World Journal of Pharmaceutical and Life Sciences
WJPLS
www.wjpls.org
SJIF Impact Factor: 3.347

DIVERSITY AND POPULATION STATUS OF GUM AND RESIN BEARING WOODY SPECIES IN GAMBELLA SOUTHWEST ETHIOPIA

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Article Received on 23/06/2016 Article Revised on 13/07/2016 Article Accepted on 03/08/2016

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ABSTRACT

The study was conducted to investigate the population status of gum and resins bearing species in two selected districts, Jor and Lare; to identify gum and resin producing woody species in the study area and to determine the current population structure, regeneration status, density, frequency. Two kebeles were selected from both districts. A total of 75quadrats (40 at Jor and 35 at Lare) were established along transects line. A 400 m^2 quadrants were used, distance between quadrates and transecting lines were 300 m and 500 m respectively. Species diversity and evenness, density, frequency, important value and regeneration status were assessed. This study reveals total of 29 woody species representing 9 families and 17genera's were found. About 11 woody species were encountered as gum and resin bearing species. The Genus of *Acacia*, *Commiphora* and *Sterculia* species were found to be the dominant gum and resin bearing species at the study districts. Economically important Gum-resin bearing species were the dominant vegetation types at study district, they represent species composition 36% and 23.8%, density ha^{-1}61% and 58 %, dominance m^2 h^{-1} 58.7% and 50.5% $m^2$and IVI 55.2% and 50.2% at Jor and Lare, respectively. Diversity of the entire gum-resin bearing species was higher at Jor (H′ =3.23 and 1.52) than Lare (H′ =3.01 and 1.45).The diversity and abundance of the resource base suggest potential for development of gum-resins commercialization to enhance livelihoods and encourage sustainable management of the wood land at the study areas.

KEYWORDS: Gum and Resins, Diversity, Population Status, Southwest Ethiopia.

INTRODUCTION

Background and Justification

In many part of Ethiopia, Non timber forest product (NTFPs) are cover a wide range of products and are most extensively used to supplement diet and household income during particular seasons in the year, and to help meet medicinal needs (Tadesse and Mbogga, 2004).For instance, oleo-gum resin collection and sale is reported to provide an income which ranked second after livestock in the livelihood of the pastoral community (Lemenih *et al.*, 2003). According to Lemenih (2005) in the period 1996 - 2003, Ethiopia exported 13,299 tons of natural gum and earned Birr 141,064,151. This does not include the informal trans-border trade with Somali, Kenya and Sudan. It is even more pressing in dry-lands of Ethiopia where there is only few options to survive and desertification is expanding at an alarming rate.

Although there is no full national inventory on the resource bases, Ethiopia is supposed to have a large coverage of gum and resin bearing species, widely distributed throughout its arid and semi-arid agro-ecological zones (Tadesse *et al.*, 2002). According to Vollesen (1989) there are about six species of *Boswellia,* 52 species of *Commiphora* and many *Acacia* species in Ethiopia. Collection, use and trade of thus by products is an age-old activity in Ethiopia and Ethiopia also one of the world's major producers and exporters of these products (Lemenih *et al.*, 2003; Eshete *et al.*, 2005).

Gambella region is one of the regional states, which have rich natural resources. Particularly forest resources are a high value of economy in the region (Paul *et. al*, 2012). They provide goods and services which are essential for the survival and well-being of all mankind (FAO, 2014). According to WBISPP (2005) report; from total areas of vegetation cover type; lowland dry forest and woodland species compositions are cover larger areas of land in the region. Different studies show that, Fitwi (2000), Lemenih *et al.*(2003) about 420,000 ha of estimated area of gum and resin producing vegetation species are occur in Gambella region, But nothing show about their diversity, density, dominancy, regeneration status, potential production as well as specific species available in the region.

Moreover, it is also threat to plan for future promotion and sustainable utilization of the resources without tangible evidence of research results (GPRSGAR 2010). On the other hand, severe deforestation rate and fire regime are also another threats in the area, that affecting the productivity of gum and resin bearing species, genetic diversity of woodland species composition and ecological importance of dry-land (WBISPP, 2005). Therefore, the aim of this study was to provide quantitative data on diversity and population status of gum and resin-bearing woody species; to identify gum and resin producing woody species in the study area and to determine the current population structure, regeneration status, density, frequency for feasible sustainable use, conservation and management intervention of the resource base.

MATERIALS AND METHODS

Description of the study area

This study was conducted in Nuer and Agnuak zone of Gambella regional state in Ethiopia. We selected thus two zone based on preliminary information indicating the presence of extensive dry forest predominated by diverse and abundant gum and resin-bearing woody species(GPRSGAR 2010). Field reconnaissance surveys and discussions with key informants were carried out to obtain an overall picture of the zone. The two districts, Jor and Lare were purposively selected using the list of the gum and resin potential districts within the zone.

Lare is one of the districts in Nuer Zone in the Gambella People's National Regional State located in south-western part of Ethiopia (Figure 1). The district bordered with Anuak Zone on the south and east, on the west by the Baro River which separates it from Jikawo. The district is located 100 km away from the regional town Gambella. The terrain in Lare consists of marshes and grasslands; elevations range from 300 to 450 meters above sea level. A notable landmark is Gambella National Park, which occupies part of the area south of the Baro. It extends between 6'N to 8.17'N latitude and 34'E to 35.02'E longitude (GBOA, 2010). The district receives average annual rainfall of 645.3 mm and annual temperature ranges from 32.71-41.32^{O}C (GBOA, 2010).The study area has wet season (May-Oct) and dry season (November-April).

Jor is one of the districts in Anuak Zone in the Gambella People's National Regional State located in south-western part of Ethiopia (Figure 1). The district bordered with Jikawo Nuer Zone on the north, on the east by Goge, on the south by South Sudan, on the west by Akobo. The district is located 145 km away from the regional town of Gambella. The terrain of Jor district is predominantly flat, with the elevation ranging between 400 to 600 meters above sea level. A major water body of the district is Gilo River and 30% of the district is forest (CSA, 2007). It extends between 7'N to 8.20'N latitude and 33'E - 36.02'E longitude (GBOA, 2010). The study area receives average annual rainfall of 645.3 mm and annual temperature ranges from 33.71-40.32^{O}C (GBOA, 2010). The study area has wet season (May-Oct) and dry season (November-April) and the total land area of the Woreda is about 182.04 km^2.

