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The Effect of Tapping Methods and Some Tree Growth Parameters on Productivity of *Acacia seyal* in South Kordofan State, Sudan

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Abstract

The study was conducted at Um Fakarin Natural Reserved Forest (Al Abbasia Forest Circle), South Kordofan State, Sudan in season 2012/2013 to investigate the effects of tapping tools, position of tapping and some tree growth parameters on yield potential of *Acacia seyal* (*variety seyal* Del., *gum talha*). Two-level factorial experiment was carried out. The first factor comprised two levels of tapping position: stem and branches. The second factor constituted four types of tapping tools: traditional axe, *sonkey*, *mengaf* and *makmak,* besides the control. A randomized complete block design (RCBD) was used with four replications. The tree growth parameters measured were diameter at breast height, total tree height and average crown diameter. Tapping was carried out on the 1st of November, then first and subsequent picks were done in interval of one month, till the 1st of June (7 picks). After having been dried at room temperature for 48 hours, the collected gum was then weighed and recorded. The findings showed no significant differences in yield in relation to tapping tools. The same result was obtained in case of positions of tapping except in the 5th pick ($p \leq 0.05$). Results proved no significant effects of interacted tools and position of tapping except in the 7th pick ($p \leq 0.05$). Branches tapped with the *sonkey* gave the highest yield (41.98g) per tree per season; however the lowest yield (16.61g) was obtained from branches tapped with the traditional axe. The study showed positive correlation between gum yield and stem diameter ($r = 0.146$), whereas inverse correlation was recorded between gum yield and both tree height ($r = - 0.155$) and crown diameter ($r = - 0.106$). Coefficient of variation for gum yield for the season was calculated as 49.3%. The study recommended conduction of experiments on gum yield in permanent trial plots in order to have data of seasonal time series, aspiration towards establishment of high yielding *Talh* stands, in addition to intensification of extension packages to raise awareness of local people about importance of *Acacia seyal* and use of the *sonkey* as an appropriate tool for tapping, besides study of other local tools.

Keywords

Tapping Tools, Gum Yield, Factorial Experiment, RCBD, Coefficient of Variation, South Kordofan

1. Introduction

Sudan, Africa's largest country, split in two on July 9th 2011, formalizing the independence of the South. In the year 2011, the Sudan Central Bureau of Statistics estimated the population of the country to be some 39 million, growing at 2.7%. More than 30 million people live in rural areas (USAID, 2012). Over 80% of Sudan's employment takes place in the agricultural sub-sector of the economy. The majority of the populations are farmers living on subsistence farming and pastoralists depending on livestock herding in a nomadic way of life. Sudan is located between latitudes 8 and 22 degrees north and longitudes 22 and 38 east, in the northeastern part of Africa. The area of Sudan is 1,882,000 square kilometers (USAID, 2012). The vast longitudinal extension gives the Sudan unique ecological characters, from dry sandy desert in the northern central parts to high rainfall areas in the south. The country is also covered with desert shrubs and stunted bushes. There are thorny low trees of low rainfall savannah in

the central belt to broad leaf high rainfall savannah in the southern part (Sudanet, 2014).

Forests play an important role in the welfare of the Sudanese population and in conserving and protecting the environment and the development of the country's national economy. The vegetation cover protects soils against wind erosion and intense seasonal rainfall as well as it helps to maintain the levels of ground and surface water (Taha, 2006). The most important forest types in the Sudan include *Acacia nilotica, Acacia seyal, Acacia senegal, Balanites aegyptiaca, Acacia mellifera* and special forest types like Dom *(Hyphaene thebaieca), Tamarix aphylla,* montane forests (Harrison and Jackson, 1958; Sahni, 1968; Vogt, 1995; Geller, et. *al.*, 2009). The Forests National Corporation (FNC) estimated that after separation of South Sudan, forests cover about 11.60% of the total area, while agricultural land, range and water constitute 13.70%, 26.40%, and 0.17%, respectively. The average annual increment of growing stock volume was estimated as 1.340 million cubic meters of which 5% was removed per hectare and year. The majority of the product was used for firewood and charcoal, while 9% was used for high quality timber (USAID, 2012).

