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Research Article

SOCIO-ECONOMIC FACTORS INFLUENCING COLLECTION OF GUM MYRRH AND OPOPONAX FROM THE WILD IN WAJIR COUNTY, KENYA

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ABSTRACT

This study aimed at generating information to streamline gum myrrh and opoponax collection and post-harvest handling activities to support livelihood of local communities in Wajir County. The resource managers, producer and other stakeholders were interviewed using pre-tested checklists and questionnaires. A total of 187 gum resin respondents were purposefully sampled. The findings showed that the main economic activity was pastoralism. The gum resins were gaining popularity and were harvested by professional gum resin collectors through either natural exudates or tapping for domestic and commerce purposes. Each collector harvested an average of 4 kg/day and 3 kg/day of Malmal and Hagar respectively during the June-September peak production. The household size, distance to the market and number of trees harvested significantly influenced quantity of hagar collected per day at 99% confidence interval. Alternatively, the distance to the market significantly influenced the quantity of malmal harvested per day at 99% confidence interval. Thus to ensure enhanced benefits to collectors, it is recommended that national and county governments enhance technical support and strengthen the capacity of collectors and institutions.

INTRODUCTION

In Kenya, Arid and Semi arid Lands (ASALs) occupy 89% of the country and are home to about 14 million people, more than 90% of the wildlife and approximately 70% of the national livestock valued at about 70 billion shillings (Republic of Kenya, 2012). There is an increasing research interest to protect the woodland resources, a major source of livelihood for inhabitants of drylands for sustainable supply of wood, non-wood products and services. Woodlands provide fodder, fuelwood, wood carving, building materials, timber and herbal medicines while helping protect the soil from erosion and restoring soil fertility. Several species of the genera *Acacia*, *Commiphora*, *Boswellia* and *Sterculia* yield commercial plant gum resins that have been traded for decades (Mulugeta and Kassa, 2011).

The main gums and resins products obtained from these species are gum arabic, frankincense (gum olibanum), myrrh (malmal) and opoponax (hagar) that are traded internationally generating foreign exchange earnings to the country (Wubalem, *et al*, 2002; Kindeya, *et al*, 2002; Mulugeta *et al*., 2003). The gum resin is available in different qualities from dust, siftings, to tears attracting different prices depending on quality, size and species (the most expensive being gum myrrh which is sold at 3.2 USD/kg, while the other gum resins fetches between 0.6-1.5 USD/kg) (Vivero, 2001). Hagar is an oily resin exudate from the stems of *C. holtziana* that oozes out and hardens to form lumps of various sizes and shapes with variable colour from yellow to dark brown or black commonly known as opoponax.

The harvesting of gum myrrh and opoponax involves natural and intentional injury of the tree by M*almaley* "a Somali word for professional malmal collectors". It oozes and hardens to form lumps of varying shapes and sizes of variable colour from red, brown to dark brown. Gum resins offer traditional livelihood strategies for ASALs that ensures conservation of woodland and biodiversity and promote non-traditional enterprises to improve local economy and diversify income

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sources of the rural poor (Falconer, 1997). Sustainable production leads to environmental benefits like carbon sequestration, nutrient recycling, erosion control, and hydrological regulation (Arnold & Pérez, 2001). Studies conducted in Indonesia show that well managed woodland for Non-Timber Forest Products (NTFPs) production retains a large amount of plant and animal biodiversity (Michon and De Foresta, 1997; Andel, 2006). Some of the regional initiatives that Kenya can borrow from Ethiopia include the federal and state government's investment on resource, product and market development of the gum resins sub-sector (Kassa, Tefera, and Fitwi, 2011).