Socio-economically, both districts are known to support some of the poorest people living on caching fish product and traditional pastoralist, but also with evolving traditions of crop production, mainly along the river banks and wet land areas. The vegetations of the study districts can be broadly classified as desert and semi-desert scrub, *Acacia-Commiphora* woodland and *Combretum-Terminalia* woodland. The dry forests wood land in both districts supports diverse and abundant wildlife (GPRSGAR 2010).

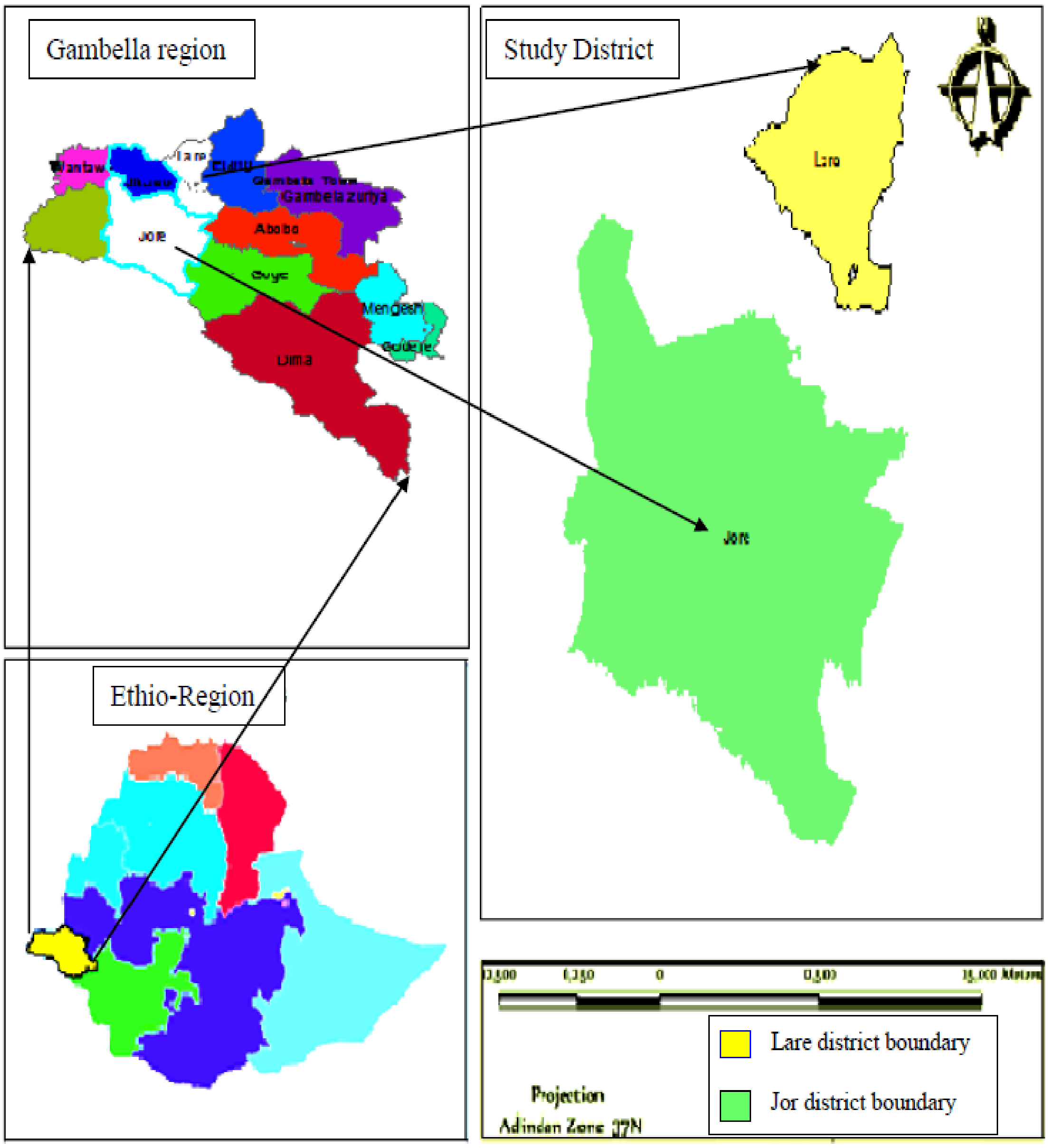


Figure 1: location of the study district.

Data collection

Field reconnaissance survey was conducted since February-April 2015 at lare and Jor districts of Gambella regional state, to select specific sites where gum bearing vegetation resources are abundantly found. In this study, a systematic sampling method was used to locate the sample plots and to generate the required vegetation data. 35 sample plots were established along seven transect lines at lare district and 40 sample plots were established along eight transects lines at Jor district. Square plots with size of 20 x 20 meter (400 m^2) were established at 300 m interval along transect line and each transects were spaced at 500 m interval (Kent and Coker 1992; Pearson *et al*. 2005).We collected data from the first sample plots on line transect and then progressing to the next quadrate in an east-west compass direction. All encountered wood species were recorded and categorized into the following class based on their heights: seedling (if height <1.5 m), 2) sapling (if height 1.5 m - 3 m), and 3) tree (if height >3 m) (Worku *et al* 2012a; Adem *et al* 2014).Diversity and regeneration profile of all encountered woody species were investigated. DBH was measured for individuals >1.5 m in height using diameter tape (Adem *et al* 2014). Seedlings (<1.5 m height) were counted and recorded. Plants were identified at the field, but those species that were not known at field, local name was registered and voucher specimens were used and identified at herbarium of Biology Department, Addis Ababa University. Specimens were dried and identified with reference to authenticated specimens (Edwards *et al*. 1995, 2000; Hedberg and Edwards 1989; Hedberg *et al*. 2006). Field observations of possible factors that affect the woodland resources of gum-resin bearing species were also identified.