Among a wide spectrum of plant exudates, gum arabic is the most important and usable gum, it includes both gums from *Acacia senegal* and *Acacia seyal* trees, which are distributed in a continuous belt known as the "Gum Arabic Belt". The Sudan is acknowledged as the world dominant leader in gum arabic production; it contributes to about 95% of the total world gum arabic production (Abdulgadir, 2013). Sudan effectively controls almost over 80% of the world market (Anderson, 1993; GAC, 1996; Forman, 2012; Abdulgadir, 2013). Gum arabic provides an average of 12 percent of the gross domestic product (GDP) of the country, and accounts for about 15.3 percent and 10 percent of the household income of gum producers and other farmers in the gum belt in Sudan, respectively (Elamin and Ballal, 1989; Mahmoud, 2004; Taha, 2006).

Gum produced from *Acacia seyal* is the next available *Acacia* gum of trade; in commercial terms it is marketed as gum arabic (IIED/IES, 1990), but Sudan exports it under different name "*gum talha"* to distinguish it from gum arabic provided by *Acacia senegal (Hashab trees)*. While the gum arabic exudates from *Hashab* trees are usually obtained by tapping the bark of the trunk or branches using a simple traditional axe or the recommended tool called *sonkey*, the exudation of gum *talha* occurs naturally in the hot dry season without deliberate tapping of the tree (Seif Eldin and Zarroug, 1996). This study was an attempt to examine the effect of tools and position of tapping as well as some tree growth parameters on productivity of gum *talha* from *Acacia seyal* variety *seyal* Del.

2. Problem Statement

Over exploitation is one of the major factors contributing to destruction of the natural forest resources and woodlands. This is especially true in the arid zone as well as large proportions of the savannah region, where vast areas have been cleared annually for wood production and cultivation of field crops (Fries, 1992; Hertherington and Elsiddig, 1993). Reference to estimations made by Foggie (1968), a range between 14,000 and 16,000 hectare was cleared annually in the savannah region. Extensive populations of *Acacia seyal* (*Talh* trees), which are considered as an important source of rural energy in form of firewood and charcoal, are particularly over utilized. As well, *Talh* wood is extensively used by women as an aromatic smoke to clean and perfume the skin (Vogt, 1995; Eldwwari, 2006). Other anthropogenic factors such as overgrazing and fires as well as adverse climatic conditions have also contributed to degradation of the natural forest resources (IIED/IES, 1990).

Despite the wide spread of natural stands of *Acacia seyal* in South Kordofan State, reliable information is very limited: there is lack of detailed statistical data about tapping techniques and proper management of *Talh* trees. Ignorance of the local people about tapping methods of such stands has been thought to render the production of gum *talha* to very small amounts.

3. Objectives and Hypotheses

The study aimed principally to provide scientific knowledge on the potential of *Acacia seyal* stands for improving production of gum *talha* with special emphasis to the following specific objectives:

- Determining effects and suitability of different tapping tools (traditional axe, *mengaf, makmak, sonkey*) on yield per tree,
- Identifying the optimum position of tapping on the tree,
- Examining effects of interacting factors (tools and position of tapping) on yield,
- Studying the correlation between gum yield and tree growth parameters, namely total height, diameter at breast height, and average crown diameter.

To fulfill stated objectives of the study, two assumptions were formulated: 1) tools and position of tapping are playing a big role on the potential of *Acacia seyal* for yielding gum *talha* & 2) growth parameters, namely tree height, diameter at breast height (DBH) and average crown diameter have a remarkable effect on yield of gum *talha*.