Therefore, gum myrrh and opoponax is a secure source of income and provide; employment opportunities for the local communities, foreign currency earnings, raw materials for economic and socio-cultural activities, traditional medicines and various ecological services that contributes to poverty alleviation (Eshete, 2011; Eshete, *et al*, 2005; FAO, 1995; Gachathi and Eriksen 2011; Mulugeta *et al*., 2003). The optimal socio-economic and ecological benefits associated with gum resin production and marketing could be enhanced through policy reforms and integration with other key sectors of the economy such as livestock production, apiculture, sericulture and silvi-culture (Mulugeta and Kassa, 2011). The gum resin collection activity is considered secondary as it is mostly carried out while executing other activities such as firewood collection and livestock herding (Tadesse, *et al*., 2007). These species also provide a secure source of fuelwood, farm implements, construction material, fodder, apiculture and for soil and water conservation (Eshete, 2011).

In Kenya, Malmal is used to make ink used in Quranic schools, for burning to repel snakes and offensive insects and in medicine for treatment of various ailments. Its industrial uses include production of essential oils, cosmetics, flavourings, antiseptics and other medicines. Alternatively, hagar is used as an acaricide against ticks and in treatment of snakebites, scorpions, foot rot among other livestock ailments. Hagar is an important raw material in many modern industries such as drugs, liqueurs, cosmetics, detergents, creams, and perfumery, paints, adhesive and dyes. Therefore, sustainable exploitation of the genus Commiphora is constrained by inadequate of information on product identification and post-harvest handling, rampant incidences of adulteration and poor pricing (Chikamai and Kagombe, 2002; Girmay, 2000; Mulugeta & Demel, 2003). The specific objective was to analyze the socio-economic factors influencing production of gum opoponax and myrrh from their natural habitats in Wajir County.

RESEARCH METHODS

Wajir County covers an area of 56,685.8 Km^2 and lies within the Sahelian climatic region that is classified as Zone VII (100% Arid) that is characterized by long dry spell and short rain seasons. It is located between latitudes 3^0 20' and 0^0 60' North and longitudes 39^0 and 41^0 East (Figure 1). Wajir County has five livelihood zones: agro-pastoralist, camel pastoralist, cattle pastoralist and mixed animal species pastoralist (Lwevo *et al.*, 2014). The main ethnic community is the Somali people whose main sources of livelihood include: Livestock keeping, gum resins collection, off-farm business, agroforestry practices and employment opportunities.

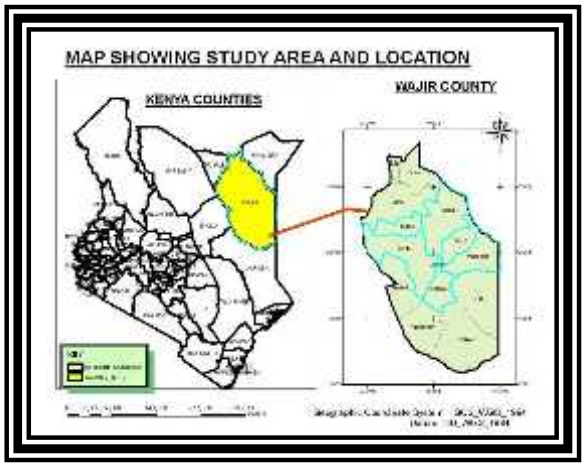

Figure 1 Location of the study area

Source: Survey of Kenya

The Ecosystem Conservator provided research team with overview information on gum collection activities in the County. The household was the basic unit of study. The target respondents were gum resin collectors who form 30% of the total population of Wajir County and camp in the bush where they collect gum resins while herding their livestock. A total of 187 respondents were purposely sampled using the formula described in Nassiuma, (2000). The respondents were sampled from a list provided by the market administrator. Every 3rd respondent was interviewed at watering points. In practice, the approximation of the sampling distribution to a normal shape is good for n>30 (Koutsoyiannis, 1977). The purposeful sampling method is perceived to be more realistic and efficient than simple randomization in terms of time, security of research team and effort and cost implications in finding respondents. Past studies indicates that purposeful method consider the spread of the respondents thus making it effective as compared to random sampling (Tongco, 2007). Tongco, recommends that the accuracy of the data collected through purposeful sampling be maximized through repeated execution of the questionnaire and experience, cross checking and validation methods such as triangulation to verify specific data sets.