Data analysis

The collected data was analyzed by considering ecological variables following Magurran (1988) these included: (1) density of woody species was computed by converting the total number of individual of each species to equivalent numbers per hectare; (2) relative density, which was the number of individuals of species divided by the total number of individuals of all species;(3) frequency was the number of sample plots in which the species was encountered, where (4) relative frequency was computed as the ratio of the number of plots in which a species occurred and the total occurrences of all species in all plots; (5) dominance was calculated as the sum of the basal areas (BA) of the individual woody species in m^2 per ha. BA was calculated for all woody species as BA = $\Pi d^2/4$, where BA = Basal area in m^2, DBH = Diameter at breast height in cm, Π =3.14; (6) relative dominance is the ratio of the basal area of a species divided by the sum of basal areas of all species; (7) Importance value index was the summation of relative density, relative frequency, relative dominance and presented in percentage (Kent and Coker 1992; Akwee *et al*. 2010). Finally, (8) Diversity of the entire species assemblage and that of gum and resin bearing woody species only was determined using Shannon-Weiner diversity and Evenness indices. Sorenson's similarity coefficient was used to quantify similarity (Krebs1989). In addition, population structure of the entire vegetation and gum- and resin-bearing species alone was investigated via constructing diameter frequency histograms, where the density of all individuals including seedlings (if any)were presented on the Y-axis and diameter classes on the X-axis (Eshete *et al*. 2011).

RESULTS AND DISCUSSION

Floristic composition

In this study, 29 woody species were recorded, 25 species from Jor district representing 9 families as well as 21 species from lare district representing 9 families. Of these 17 woody species are common to both districts (Table 1).

The family Fabaceae was the first diverse family represented by 9 species (36%) at Jor district and 8 species (38%) at lare. Burseraceae was the second diverse family represented by 3 species (12%) at Jor and 1 species (5%) at lare. Rhamnaceae was the third diverse family represented by two species (8%) at Jor district and (8%) lare district respectively and other two families were represented by one species each(Table 2).

Argaw *et al.* (1999) and Eshete (1999) made a study in the woodlands of the Upper Rift Valley and found only six woody species along the established plots. Likewise, studies conducted in the wood lands of the northern part of the country had also reported only 13 species (Gebrehiwot, 2003) as compared to what was found in this study. The study vegetation had diverse species composition as compared to some other sites with more or less similar agro-ecology and vegetation formation in Ethiopia. Such difference may be due to the physical and edaphic characteristics of the area.

Gum- and resin-bearing species were more numerous than others, especially those of the genus *Acacia*. A total of 11woody species (10 at Jor and 7 at Lare) were identified as sources of commercial gum and resins (Table 1).

Acacia were most diverse at both sites and were represented by 6 species and 5 species, at Jor and Lare district respectively. *Sterculia* and *Boswellia* were each represented by one species at both districts. Two species, *Commiphora Africana* and *Commiphora habisinica* were recorded at Jor were not recorded at Lare district. Tree was the dominant life form with 16 species (61.5%), while tree-shrub was represented by 7 species (26.9%), and shrub was represented by 3 species (11.5%).In general, gum- and resin-bearing species comprised 40% and 33.3% at Jor and Lare district, respectively (Table 2).

Table 1: Summary of the number of the entire and gum and resin bearing families, genera and species.

Entities	Whole vegetation		Gum and resin bearing species	
	Jor	Lare	Jor	Lare
Number of families	9	9	3	2
Number of genera	15	12	4	3
Number of species	25	21	10	7
Proportion of the gum-resin species composition (%)			61	58
Proportion of associated woody species (%)			39	42

Table 2: Species recorded; RD, RF, RDO and IVI of the study wood land at Jor and Lare District.

Scientific name	Family	Plant form	Jor				Lare			
			RDE	RFR	RDO	IVI%	FDE	RFR	RDO	IVI%
Acacia albida	Fabaceae	Tree	3.517	1.427	0.018	2.008	-	-	-	
Acacia brevispica	Fabaceae	tree/shrub	-	-	-	0.000	3.845	2.366	0.588	2.266
Acacia busseiHarms ex S. jostedt	Fabaceae	Tree	3.593	1.340	0.576	1.836	3.565	3.333	0.645	2.514
***Acacia hockii* De Wild.**	Fabaceae	tree/shrub	3.543	3.272	0.648	2.488	3.74	3.605	0.712	2.686
***Acacia oerfita*(Forssk.)Schweinf**	Fabaceae	*Shrub	3.391	3.304	0.735	2.477	4.754	2.576	0.810	2.713
Acacia poliyacantha	Fabaceae	*Tree	6.933	3.573	28.243	12.916	8.633	1.408	45.541	18.527
***Acacia senegal (L.)* Willd**	Fabaceae	*tree/shrub	6.478	2.229	18.075	8.927	6.711	14.419	14.871	12.000
Acacia seyal	Fabaceae	*Tree	8.148	5.663	34.868	16.226	7.69	1.02	23.235	10.648
Acacia sieberina	Fabaceae	*Tree	3.796	1.076	0.155	2.343	3.915	0.118	0.588	1.540
Acacia nilotica	Fabaceae	* tree/shrub	3.138	0.335	3.602	2.358	-	-	-	
***Albizia schimperiana*Oliv.**	Fabaceae	Tree	3.264	4.898	1.956	3.373	-	-	-	
Anogeissus leiocarpus	Combretaceae	Tree	3.138	6.291	1.130	3.520	-	-	-	
Antiaris toxicaria	Moraceae	Tree	2.885	7.767	1.130	3.927	-	-	-	
***Balanitesa egyptica*(L.) Del.**	Balanitaceae	Tree/shrub	3.467	0.115	0.168	1.250	3.985	0.222	0.261	1.489
Baphia abyssinica	Fabaceae	Tree	3.214	6.291	0.349	3.285	3.635	7.666	0.810	4.037
Boswellia rivae	Burseraceae	* tree/shrub	6.225	3.459	0.269	3.318	6.956	4.442	1.265	4.221
***Commiphora africana*(A. Rich.) Engl**	Burseraceae	*Tree/shrub	4.175	4.427	1.130	3.244	-	-	-	-
***Commiphora habisinica*(Berg)**	Burseraceae	*Tree/shrub	4.352	0.418	0.712	1.827	-	-	-	
Diospyros mespiliformis	Ebenaceae	Tree	3.593	15.851	1.564	7.003	4.474	1.251	1.078	2.268
Grewia bicolarJuss.	Tiliaceae	Shrub	-	-	-	-	4.649	0.984	1.000	2.211
***Grewia villosa*Willd**	Tiliaceae	Shrub	-	-	-	-	4.334	13.043	1.377	6.251
Lonchocarpus laxiflorus	Fabaceae	Tree	3.517	22.117	0.593	8.742	4.404	11.039	1.822	5.755
***Sterculia Africana* (Lour.) Fioris**	Sterculiaceae	*Tree	3.897	0.325	0.502	1.575	-	-	-	
Sterculia setigera	Sterculiaceae	*Tree	-	-	-	-	6.292	2.253	1.265	3.270
Tamarindus indica	Fabaceae	Tree	3.416	0.116	0.167	1.233	3.88	0.263	0.588	1.577
Terminalia laxiflora	Combretaceae	Tree	3.264	2.417	0.785	2.155	3.635	7.796	0.758	4.063
Vitellaria paradoxa	Sapotaceae	Tree/shrub	3.163	9.830	1.130	4.708	3.81	17.249	0.810	7.290
Ziziphus pubescens	Rhamnaceae	Tree/shrub	3.011	4.092	0.712	2.605	3.635	3.407	1.265	2.769
Ziziphusspina-christ	Rhamnaceae	Tree/shrub	2.885	4.369	0.785	2.680	3.46	7.54	0.712	3.904
Total			**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Total density per ha = 2346 and 1702 at Jor and Lare Districts, respectively. [RDE (%) = relative density, RFR (%) = relative frequency, RDO (%) = relative dominance, IVI = Importance Value Index (%). *Gum- and resin-producing species, as identified by local communities. Most of these species are also mentioned in similar studies in other parts of the country (E.g. Lemenih *et al*. 2003; Worku *et al*. 2012a; Adem *et al* 2014).