4. The Study Site Description

South Kordofan State is located in the southern half of the Sudan between latitudes 9° to 13° N and longitudes 27° to 32° E covering an area of about 141,096 square kilometers. Administratively, the state is composed of fifteen localities (www.fr.m.wikipedia.org). Its landscape contains four main physiographic regions: the Nuba Mountains, the southern plains bordering Bahr el Arab; the western sandy plains, and the eastern plains bordering the White Nile. The study area (Um Fakarin Natural Reserved Forest) belongs to the eastern plains; it is located between latitudes 12 29 25 N to 12 35 09 N and longitudes 31 17 33 to 31 20 00 E, approximately 50 Km north to Al Abbasia town. It has been reserved in 1954 with an area of 1400 hectares extended in 1999 to about 2940 hectares;

its Gazette number is (9) issued on 30th September1999. The forest is dominated by *Acacia seyal* var. *seyal* and other scattered species that include: *Acacia seyal* variety *fistula* (locally known as *Saffar abiad*), *Balanites aegyptiaca*, *Ziziphus spina-christi*, *Acacia mellifera*, *Acacia senegal*, *Acacia nubica* and *Boscia senegalensis* (Al Abbasia Forests Circle, 2011). The soil of the area reflects variations and differences in climate, physiography, parent material and history of use. The soil of the Nuba Mountains has been formed as a result of in-situ weathering; it is reddish or brownish and varying in texture from sandy loam to clay. The southern plains form plateaus and ridges of sandy textured soils, while the eastern plains contain old and recent flood plains with cracking clay soils and the western plains are generally sandy soils (SKADP, 1992). The bio-climate of South Kordofan State is separated into two zones: the southern Sahel (open thorn savannah) and the Sudan Savannah (shrub woodland). The Sahel is drier and its agriculture encounters higher risk; the greatest hazard is the short duration of the rainy season and drought resistant species are dominant. Greater part of South Kordofan State lies in the Sudan savannah, where opportunities for crop production are relatively good; mean rainfall is in the range of 500mm per annum. An early rainfall season starts from mid April to June and the real term begins from July till mid October. The area is hot throughout the year with the primary peak occurring during April and May and secondary peak during October. Lowest temperatures happen in January and again during August. During the growing season, temperatures are between 25° and 28° (SKADP, 1992).

Harrison and Jackson (1958); Sahni (1968) and Vogt (1995) related vegetation of South Kordofan State to soil and climate; much of the area can be classified as low rainfall woodland savannah. Typically alluvial soils have a closed grass cover particularly in the south. The soils of plateau and peneplains have an open tree and shrub savannah on undisturbed sites, with very open shrub savannah around villages. Relatively undisturbed areas of sandy soils (*goz*) are characterized by savannah woodland in the south and by tree and shrub savannah in the north with open shrub communities on fallow land. The natural vegetation of the Sahel region includes: *Acacia senegal*, *Balanites aegyptiaca* and *Tamarindus indica*. Important grasses are *Aristida spp*. and *Eragroszis spp*. Dominant shrubs are *Acacia nubica* and *Ziziphus spina-christi*. In Sudan Savannah, typical vegetation includes: *Acacia seyal*, *Balanites aegyptiaca*, *Terminalia laxiflora* and *Tamarindus indica*. Important grasses are *Andropogon gayanus* and *Hyperhenia spp*. and the dominant shrub is *Acacia mellifera*.

According the census of 1993, the total population of South Kordofan State was 1.65 million, with growth rate of 3.1% per year. The principal cultural groups include Nuba, Baggara and other Arabs, West Africans and Nilotics.

The Nuba, who are primary upland farmers, concentrate in the central Nuba Mountains and in Kadugli (the capital of the state). The Arabs Baggara are found mainly in the central clay plains and around hills, they are basically transhumants and cattle-owning tribes of Arab origin. Other Arabs non-Baggara located near Rashad are former cattle owners. West Africans concentrate north and south of Rashad, they are predominantly farmers, and also manage sedentary cattle. The Nilotic tribes concentrate in southwest Salam Locality, where they undertake sedentary crop and livestock production (SKADP, 1993).