To assess the present economic benefits and other socio-cultural roles of gum resins from *Commiphora holtziana* Engl. *and C. myrrha* (Nees) for the local population, semi-structured questionnaire was used to solicit information. Key informants, individual or/and groups were interviewed using questionnaires/checklists conducted in local languages through assistance of local interpreters. The data collected covered economic activities, community organization and capacity, education, age, family size, income, land and tree resource, household labour and chores, gender issues and gum resins collection. The other issues of interest were tapping techniques, tools used, quantities collected, quality control, seasonality, collection time, distance covered, post-harvest handling and grading, storage, domestic use, transport and associated constraints in gum resin collection. The role of gum myrrh and opoponax in the household economy was also assessed. The information collected was supplemented through observations

and secondary data. Research assistants were identified and trained to administer the questionnaire and collect field data.

The survey data was analysed using MS Excel and STATA V10 computer packages. Data was analysed for descriptive statistics (means, frequency, percentages, minimum and maximum) and a multiple linear regression model fitted where the coefficient of determination (R^2) and/or the standard error (s) were generated to provide information on the goodness of fit of the model. The higher the value of R^2 the greater the percentage of the dependent variable explained by the regression model.

$$Y_n = \sum_{0}^{n} b_i x_i + e_n$$

Where: Y = the average quantity of gum resin collected per day, b_1 - b_7 = regression coefficient of the variables, b_0 = Constant Term, e = Error Term, X_1 = Age (yrs), X_2 = Price, X_3 = Family Size, X_4 = Years of Experience, X_5 = Hours spent in gum myrrh and opoponax collection per day, X_6 = Distance to the market and X_7 = Number of trees harvested

The presence or absence of multi-collinearity was measured using Tolerance and Variance Inflation Factor (VIF). The Variance Inflation Factor (VIF) measures the impact of collinearity among the variables in a regression model. The VIF is calculated as 1/Tolerance and it is always greater than or equal to 1. Values of VIF that exceed 10 are often regarded as indicating multi-collinearity. When VIF is high there is high multi-collinearity and instability of the β_0 and β_i coefficients. The VIF value of between 1 and 5 shows moderate presence of multi-collinearity while values greater than five upto ten show high levels of correlation (Minitab 17 support, 2015). The Breusch -Pagan test was used to detect any linear form of heteroscedasticity (Williams, 2015).

RESULTS AND DISCUSSIONS

Factors Influencing Gum Myrrh and Opoponax Collection

The average age of respondents was 37 years, mainly married men with an average experience of twelve years in hagar and malmal collection. Their average family size was 10 people. Pastoralism (99%) was main economic activity. The average number of livestock kept by *Malmaleys* in all the study sites included: cattle (5), goats (29), donkeys (5), camels (7) and poultry (15). Poultry keeping was mainly practised in Eldas Sub County. Most of the *malmaleys* derived their monthly income (Table 1) from either gum resins production (Ksh. 12,400) or livestock (Ksh. 5,500).

Though the income from gum resins was high, majority of the respondent derived their income from livestock production. Sheep and goats were the most commonly and highly sold types of livestock. Each family sold an average of 20 goats over a one year period at a price of Ksh. 2,000-3,000 per goat.

Most of the local communities in Wajir County indirectly benefit from gum resins collection though only 30% of the population (*Malmaleys*) undertake full time collection of gum resins mainly for cash income generation. Most of the respondents specialised in gum resins collection (horizontal integration) as opposed to involvement in other activities along the Hagar and Malmal supply chain (vertical integration). Vertical integration has the advantage of value addition thus higher cash flows to the collector. Few collectors were engaged in retail business (2%) and transport (1%).

Furthermore most of the respondent sold their livestock as a last resort. The other sources of income include salary and wages, business, agriculture, sale of firewood and charcoal, sale of milk and transport services using drought animals which accounted a for mean monthly income of Ksh. 1,900.