In both study area support high diversity of gum- and resin-bearing species compared to other areas in Ethiopia with similar agro-ecology. Argaw *et al* (1999), for example, reported only two gum- and resin-bearing species (*A. senegal*and *A. seyal*) from the central Rift valley woodlands. Although, equivalent in terms of total species diversity, fewer gum- and resin-bearing species were reported from northern Ethiopia as compared to in this study area (e.g. Eshete *et al*. 2011). In this part of the country, *B. papyrifera, A. senegal, A. seyal* and *S. setigera* were the main sources of commercial gum and resins (Gebrehiwot 2003; Eshete *et al*. 2011). In terms of gum- and resin-bearing species diversity is equivalent with findings in Borana zone, South Ethiopia and South Omo (Lemenih *et al*. 2003, Worku *et al*. 2012a and Adem *et al* 2014).

Density, frequency and dominance

The total density of all woody and gum- and resin-bearing species was 2346and 1433 ha^{-1} and 1703 and 955 ha-1 at Jor and Lare, respectively. This difference may be due to the difference in species composition and difference in land use system between the two districts. *Acacia seyal, Acacia poliyacantha, Acacia senegal, Boswellia rivae, Commiphora habisinica, Commiphora Africana* and *Sterculia Africana* were the most densely populated species, constituting 40.05% of overall density at Jor. *Acacia policanta, Acacia seyal, Boswellia rivae, Acacia Senegal, Sterculia setigera, Acacia oerfita* and *Grewia bicolar* were the dominant species, accounting for 45.68% of recorded species density at Lare. Gum- and resin-bearing species were comprised 1433 and 955 ha^{-1} (61 and 58 % of the total woody stems density) at Jor and Lare, respectively (Fig. 2). Comparable results reported from other gum and resin production area in Ethiopia. For instance, Worku *et al*. (2012) and Adem *et al* (2014) reported total density ha^{-1} of 1017 and 882 (49% and 68% of the total woody stems density) at Arero and Yabello districts in Borana zone, Oromia region in Ethiopia and 919 and 1085 ha-1(48% and 50% of all species density) at Hamer and Bena-Tsemay south Omo zone, southern region in Ethiopia.

At Jor, *Acacia seyal, Acacia poliyacantha, Acacia Senegal* and *Boswellia rivae* were the most abundant species, each represented by 186, 163, 152 and 146stems ha^{-1}. The second-most abundant species were *Commiphora habisinica, Commiphora Africana* and *Sterculia africana* with 102, 98and 91 stems ha^{-1}. At Lare, *Acacia poliyacantha, Acacia seyal, Boswellia rivae and Acacia senegal,* were dominant, each represented by 187 , 158 , 138 and 136 stems ha^{-1}. *Sterculia setigera, Acacia oerfita* and *Grewia bicolar ranked* second in density, each represented by 127, 108 and 98 stems ha^{-1}.However, density typically varies greatly by species. For instance, it ranged from 11 to 313 at South Omo (Adem *et al* 2014) and 12 to 162 at Borana (Worku *et al*. 2012). Eshete *et al*. (2005) reported stem ha^{-1}from 87 to 175 for *B. papyrifera* at Amhara region, northern Ethiopia, while Gebrehiwot (2003) counted between 100 and 254 stems ha^{-1}for similar species in Tigray Region, northern Ethiopia. Such great variation in stem densities might be due to the effect of agriculture expansion, climate regime and species characteristics. In general, the stem density at Jor and Lare district, Gambella region suggested potential for commercial gum and resin and tapping practices. The total basal area for all woody species was 40.12 m^2 and 35.3 m^{2}ha^{-1}at Jor and Lare respectively. The total basal areas of gum and resin bearing species was 23.56 (58.7%) and 17.8 (50.5%) m^{2}ha^{-1} at Jor and Lare, respectively.