5. Materials and Methods

The experiment was factorial (2x5) in randomized complete block design (RCBD) with four replications, carried out within season 2012/2013. The first factor comprises position of tapping which was tested in two levels, namely the stem (a1) and branches (a2). The second factor represents tapping tools (Plate 1) tested in five levels; traditional axe (b1), *sonkey* (b2), *mengaf* (b3), *makmak* (b4) and control (b0).

Each experimental block constitutes 10 experimental units and each unit comprises two trees selected randomly. The total number of trees for the whole experiment was 80 trees ((2 trees x 2 positions x 5 tools {4+ controls} x 4 replications)). Symbols of interacted factors of tools and positions of tapping were distributed randomly among the trees and marked on the tree stem.

The growth parameters (total tree height, diameter at breast height and average crown diameter) were measured using relevant instruments; suunto hypsometer, caliper and diameter tape. The crown diameter was estimated by taking the mean of crossed lines measured. Trees were tapped on 1st November coinciding with the end of the rainy season. The first gum pick was done on first December (after drying of gum nodules), the subsequent picks were carried at intervals of one month until the seventh pick on first June (beginning of the rainy season). Gum collected from each experimental unit was dried at room temperature under shade and exposed to free ventilation for 48 hours, then weighted separately and recorded.

The data were subjected to the standard statistical analysis of variance (ANOVA) using MSTAT-C statistical package to examine the effect of individual and interacted factors (tools and position of tapping) on yield of gum talha. Duncan's Multiple Range Test (DMRT) was used for separation of means. Multiple correlation coefficients between means of tree growth parameters and gum yield were computed. Ultimately, the coefficient of variation was found out to evaluate the results of the experiment.

6. Results and Discussion

6.1. Effect of Tapping Tools on Yield of Gum *talha*

As presented in Appendix (1), the results of analysis of variance (ANOVA) for all picks showed no significant effects of tools used for tapping *Talha* trees. Mean squares of gum *talha* for all picks were 18.45g, 23.14g, 4.43g, 2.61g, 12.69g, 96g, and 7.11g collected in the first, second, third, fourth, fifth, sixth, and the seventh pick, respectively. Average yield of gum *talha* per tree per pick was 3.42g, 4.65g, 4.13g, 4.63g, and

3.57g obtained by using an axe, *sonkey*, *mengaf*, *makmak*, and control, respectively. The total yield amounts of gum *talha* per tree for the whole season were 23.97g, 32.54g, 28.93g, and 24.98g obtained by tapping trees with an axe, *sonkey*, *mengaf*, *makmak*, and control, respectively (Table 1).

Table (1). *Average yield of gum talha (g/tree) in relation to tapping tools*

	.	Tapping	.tools	.	.
Picks	**Axe**	***Sonkey***	***Mengaf***	***Makmak***	**Control**
1st	2.09	5.04	1.60	2.35	1.17
2nd	5.26	5.03	4.79	8.20	3.61
3rd	0.64	2.10	0.78	0.76	2.06
4th	5.69	4.66	6.19	5.28	5.22
5th	5.83	6.72	8.70	7.56	7.87
6th	2.00	4.24	2.13	3.55	1.93
7th	2.91	4.75	4.74	4.69	3.12
Mean	3.42	4.65	4.13	4.63	3.57
Total	23.97	32.54	28.93	32.39	24.98

The non-significant correlation between tapping tools and yield of *Talha* trees could be attributed to the weak response of such trees to relatively wide incision made by those tools. This result agrees with the conclusions of Anderson and Herbich (1963); Seif Eldin and Zaroug (1996) who reported that exudation of gum *talha* occurs naturally without deliberate tapping of the tree. Also it was quite evident from personal observations of the authors that much of gum exudates were reported to emerge through any natural incision rather than wounds caused by tapping tools. Nevertheless, tapping has a significant influence on yield of gum *talha* (Mohammed and Roehle, 2011). Usually tapping operations are performed at the beginning of November**,** often after the cold weather (winter) that inhibits the gum exudation. Such a case was thoroughly described by IIED/IES (1990), as it was reported that high yield of gum is habitually obtained in the hot dry period of the season.