A paired t-test between income from livestock and Gum Resins show significant difference [Pr(|T|>|t|) = 0.0025] between the two sources of income (Table 1). Agriculture was still at nascent stage with few farmers being identified within the county. Frequent and prolonged drought was to blame for the minimal crop production activities in the county. Few fruits and vegetables farmers were identified along the Ewaso Ng'iro basin. Livestock was not readily available for sale due to cultural factors such as prestige or sign of wealthy in society though this culture is slowly eroding away. Distribution of the domestic animals varied throughout the county depending on the various climatic zones. The social economic classes among the local communities were influenced by the number and type of livestock owned per household: poor (70%), medium rich (25%) and rich (5%) of the county population. The richest people owned camels (300), goats (200) and several heads of cattle. On average each family owns 50 cattle, 50 sheep and goats, 70 camels and 5 donkeys. Some families did not keep camels.

Hagar and Malmal Collection

The type of gum resins collected by *Malmaleys* from the woodland include Malmal (85.6%), Hagar (85.6%), gum arabic (13.9%), Frankincense (11.3%) and Hagar jerer (3.2%) which enter the market as an adulterant through mixing with Hagar. All gum resin collection was from communal land that was associated with negative impacts on land use and conflicts due to open-access rights with the exception of *C. myrrha*. *Malmaleys*, had access right to the specific locations and malmal trees assigned to them through traditional resource management system where trees were clearly marked using

Table 1 Paired t-test between income from livestock and Gum Resins

Source of income	Observations	Mean	S.E.	SD	[95% confidence Interval]	
Livestock sales	74	5525.68	598.80	5151.04	4332.28	6719.07
Gum resins	74	12368.9	2034.76	17503.7	8313.65	16424.19
Difference	74	-6843.2	2183.97	18787.2	-11195.89	-2490.60
mean (diff)	= mean (livestock - gum resins)				t =	-3.13
Ho: mean (diff)	=			DF	=	73
Ha: mean (diff) <0	Ha: mean (diff) <0 ! = 0				Ha: mean (diff) <0	
Pr (T<t) =	0.00	Pr (|T|>|t|) =		0.00	Pr (T>t) =	1.00

Note: SE = Standard Error, SD = Standard Deviation

specific signs to exclude others who do not belong to their group from collecting the tapped Malmal.

This traditional resource management and governance system ensured resource sustainability. This management approach was threatened by traditional/cultural breakdown as witnessed by the poor tapping technologies and stealing of gum resins in the bush.

The collectors undertake collection and delivery of product with minimal cleaning and sorting. Resin collection was organised on individual or group basis and undertaken as a fulltime or part-time activity. Eighty two percent of the interviewed respondents collect gum resins on full time basis. The average distance to collection points was 14 km in all the study areas. Each collector spent an average of 6 hours on gum resin collection. Those collecting resins on part-time basis were combining collection with herding (12%), firewood collection (5%) and water collection (2%). Malmal was collected through tapping whereas Hagar was collected either through from natural exudates (42%) or tapping (58%).

In practice there was no tapping of Hagar observed in the field. The Hagar and Malmal collection materials and gear included an axe (49%), container (26%), food (12%) and water (13%). The weekly cost of food and water per person was estimated at Ksh. 1,300. An axe with a lifespan of four years, cost Ksh. 1,000. The collected Hagar or Malmal was transported using donkey (91%) or head-load (9%). The products delivered to the market include Malmal (45%), Hagar (45%) and Hagar jerer (10%).

Tapping of Malmal commences as soon as rains subside and continues through the dry spell. Tapping involves removing small areas of bark from the tree, sometimes using a specially designed tool, "mangif", otherwise an ordinary axe. A week later gum exudes from the wound in liquid form. The respondents reported that natural exudates dry in two to three weeks ready for first collection. The gum resin collected after three weeks was of poor quality. The wounds were renewed immediately while collecting the resin to prevent the wound from drying. The best grade could be obtained after 45 days after wounding the tree though in most cases this was not observed. After 45 days it solidified, smelt different and has a brighter colour. The whole process is repeated at intervals of two to three weeks for a period of three to four months until the onset of the rainy season or the wound size has attained a width of 4 cm. Hagar exudes naturally and therefore several collectors are available and yield is dependent on the amount of rainfall received just before the collection period.