At Jor, the least and greatest frequencies were 12 and 35 while atLare7 and 34 respectively. The most frequent gum- and resin-bearing species was *Acacia seyal* at Jor. It was encountered in 35 plots, whereas, *Sterculia africana, Acacia hockii* and *Acacia poliyacantha* were recorded in 33, 32 and 32 of 40 sampled plots. At Lare, *Acacia seyal* was most frequent and recorded in 35 of 35 sample plots, followed by *Acacia poliyacantha, Sterculia setigera* and *Boswellia rivae each* recorded in 32, 31 and 30 plots, respectively. *Baphia abyssinica Lonchocarpus laxiflorus* and *Diospyros mespiliformis* were the most frequent associate species in both districts. The high frequency indicates regular horizontal distribution of the species in the forests. The variation in density and frequency between species may be attributed to habitat differences, habitat preferences among the species, species characteristics for adaptation, degree of exploitation and conditions for regeneration (Eshete *et al.*, 2005).

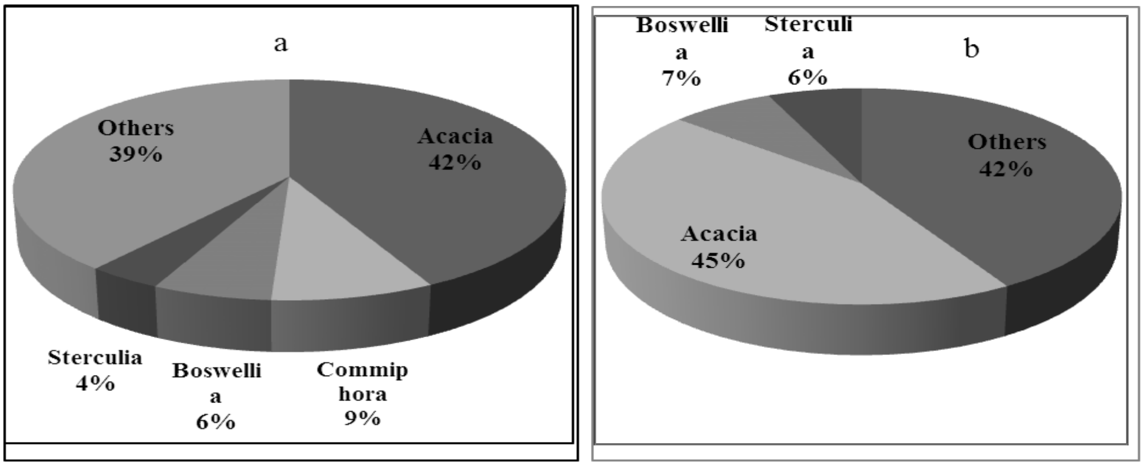


Figure 2: Proportion of the density ha^{-1}of gum- and resin-bearing and associated species at Jor (a) and lare (b) Districts.

Importance value index (IVI)

Gum- and resin-bearing species demonstrated high IVIs of 58.58% and 56.06% at Jor and Lare, respectively. *Acacia seyal, Acaciasenegal, Acacia poliyacantha* and *Boswellia rivae,* were species with highest IVI and constituted about 45.36%of total IVI at Jor. *A. poliyacantha, A.senegal, A. seyal, Boswellia rivae* and *Sterculia setigera* at Lare contributed 48.7% of total IVI (Table 2). At Jor, *Acacia bussei, Acacia, nilotica, Balanites egyptica, Commiphora habisinica, Sterculia Africana, Tamarindus indica, Terminalia laxiflora* and at Lare, *Acacia sieberina, Tamarindus indica and Balanites egyptica* had the lowest IVIs (Table 2). Accordingly, Gum- and resin-bearing species were the principal components of the studied vegetations, as demonstrated in the above result. More or less comparable results were reported by Worku *et al*. (2012a) and Adem *et al* (2014) at Borana and South Omo respectively. Some associated and gum-resin species showed lower IVI at both study sites, this may be due to intensive human interference of the area.

Diversity, evenness and similarity

The Shannon-Wiener diversity indices (H′) for all woody species and gum- and resin-bearing species were (H′ =3.23 and 1.52) at Jor and (H′ =3.01 and 1.45) at Lare, respectively. Shannon evenness indices (J’) for all woody species and gum and resin-bearing species were (J =0.98, 0.42 and 0.97, 0.35, respectively) at Jor and Lare. Sorensen’s Similarity coefficient for all species and gum- and resin-bearing species at both sites were 0.8 and 0.5 respectively (Table 3).

In this particular study, the result showed the existence of normal diversity in the case of the whole woody species encountered in the study sites. However, Lare had relatively less value of Shannon index (H’=3.01) as compared to Jore (H’= 3.23). Nonetheless, the vegetations of both districts were in the normal diversity ranges (H′ =1.5 and 3.5) (Kent and Coker 1992).This result higher than that reported by Adem *et al* 2014 (H’ =2.48 and 1.28) at Hamer and (H’ =2.61 and 1.4) at Bena-Tsemay in south Omo and Worku*et al*. 2012(H’=2.77) at Yabello district (H’= 3.22) and at Arero district in southern Ethiopia.

According to Kent and Coker (1992), low Shannon evenness is an indication of the existence of unbalanced distribution of the individuals of species encountered at a given study areas. In this study however, the Shannon evenness for the whole vegetation of the study areas was found to be very high (Table 3), implying more or less the even representation of individuals of all species encountered in the study plots.

The Sorenson's similarity value showed that the vegetation of the two districts as a whole had similarity ranges (>0.5) (Kent and Coker 1992) and in terms of the study species, they had less similarity value which is below 0.5. This may probably due to differences in species richness, which might again result from the observed land use differences between the two districts.

Table 3: Summary of diversity parameters for the entire and gum and resin bearing species at both districts.

Characteristics	Sites			
	Jor		Lare	
	All encountered species	Oleo-gum bearing species	All encountered species	Oleo-gum bearing species
Species richness	25	10	21	7
Density/ha	3246	1433	1703	955
Shannon diversity (H')	3.23	1.52	3.01	1.45
Evenness index (E')	0.98	0.42	0.97	0.35

Population structure and Regeneration

The comparative patterns of the population structure of the vegetation of the two districts were presented in Figure 3. The result depicts the existence of variations in diameter size classes of the vegetation at both districts. In general, Abundance of stems was very high at lower diameter classes. Unlike, most gum- and resin-bearing species, good abundance of individual stems of the entire vegetation were found up to the fourth diameter class and decline sharply at higher diameter classes.