6.2. Yield of Gum *talha* in Relation to Position of Tapping

Table (2). *Average yield of gum talha (g/tree) in relation to position of tapping*

	Tapping	Position	
Picks	**Stem**	**Branches**	**SE±**
1st	2.73bcd	2.17cd	0.95
2nd	6.29d	4.47bc	1.48
3rd	1.19d	1.35d	0.47
4th	5.08ab	5.73b	1.00
5th	5.87a	8.63a	0.80
6th	2.32cd	3.22bcd	0.82
7th	4.11abc	3.98bc	0.73
Mean	3.94	4.22	-
Total	27.59	29.55	-

Means followed by the same letter(s) in each column are not significantly different according to Duncan's Multiple Range Test at P = 0.05.

Appendix (1) showed no significant differences between the two levels of tapping (stem & branches) and yield of gum *talha*, except in the fifth pick ($P \leq 0.05$). Mean squares of gum yield for all picks were 3.198g, 33.197g, 0.259g, 4.199g, 76.010g, 8.172g, and 0.174g obtained from the first, second, third, fourth, fifth, sixth, and the seventh pick, respectively. Table (2) explains the average yield of gum per tree as related to tapping position. For the stem, the highest average yield of gum per tree was 6.29g obtained from the second pick and the lowest average yield of gum per tree was 1.19g obtained from the third pick. The average yield of gum per tree per pick was found as 3.94g, while the total yield of gum per tree for the whole season was reported to be 27.59g. Regarding the branches, the highest and lowest average yield amounts of gum per tree were 8.63g and 1.35g collected in the fifth and third picks, respectively. The average yield of gum per tree per pick was 4.22g and the total gum yield per tree per season was 29.55g. From these results it could be concluded that branches of *Acacia seyal* tree give slightly higher yield of gum *talha* compared with the tree stem.

Findings indicated non-significant correlation between amounts of gum yield and the two positions of tapping (stem and branches) except in the fifth pick, however it was found that relatively higher yield of gum *talha* was obtained from branches rather than the tree stem. This comes in line with the theory assuming that higher yield of gum would be obtained, as the level of tapping on the tree is raised (Nasroun, 1978).

6.3. Combined Effect of Tools and Position of Tapping on Yield of Gum *talha*

Analysis of variance (Appendix 1) explained no significant differences between the two factors tested; tools and position of tapping, except in the seventh pick ($P \leq 0.05$). As has been summarized in Table (3), yield amounts of gum *talha* obtained from the first, second, third, fourth, fifth, sixth, and the seventh pick were 13.409g, 57.540g, 8.323g, 20.775g, 13.926g, 5.267g, and 23.857g, respectively. The highest average gum yield per tree over all picks was 11.52g obtained in the second pick from stem tapped with *mengaf*, 10.83g collected from branches tapped with *mengaf* in the fifth pick, 7.42g picked from stem tapped with *sonkey* in the seventh pick, 7.24g harvested from branches tapped with *sonkey* in the seventh pick, 6.80g obtained from stem tapped with *sonkey* in the first pick, 5.06g collected from branches tapped with *sonkey* in the sixth pick, and 3.76g provided by untapped branches in the third pick. Whereas the lowest average yield per tree over picks was 0.36g obtained from stem tapped with *mengaf* in the first pick, 0.37g collected from untapped stem in the third pick, 0.82g picked from stem tapped with *mengaf* in the sixth pick, 1.15g harvested from branches tapped with an axe in the seventh pick, 1.59g obtained from branches tapped with an axe in the second pick, 2.69g collected from stem tapped with *sonkey* in the fourth pick, and 3.90g provided by stem tapped with *sonkey* in the fifth pick. The highest total gum yield per tree for the whole season was 41.98g obtained from branches tapped with *sonkey*, however the lowest total yield was 16.61g collected from branches tapped with the axe (Table 3).