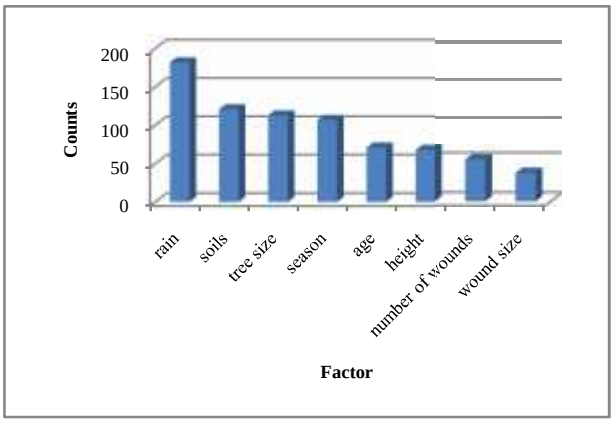

Figure 2 Perceived Factors that Influence Gum Resin Yield

Source: Field data, 2014

The perceived factors that influence gum resin yield per tree (Figure 2) were: rain received (24.2%), soil types (16.1%), size of the tree (15%) and season (14.2%) in that order. Other factors include the age (9.5%) and height (9.1%) of the tree and number and size of wounds (7.1%). These findings are in agreement with what has been reported in the Mutema region, Ethiopia (Getachew, Sjaastad & Vedeld, 2007; Mulugeta, 2011; Muzayen, 2009). Hotelling's generalised means test involving factors influencing yield show a significant different [prob > F (8,163) = 0.0000] among the factors.

The average quantity collected per day for Malmal was 4 kg while for Hagar was estimated at 3 kg within a range of between 0.5 kg - 10 kg from an average of 105 and 120 trees of Hagar and Malmal respectively. The collection is undertaken on an average of 5 days per week. A paired t-test between quantities of malmal and hagar collected per day show a significant difference [Pr(|T|>|t|) = 0.0000] between the two sources of income (Table 2).

The gum resin monitoring data involving three dealers in Eldas gave a daily delivery of Hagar and Malmal per collector over a one year period at 2 kg and 4.5 kg respectively. These findings agree with earlier studies which puts the daily gum resin collection rate of 5 kg per day or 150 kg per month (Chikamai *et al.*, 2005). There are four seasons in Wajir County: January-March (*Orahet)* that is characterised by dry and hot weather), April-June (*Gu)* characterised by short rain season, July-September (*Hagai)* characterised by hot and cool season and October-December (*Der)* characterised by long rains season. The peak collection period as reported by most of the respondents was June - September season is referred to as "*Hagai"* in Somali language (Figure 4) which is characterised by dry and cool climate as influenced by rainfall and temperature. The January-March (*Orahet*) was classified as a low Malmal collection season due to harsh weather conditions though it was still possible to harvest some amount of Hagar throughout the year. Hotelling's generalised means test involving peak resin production month show a significant different [prob > F (4,183) = 0.0000] among the peak month of the year. The level of awareness on resins conventional tapping techniques was generally low (20% of the respondents). About 80% of gum collectors lack basic knowledge on tapping. There were high awareness levels on the collection of tapped resin after 45 days though this was not practiced by the collectors probably to safeguard their commodity from theft or earn quick money from the dealers. Due to ignorance, some of the respondents collected the tapped resins after seven days whereas others collected after two to three weeks thus compromising on quality. The main challenges faced by Hagar and Malmal collectors include attack from wildlife (19.5%), lack of collection gear (16.3%), limited supply of food and water (13.2%), poor tapping techniques (10.9%) and loss of collected Hagar and Malmal through stealing (10.2%). Alternatively, constraints faced in marketing of gum resins include lack of storage facility, high transport costs, unstable