The first and second diameter classes were dominated by *Diospyros mespiliformis, Acacia oerfita* and *Lonchocarpus laxiflorus* and the third and fourth by gum- and resin-bearing species at both districts. Generally, the patterns of diameter size distribution of the vegetations were found to be inversely proportional to the increasing diameter class at both districts. In other words, the vegetation structure at both districts was a reversed J-shape distribution.

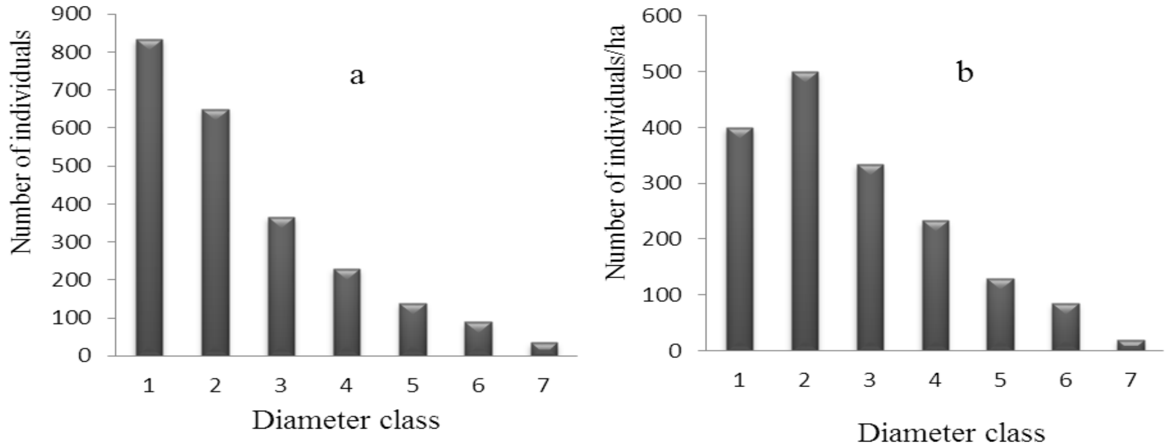
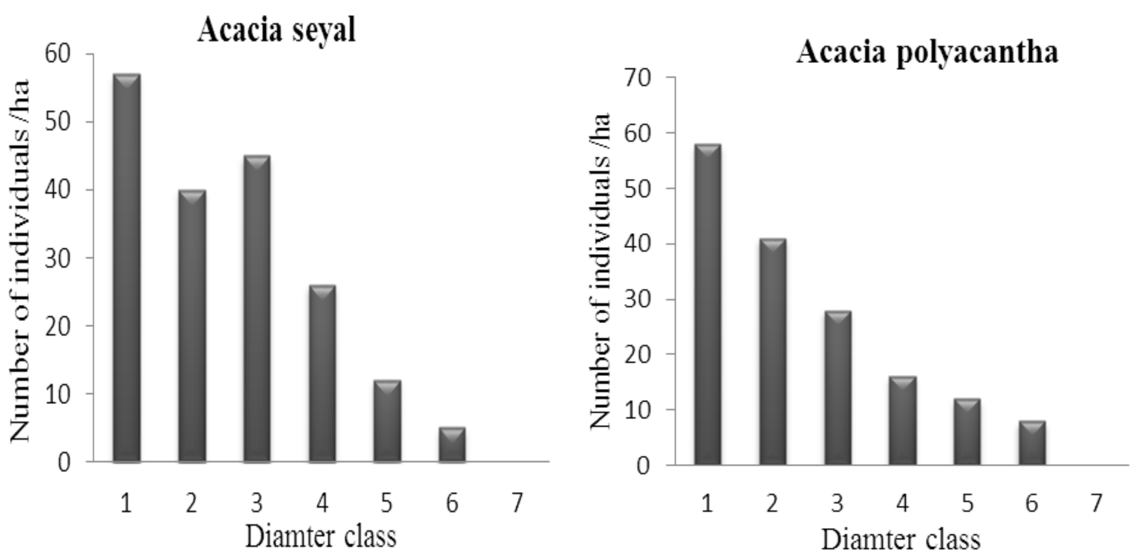


Fig. 3: Diameter class distribution of the whole vegetation at Jor(a) and Lare (b). Diameter size class in (cm) (1: < 5, 2: 5-10, 3: 10-15, 4: 15-20, 5: 20-25, 6: 25-30, 7: 30-38, 8: 38-47, 9: > 48).

The population structure of gum- and resin-bearing species can be categorized more or less into three groups: inverted J-shape, J-shape and bell-shape diameter distribution patterns (Fig.4 & 5).*Acacia sieberina* at Lare districts exhibited J-shape, which was an unhealthy distribution due to the lack of seedlings and had no individuals in the first and second diameter class (Fig 5). This reflects a hampered regeneration status of the species due to possible reasons like human disturbance, livestock trampling or browsing, fire and flooding in the area. *A. poliyacantha* was depicted an Inverted-J-shape pattern at both district and *A. seyal* and *B. rivae* more or less showed an Inverted-J-shape pattern at Jor district. This reflects good regeneration status of the species; it may be due to resistance potential in browsing, grazing, fire regime and flooding.