Table (3). *Average yield of gum talha (g/tree) in relation to interacted tools and position of tapping, season 2012/2013*

				Interacted	Factors					
Picks	a1 b0	a1 b1	a1 b2	a1 b3	a1 b4	a2 b0	a2 b1	a2 b2	a2 b3	a2 b4
1st	1.82	1.21	6.80	0.36	3.47	0.51	2.96	3.28	2.85	1.22
2nd	4.87	8.93	3.12	3.01	11.52	2.36	1.59	6.95	6.57	4.96
3rd	0.37	0.76	3.22	0.98	0.63	3.76	0.53	3.34	0.59	0.89
4th	3.40	6.85	2.69	7.42	4.80	7.04	4.28	6.62	4.96	5.75
5th	6.18	5.99	3.90	6.57	6.71	9.57	4.78	9.55	10.83	8.41
6th	2.03	2.67	3.43	0.82	2.65	1.84	1.32	5.06	3.44	4.45
7th	3.04bc	4.68abc	2.28c	6.32ab	4.24abc	3.19bc	1.15c	7.24a	3.17bc	5.15abc
Mean	3.10	4.44	3.63	3.64	4.86	4.04	2.37	6.00	4.63	4.40
Total	21.17	31.09	25.44	25.48	34.02	28.27	16.61	41.98	32.41	30.83

Means followed by the same letter(s) in the same row are not significantly different according to Duncan's Multiple Range Test.
a1 and a2 denote position of tapping (stem and branches), respectively.
b0, b1, b2, b3 and b4 represent tools of tapping (control, axe, *sonkey, mengaf, and mamak*), respectively.

As an approval to the effect of the tools used for tapping branches, it was found that the *sonkey* gave the highest yield of gum *talha* in contrast to the lowest amount collected when the traditional axe was used. Differences in amounts of gum obtained might also be attributed to the remarkable variation of uneven-aged natural *Talh* stands.

Hassan (1998) reported that both amounts of gum yield per pick and the number of picks increase with increasing tree age. Seeds transferred by wind, water, animal and other factors from different sources of mother trees, which are of unknown genetic characteristics might give trees of different yield potentialities. This is the same situation in Um Fakarin Forest, the subject area. This could support views that consider differences in gum yield as an indication of genetic variability (IIED/IES, 1990). Variation in soil fertility and density of understory might play an important role in determining yield potential of such trees as well. Irregular distribution of natural *Talh* stands throughout Um Fakarin forest renders the gum yield from wide-spread trees higher than that obtained from dense, close and in turn competing stands.

6.4. Effect of Tree Growth Parameters on Yield of Gum *talha*

As presented in Table (4) and Appendix (2), the mean yield of gum *talha* per tree in relation to growth parameters; the diameter at breast height (DBH), total tree height and the average crown diameter have been illustrated. The study results showed positive significant correlation between gum yield and the DBH (r = 0.146), indicating that the two variables are directly proportional. Similar observations were indicated by Olighe and Akinni (1992) who found significant correlation between the tree girth and magnitude of gum yield. This might be due to the abundance of vascular bundles rich of rays, which are responsible for preserving gum deposits. Seif Eldin (1981/82) also maintained that wood is characterized by the presence of numerous rays in which gum deposits could be observed.

On the other hand, the yield of gum *talha* was found to be inversely correlated with the tree height (r = - 0.155); as it is revealed in Table (4), perhaps the yield of gum *talha* decreases with the increasing tree height. Maybe gum deposits on rays encounter some difficulties to transfer through a long distance to collect around the wound and then after exude. This result comes in contrast with the conclusions made by Nasroun (1978); Oleghe and Akinni (1992); Ballal (2002) who advocated significant correlation between the tree height and gum yield.