Table 2 Paired t-test for comparison between quantities of malmal and hagar

Quantity/person/day	Observations	Mean	SE	SD	[95% confidence Interval]	
Malmal	157	4.04	0.20	2.50	3.65	4.44
Hagar	157	3.03	0.14	1.78	2.74	3.31
difference	157	1.01	0.24	3.05	0.54	1.50
mean (diff)	= mean (quantity of malmal -quantity of Hagar)				t =	4.19
Ho: mean (diff)	=			DF	=	156
Ha: mean (diff) <0		Ha: mean (diff) ! = 0			Ha: mean (diff) > 0	
Pr (T < t) =	1.00	Pr (|T| > |t|) =		0.00	Pr (T>t) =	0.00

Note: SE. Standard Error, SD Standard Deviation

Table 3 Socio-economic Factors Influencing Quantity of Hagar Collected

Source	SS	df	MS	Number of obs =	139	
Model	138.06	7	19.72	F(7, 131) =	9.68	
Residual	266.88	131	2.04	Prob>F =	0.00	
Total	404.93	138	2.93	R-squared =	0.34	
				Ad R-Squared =	0.32	
				Root MSE =	1.43	
Quantity of hagar/per/day	Coeff.	SE	t	P>|t|	[95% Conf.	Interval]
Age of head of household	-0.04	0.02	-2	0.02**	-0.08	-0.01
Household size	0.14	0.05	3	0.00***	0.05	0.24
Distance to the market	0.56	0.11	4	0.00***	0.34	0.78
Experience in years	0.09	0.04	2	0.01**	0.02	0.16
Time taken/day	-0.11	0.08	-1	0.15*	-0.26	0.04
Number of trees harvested	-0.58	0.20	-2	0.01**	-0.98	-0.18
Price/kg	-0.60	0.24	-2	0.1*	-1.07	-1.13
Constant	5.02	1.20	4	0.00	2.64	7.40

Note: Independent Variable: average quantity of Hagarcollected per day, R2=34.1%, SS = sum of squares, df = degree of freedom, MS = Mean square, SE = Standard Error, * significant at 90% confidence interval, ** significant at 95% Confidence Interval and *** highly significant

market prices, exploitation by middlemen, adulteration and poor regeneration of Malmal trees. Adulteration from *Hagar jerer* that was harvested from *C. ogandensis* (L.) C.Chr. was reported in Tarbaj, Khorof Harar, Qarsa and Riba among buying agents, kiosks and retail shop owners. If un-checked, adulteration could seriously compromise the quality of Hagar marketed in Wajir County.

The findings show that quantity of gum resin collected per day was influenced mainly by lack of appropriate tools (27%), wildlife threat (20%), food and water supply (13%). The other challenges faced by *Malmalleys* include theft of collected resins, lack of storage facilities, poor regeneration, over-exploitation, adulteration and unstable prices (Figure 3). Hotelling's generalised means test involving factors influencing yield show a significant different [prob > F (11,176) = 0.0000] among the factors.

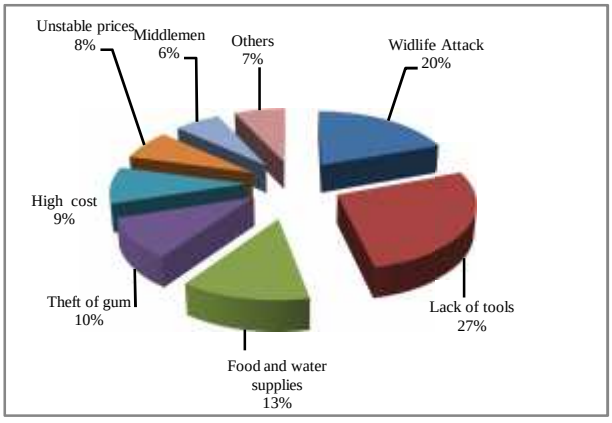

Figure 3 Challenges Affecting the Collection of gum resins

Source: Field data, 2014

Domestic Consumption of Hagar and Malmal

The main product from *C. holtziana and C. myrrha* was resin mainly harvested for both domestic and income generation. It was reported that every family stocked an average of 2 kg each of Hagar and Malmal for domestic use in Wajir County with an estimated annual domestic consumption of 120,000 Kg. Locally, malmal was mainly used as a snake repellent (41%). The other uses were preparation of ink used in quranic schools "duski" (23%), chest paint (8%) and 1% use its dye for carvings (Figure 5). Hotelling's generalised means test involving the various uses of malmal show a significant different [prob > F (9,28) = 0.0000] among the factors.