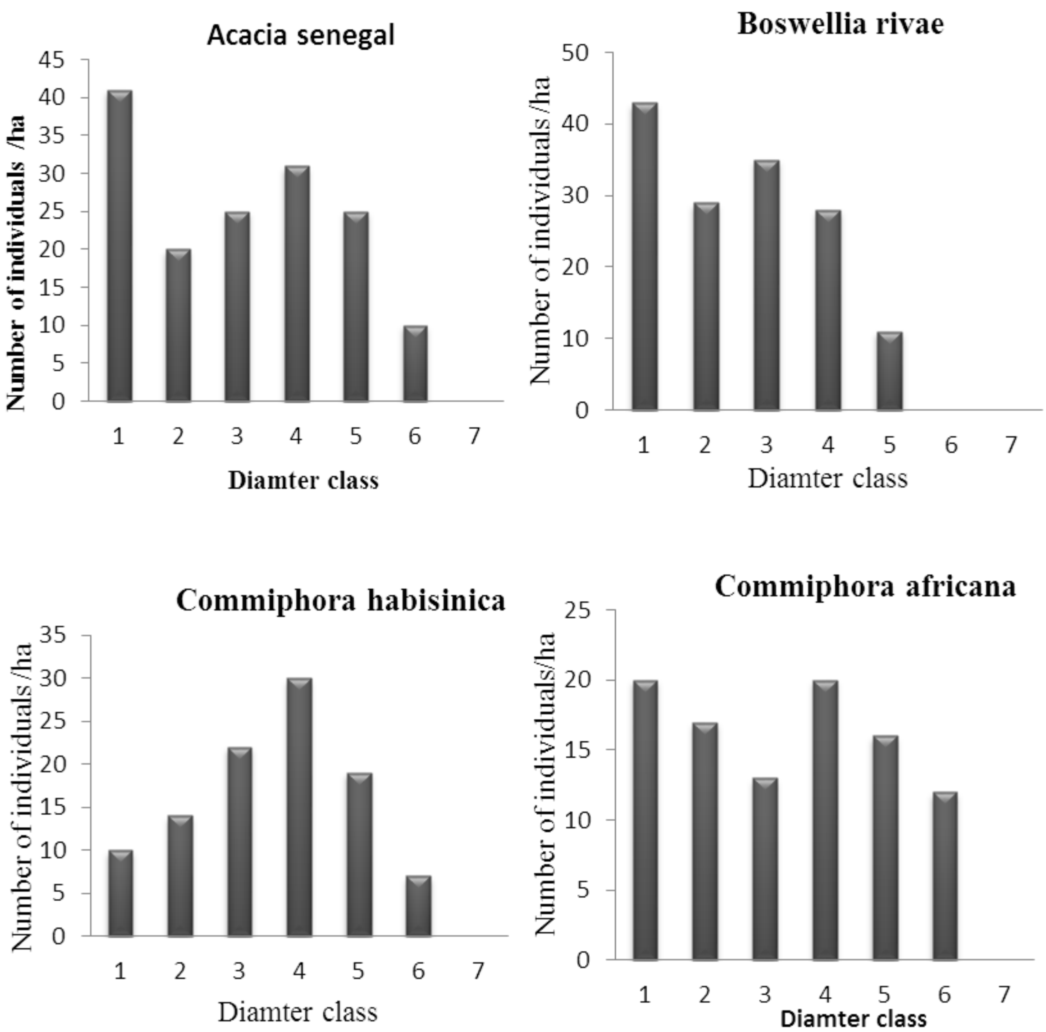
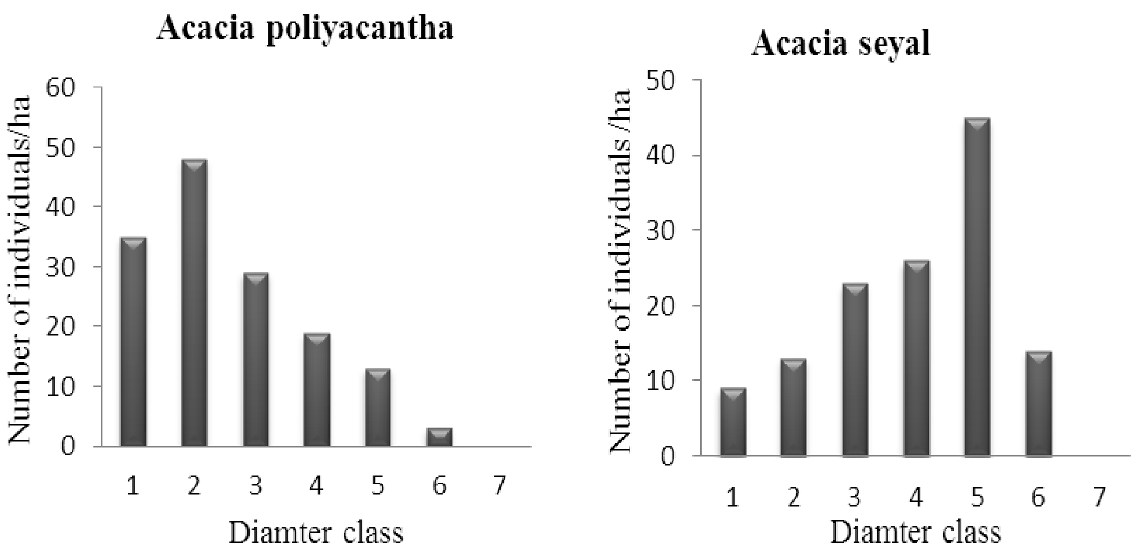


Figure 4: Diameter class distributions of gum and resin bearing species at Jor district, Diameter size class in (cm) (1: < 5, 2: 5-10, 3: 10-15, 4: 15-20, 5: 20-25, 6: 25-30, 7: 30-38, 8: 38-47, 9: > 48).