Table (4). *Average yield of gum talha (g/tree) in relation to DBH, tree height, and crown diameter*

Interacted Factors	Stem Diameter (cm)	Tree Height (m)	Crown Diameter (m)	Gum Yield (g/tree)
a1 b0	14.1	8.3	8.3	3.1
a1 b1	14.0	8.6	8.3	4.3
a1 b2	12.1	7.8	7.6	3.7
a1 b3	11.7	7.9	7.0	3.7
a1 b4	12.4	8.7	7.5	4.9
a2 b0	12.9	7.8	7.1	3.8
a2 b1	12.4	8.1	8.5	2.4
a2 b2	15.3	8.5	8.3	5.7
a2 b3	14.4	8.7	8.2	4.6
a2 b4	14.7	8.7	9.2	4.4
Mean	13.4	8.3	8.0	4.1

Where: a1 and a2 represent position of tapping (stem and branches), respectively.
b0, b1, b2, b3 and b4 denote tapping tools (control, axe, *sonkey, mengaf* and *makmak*), respectively.

A negative correlation was found between gum yield and the average crown diameter (r = - 0.106). This indicates that yield of gum *talha* may decrease with the increase in crown diameter. Such a finding is not in line with the concluding remarks made by Elagab (1995) and Hassan (1998). The gum yield is positively correlated with the tree size, particularly the crown (Hassan, 1998). Elagab (1995) stated that large crown diameters could be considered as an indicator for higher gum yield; this may simply be interpreted as follows: flat-topped crowns with stretched branches are exposed to sun light and receive enough solar radiation that assist in nutrient synthesis during the growing season. When the dry season prevails, tree leaves are shed, and the tree becomes more susceptible to any infection by organisms or incision made by tapping tools. Blunt (1962) maintained that tree infection caused by a bacterium is the reason for gum exudation and that organisms are usually transferred by insects, camels and even the tools used for tapping. The coefficient of variation for season

2012/2013 was estimated as 49.30%; such relatively high value might be due to variation in the tree age, size and soil fertility.

7. Conclusions

Results of data analysis indicated no significant differences on yield of gum *talha* due to tapping tools as main effects. From one hand, this might be due to the weak response of *Talh* trees to relatively wide incisions made by such tools. On the other hand, tapping is usually carried out just before the cold weather, which suppresses the process of gum exudation.

Although no significant differences were indicated between the two levels of tapping (stem & branches) and yield of gum *talha* except in the fifth pick, it was revealed that branches of *Acacia seyal* give significantly higher gum yield compared with the tree stem, which case has come in agreement with the study hypothesis.

Findings of the study showed no significant effects of interacted factors examined; tools and position of tapping except in the third and seventh picks. It was explained that tree branches tapped with the *sonkey* gave significantly the highest yield, and branches tapped with an axe produced the lowest yield, in spite there are many other factors playing an important role in variation of gum yield, such as tree age and size, genetic source of seeds, variation in soil fertility, density of grasses under the tree, space between trees, and the weather.

The tree diameter at breast height (DBH) was proved to play a significant role in determining yield of gum *talha*, such results coincide with the study hypothesis. In contrast to study assumptions, results showed negative correlation between the yield of *gum talha* and both the total tree height and the average crown diameter.

The coefficient of variation calculated for the season was relatively high; this may be attributed to variation in the tree age and size and soil fertility.

Recommendations

Sonkey is recommended for tapping the branches of *Talh* trees and wide-bladed tools that may cause a severe damage on the tree bark should be avoided. Another tapping tool, locally called *Sombuk*, has to be studied; it may improve the yield as it has tapering end that can be used for tapping *Acacia seyal*, which requires just small incisions on the bark.

Intensification of extension packages to raising awareness of local people about importance of *Acacia seyal* and its product *gum talha* and use of the *sonkey* as an appropriate tool for tapping.