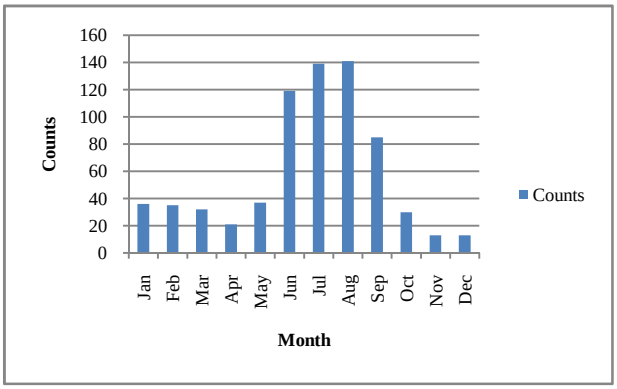

Figure 4 Annual trend in gum resin collection

Source: Field data, 2014

Alternatively, Hagar was mainly used in the treatment (Figure 6) of snake bites (30%), general medicine (22%), as an acaricide (19%) and treatments of wounds (11%). The other domestic uses include treatments of chest pain (5%), stomach-ache (5%), break bones or physio-therapy (4%) and head-ache (4%). Hotelling's generalised means test involving domestic

use of hagar show a significant different [prob > F (11,176) = 0.0000] among the factors. The other general products derived from the *C. holtziana* and *C. myrrha* trees include firewood (21.0%), carvings (12.7%), medicine (37.7%), adhesives (2.2%), dye (23.0%) and fragrances (3.4%).