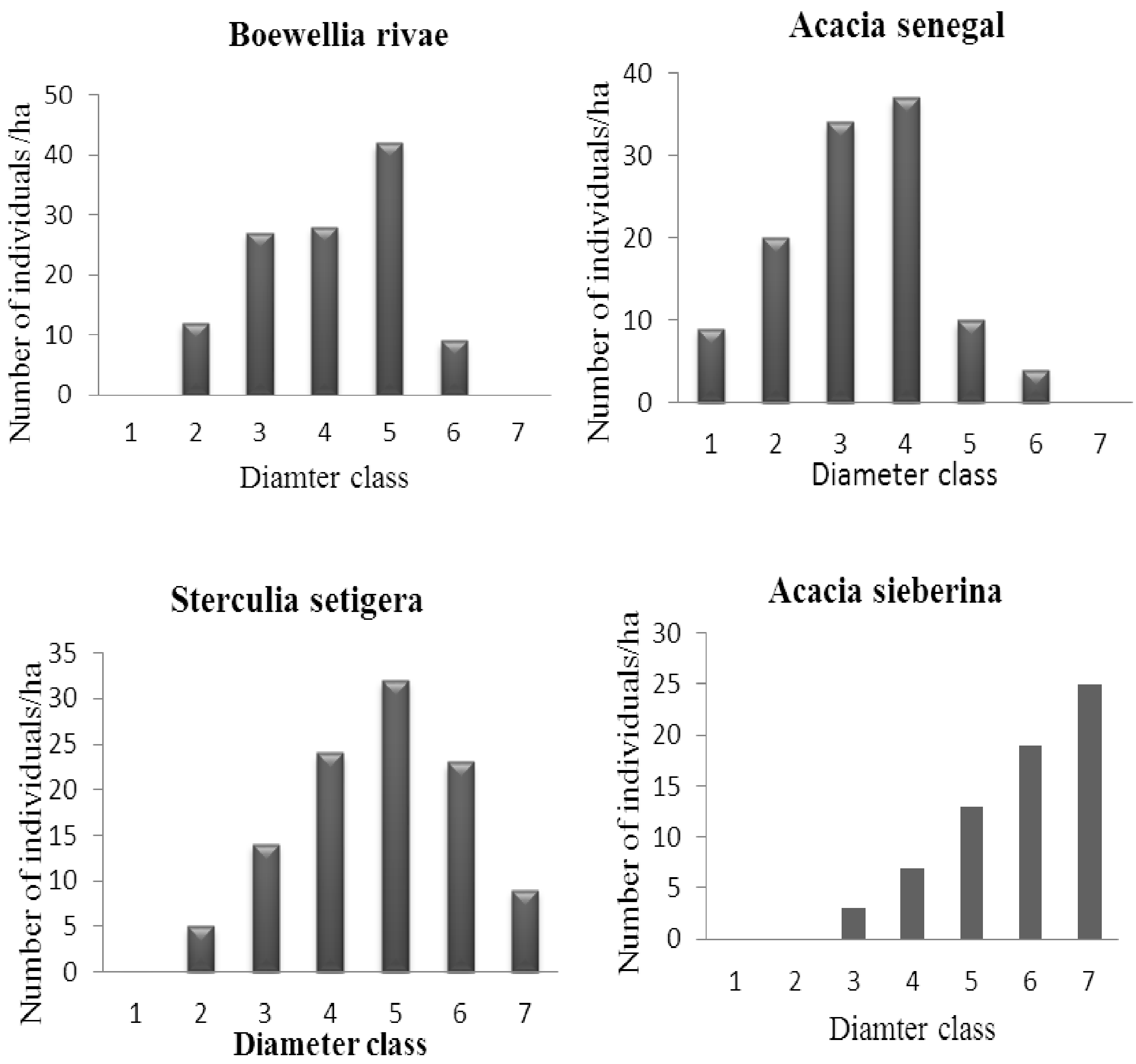


Figure 5: Diameter class distributions of gum and resin bearing species at Lare district, Diameter size class in (cm) (1: < 5, 2: 5-10, 3: 10-15, 4: 15-20, 5: 20-25, 6: 25-30, 7: 30-38, 8: 38-47, 9: > 48).

The rest major gum and resin bearing species in both districts more or less demonstrated a bell-shape distribution, where there was small number of individuals in the lower and higher diameter classes. Although they all had bell-shape distribution, *A. senegal*, and *C Africana* in Jor district got some individuals of seedlings and/or sapling that belong to the first class, compared to *C habisinica* in Jor district and *A. seyal*, *A. senegal*, *B. rivae* and *S. setigera* in Lare district, which demonstrated hampered regeneration (Fig.4 & 5). This may due to heavy grazing, frequent flooding and fire regime as major factors limiting regeneration of most woody species and study species particularly at lare district.

Eshete *et al*. (2005) and Worku *et al*. (2012) argued that sustainable supply of gum and resins from dry forests could be achieved the current population structure of the entire forest and/or particular species. To achieve stable levels of trade volume in gum and resin, a species needs many seedlings and saplings in comparison to the stem counts for higher diameter classes to ensure species maintenance. Simultaneously, the forest must support many trees in the middle and higher diameter classes because these trees are the ones that are tapped right-away to produce commercial products (Lemenih *et al*. 2003; Yebeyen 2006; Worku *et al*. 2012).

In general, the observed declining regeneration profile of gum and resin species on our study areas was similar to the situations reported for the various gum and resin belts in the country (Argaw *et al*. 1999; Yebeyen 2006; Eshete *et al*.2011; Worku *et al*. 2012).

CONCLUSION AND RECOMMENDATION

The results of this study revealed that, the study districts are rich in terms of gum and resin bearing vegetation resources especially, the genus *acacia*, even though there is difference in species composition of gum and resin bearing species between the study districts. In addition, study indicated gum and resin bearing species as the dominant vegetation of the study districts. This implied more or less the wood land cover is dominated by gum and resin bearing species, which reflects the high potential of gum and resin to be collected for commercial. Thus, there is a need to promote and commercialize the use of such resource through involvement of the local community so that local level accountability of resources management will be enhanced. However the regeneration status of few study species was not good, this shows problem in recruitment of the study species which again limits both ecological and economic role of gum and resin bearing species at the study districts in the future.

Based on this study, the following recommendations can be forwarded.

1. This study was done during dry spell (February-April) therefore; further research is needed during the wet season to provide analysis of factors contributing to natural regeneration and to identify practicable dry-forest sustainable management options.
2. Creating awareness about the contribution of gum-resin species to their income for local people is highly mandatory to identifying and conserving for sustainable production of the resources.

3. To improve the current poor natural regeneration of some gum and resin bearing species, we need to establish community-based and state-promoted nurseries and rehabilitation projects in the area.
4. Strategy must be devised for effective control and management of fire regime, flooding problem, deforestation and overgrazing to reduce their impact on natural regeneration of gum and resin bearing species.

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