Results of the present study were based on a single season data and that may underscore the real effect of tapping techniques and growth parameters on yield of gum *talha*. Therefore, it is necessary to conduct gum yield experiments in permanent trial plots in order to analyze gum yield of seasonal time series.

Aspiration towards establishment of high yielding *Talh* stands using improved seeds that can be collected from superior mother trees.

Overutilization and illicit felling of *Talh* trees should be prevented and forest offenders must be subjected to enforcement of forest laws.

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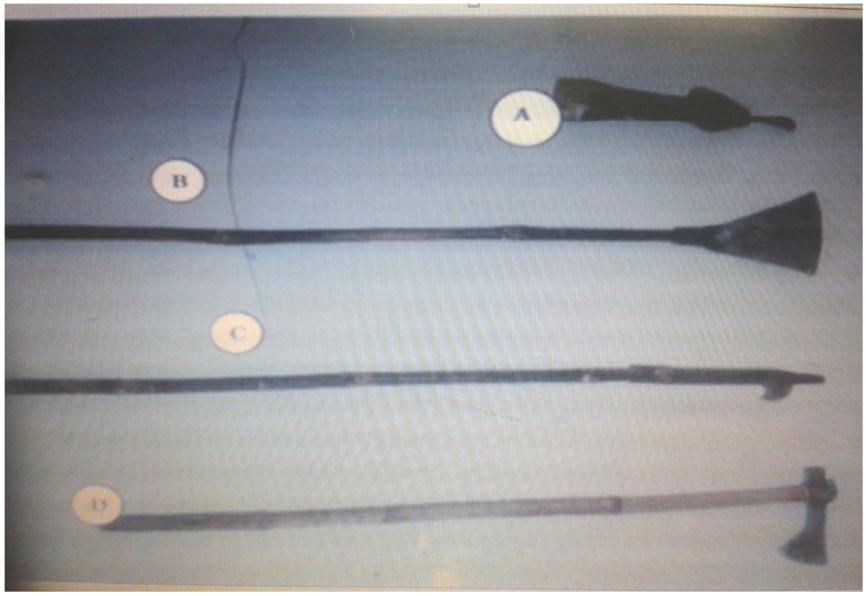

Whereas: A= *Mengaf*, B= *Makmak*, C= *Sonkey*, D= *Axe*

Plate (1). *Tapping tools*

Appendix (1). *Mean squares of gum talha yield (g/tree) over picks – season 2012/2013*

Source. of variation	df	1st Pick	2nd Pick	3rd Pick	4th Pick	5th Pick	6th Pick	7th Pick
Tapping.position	1	3.198^{ns}	33.197^{ns}	0.259^{ns}	4.199^{ns}	76.010*	8.172^{ns}	0.174^{ns}
Tapping tools	4	18.453^{ns}	23.139^{ns}	4.433^{ns}	2.608^{ns}	12.692^{ns}	8.961^{ns}	7.105^{ns}
Position*Tools	4	13.409^{ns}	57.540^{ns}	8.323^{ns}	20.775^{ns}	13.926^{ns}	5.267^{ns}	23.857*
Error	27	18.078	43.660	4.495	20.181	12.764	13.517	10.683
C.V%	-	173.67%	122.87%	166.88%	83.13%	49.30%	132.73%	80.83%
SE±	-	1.831	3.793	1.442	2.279	1.866	1.147	2.442

Whereas: * Significant (0.05), ** Significant (0.01), ns Not significant

Appendix (2). *Magnitudes of Correlation Coefficient (r) and Standard Error (SE)*

Season	Co- of correlation (r)		Standard Error (SE)	
	Parameter	r	Parameter	SE
2012 /2013	DBH	0.146	DBH	0.021
	Height	-0.155	Height	0.007
	Crown diameter	-0.106	Crown diameter	0.012

Source: Field Survey, 2012/2013.

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