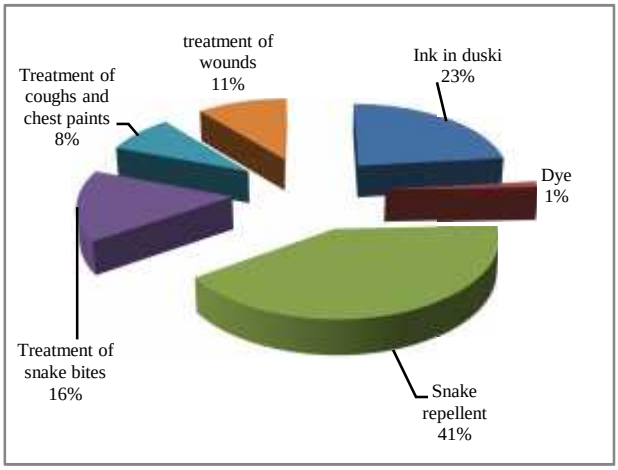

Figure 5 Reported Local Uses of Malmal

Source: Field data, 2014

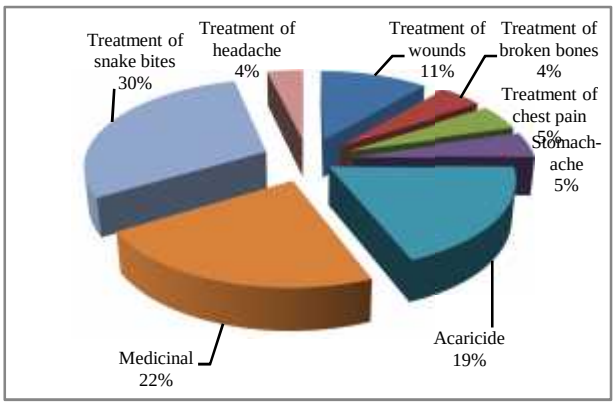

Figure 6 Reported Local Uses of Hagar

Source: Field data, 2014

Multiple Linear regressions model for Hagar

The results of a linear multiple regression analysis (Table 3) show that the ANOVA test was highly significant with the goodness of fit value of 34.1%. The size of household, distance to the market and the number trees harvested were significant at 99% confidence interval thus affected the quantity of hagar harvested per day per collector. Large households require more financial resources to support their livelihood thus the need to collect more resin. The quantity collected per day was indirectly influenced climatic and bio-physical factors among others. Analysis of multicollinearity using variance inflation factor test for independent variable gave an average factor of 1.12 and tolerance factor of greater than Zero. VIF factor of less than 2.5 and Tolerance factor greater than zero show weak presence of multi-collinearity (Minitab 17 support, 2015). Breusch-Pagan test for heteroscedasticity show lack of heteroscedasticity at 95% Confidence Interval (prob>chi2 = 0.1080).

Multiple Linear regressions model for Malmal

The result of an ANOVA test was highly significant whereas a multiple linear regression analysis (Table 4) gave the goodness of fit value of 25.5%. The quantity collected per day was indirectly influenced climatic and bio-physical factors among others that have not been taken into account. The distance to the market and time taken were significant at 95% confidence interval thus influencing the quantity of Hagar collected and delivered to the market. Large families would send more members and require more resources for their survival and vice versa. Alternatively the closer the market the more number of trips to the market. The Variance inflation factor (VIF) of 1.14 and tolerance of greater than zero show weak presence of multi-collinearity. Breusch-Pagan test for heteroscedasticity show lack of heteroscedasticity at 95% Confidence Interval (prob>chi2 = 0.6890).

CONCLUSION AND RECOMMENDATIONS

The full-time gum resin collection was undertaken by *Malmaleys* though with increasing commercialization, other members of the household undertake the too. Gum resin collection was mainly undertaken during the peak month of June-September when the weather is dry and cool. The average quantity collected per day for Malmal was 4 kg while for Hagar was estimated at 3 kg for commercial purposes. The quantity of

Table 4 Socio-economic Factors Influencing Quantity of Malmal Collected

Source	**SS**	**df**	**MS**	**Number of obs =**		**139**
Model	16.04	7	2.29	F(7, 131) =		3.62
Residual	82.89	131	0.63	Prob>F =		0.00
Total	98.93	138	0.72	R-squared =		0.16
				Ad R-Squared =		0.12
				Root MSE =		0.80
Quantity of malmal/per/day	Coef.	SE	t	P>|t|	[95% Conf.	Interval]
Age of head of household	0.00	0.01	0.33	0.74	-0.02	0.02
Household size	0.00	0.03	0.01	0.99	-0.05	0.05
Distance to the market	0.17	0.07	2.56	0.01**	0.04	0.31
Experience in years	0.02	0.02	0.88	0.38	-0.02	0.06
Time taken/day	-0.07	0.04	-1.83	0.07*	-0.15	0.01
Number of trees harvested	0.15	0.07	2.13	0.04**	0.01	0.28
Price/kg	0.24	0.12	2.03	0.04*	0.01	0.48
Constant	3.13	0.60	5.26	0.00	1.96	4.31

Source: Field data, (2014); Independent Variable: average quantity of Malmal collected per day, R^2=25.5%, SS = sum of squares, df = degree of freedom, MS = Mean square, SE = Standard Error, * significant at 90% confidence interval, ** significant at 95% Confidence Interval and *** highly significant

Socio-economic Factors Influencing the Production of Gum Resins

A linear regression analyses performed on the quantity of Hagar and Malmal as dependent variable gave the following results:

gum resin collected per day was significantly influenced by climatic and physiological factors. Therefore, it is recommended that the capacities of the Hagar and Malmal collectors, producer associations and extension staff be strengthened for enhanced regeneration, productivity and survival and good tapping methods of *C. myrrha*. Secondly, it is advisable to involve all key stakeholders in appropriate gum resin collection techniques.

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