lending a greater stability to the total soil life.

Regarding to the family Anacardiaceae, mostly occur in dry semi deciduous and deciduous forests, during the dry season these species are frequently leaf shedding, for the sake of enduring hardship. In addition, *Osyris quadripartita* prefers a well-drained, humus-rich clay or loamy soil in the wild and hemi-parasitic plant due to this it might be mostly occur friendly with Anacardiaceae family.

Table 3: Plant species associated with *Osyrisquadripartita.*

No.	Scientific name	Family	Remark
1	*Acacia tortilis*	Fabaceae	
2	*Acacia abyssinica*	Fabaceae	
3	*Acacia brevispica*	Fabaceae	
4	*Acacia bussie*	Fabaceae	
5	*Acacia drepanolobium*	Fabaceae	
6	*Acacia nilotica*	Fabaceae	
7	Acacia polyacantha	Fabaceae	
8	*Acacia Senegal*	Fabaceae	
9	*Acacia seyal*	Fabaceae	
10	*Acokanthera schimperi*	Apocynaceae	
11	Albizia grandibracteata	Fabaceae	
12	*Albizia spp,*	Fabaceae	
13	*Allophylus abyssinicus*	Sapindaceae	
14	*Asparagus officinalis*	Asparagaceae	
15	*Azadirachta indica*	Meliaceae	
16	*Berchemia discolor*	Rhamnaceae	
17	*Brucea antidysenterica*	Simaroubaceae	
18	*Cadaba farinose*	Capparidaceae	
19	Calpurnia aurea	Fabaceae	
20	*Canthiumlactescens*	Rubiaceae	
21	*Capparis tomentosa*	Capparidaceae	
22	*Carissa spinarum*	Apocynaceae	
23	*Celtis africana*	Ulmaceae	
24	*Combretum collinum*	Combretaceae	
25	*Combretum molle*	Combretaceae	
26	*Commiphorah abessinica*	Burseraceae	
27	*Commiphora serrulata*	Burseraceae	
28	*Crinum abyssinicum*	Amaryllidaceae	
29	*Croton macrostachyus*	Euphorbiaceae	
30	*Cyphostemma adenocaule*	Vitaceae	
31	*Dichrostachys cinrea*	Fabaceae	
32	*Dodonaea angustifolia*	Sapindaceae	
33	*Dombeya aethiopica*	Sterculiaceae	
34	*Dombeya torrid*	Sterculiaceae	
35	*Euclea divinorum*	Ebenaceae	
36	*Euclea racemosa.*	Ebenaceae	
37	*Euphorbia tirucalli*	Euphorbiaceae	
38	*Gardenia ternifolia*	Rubiaceae	
39	*Gladiolus negeliensis*	Iridaceae	

40	*Grewia bicolor*	Tiliaceae	
41	*Grewia kakothmnos*	Tiliaceae	
42	*Grewia trichocarpa*	Tiliaceae	
43	*Harrisonia abyssinica.*	Simaroubaceae	
44	*Helichrysum gerebrifolium*	Asteraceae	
45	*Jasminium abyssinicum*	Oleaceae	
46	*Lannea schimperi*	Anacardiaceae	
47	*Myrsine africana*	Myrsinaceae	
48	*Ocimum basilicum*	Lamiaceae	
49	*Olea capensis*	Oleaceae	
50	*Phyllanthus sepialis*	Euphorbiaceae	
51	*Pistacia aethiopica*	Anacardiaceae	
52	Protea gaguedi	Proteaceae	
53	Prunus africana	Rosaceae	
54	*Rhus natalensis*	Anacardiaceae	
55	Rhus vulgaris	Anacardiaceae	
56	*Scherebera alata*	Oleaceae	
57	*Solanum marginatum*	Solanaceae	
58	*Steganotaenia araliacea*	Apiaceae	
59	*Syzygium guineense*	Myrtaceae	
60	*Teclea simplicifolia*	Rutaceae	
61	*Terminalia brownie*	Combretaceae	
62	*Trimeria grandifolia*	Flacourtiaceae	
63	*Vepris dainellii*	Rutaceae	
64	*Vernonia schimperi*	Asteraceae	
65	*Zanthoxylum chalybeum*	Rutaceae	

4.4. Socioeconomic importance of *Osyris quadripartita* in the study areas

As to the traditional use of *Osyris quadripartita*, 87.5% of the respondents reported that *Osyris quadripartita* has no use and 12.5% of them reported that *Osyris quadripartita* used as fence. But the local communities and the associations were benefited from the plant. Based on the respondents report, the benefit to the local communities from the collection of *Osyris quadripartita*, majority of them (93.8%) believed that the local communities benefited from the collection of *Osyris quadripartita* by the company and only 6.2% of them reported that the local communities did not benefited .The kind of benefit to the local communities from the collection of *Osyris quadripartita* by the company, 62.5% of them reported used to create job opportunities, provide training, conservation and financial use,31.2% used only for financial purpose and 6.3% of them it had no use at all.

As to the status of the benefit gained from commercialization of *Osyris quadripartita* by the company, 12.5% of the respondents believed that the status of the benefit gained from commercialization of *Osyris quadripartita* was extremely high, a little below half of the respondents (43.8%) believed the status of the benefit gained by the local communities from commercialization of *Osyris quadripartita* was high,37.5% of them reported as if it was medium and 6.3% of them believed that there was no benefit gained at all.

Regarding to the initiative of the society for the conservation and sustainable utilization of *Osyris quadripartita* after the agreement on Access and Benefit Sharing by the company, majority of the respondents (68.8%) reported that the initiative of the society for the conservation and sustainable utilization of *Osyris quadripartita* was increased,18.8% of the respondents reported that the initiative of the societies was highly increased and 12.5% as if their initiative for the conservation and sustainable utilization of *Osyris quadripartita* was decreased. As to the parts of the plant utilized by the company, 81.2% of the respondents reported that the wood was utilized by the company and only 18.8% of the respondents had no information about the part of the plant utilized by the company.

Figure 3: The seeds and collected wood of *Osyrisquadripartita* for utilization.

5. CONCLUSIONS AND RECOMMENDATIONS

The results of this study showed that in 75% of the areas *Osyris quadripartita* was found abundantly whereas in 25% of the plots *Osyris quadripartita* was found rarely. On the other hand, based on direct observation during the study individual harvested plant has the potential to produce 4_7 another plants. This might indicate that *Osyris quadripartita* has high coppicing abilities. But the propagated seedlings from stump plant should be keeping from the natural enemies that attack them such as goat, sheep, wild animals and cattle.

However, most of the areas that *Osyris quadripartita* abundantly found were protected areas. Furthermore, the plant's poor natural regenerative power from seeds and root suckers, and its being dioecious may threatens the survival of the plant. As a result these facts the cultivation of the plant should be encouraged. Moreover, the local communities, the government and the company should work together for the continuities of the benefit from this plant, especially by promoting the cultivation of *Osyris quadripartita* which will be accompanied by nursery and land preparation.

Though, the nursery preparations for cultivation of *Osyris quadripartita need* further investigation due to the hemi parasitic nature of this plant.

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ABBREVIATIONS

SNNPR: South Nation Nationality People Regional state; SPSS: Statistical Package for Social Science.

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