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Sorghum Production Practices: A Case Study of Four Districts in Navrongo, Ghana

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ABSTRACT

A study was conducted in Biu, Pungu, Gia and Kologo in the Navrongo Municipality of the Upper East Region of Ghana, to examine the extent to which farmers' knowledge, perception and management practices influenced the cultivation of grain sorghum. This survey was undertaken to provide background information regarding the crop to aid in future improvement and marketing efforts in the Navrongo Municipality. A total of hundred farmers were sampled from these areas with twenty farmers from each district, using a simple random sampling technique. In the survey, both open and close-ended questionnaires as well as interviews were adopted. Data collected included, demographics of respondents, general production and utilization, number of acreages cultivated, yield levels, marketing and constraints to the production of sorghum. Data gathered was analyzed using the Statistical Package for Social Scientist (SPSS version 16.0). Frequencies, percentages, bar and pie charts were used to present the results of the various variables analyzed. The findings from the study showed that farmers in these four communities cultivated sorghum but intercropped with other crops and vegetables; sorghum was cultivated by the people as a main crop (65.00%). Males formed the majority (61.00%) of people involved in the cultivation of sorghum. Active working age of people who engaged in sorghum production was between 20 and 29 years. Majority (37.00%) in these communities were Christians, even though sorghum is said to be a traditional crop. Most of the farmers in the four communities used the red sorghum landrace or variety (61.00%). From the results, smaller families (1-4, 34.00%) were more involved in sorghum production either for sale or consumption, and the number of acres most farmers cultivated was 1-2 acre (32.00%). Sixty-four percent (64.00%) of the farmers inherited their farm lands, 72.00% of the respondents sold their products in the market and also had ready market for their sorghum produce. Results from this baseline survey could be useful to the Ministry of Food and Agriculture, the District Assemblies and Non-Governmental Organizations in their poverty reduction strategies, ultimately contributing to food security.

KEYWORDS: Constraints, farmers, improvement, market, poverty, questionnaires, Sorghum

1.0 INTRODUCTION

Sorghum (*Sorghum bicolor* L. Moench), a popularly cultivated cereal grass crop in the tropical regions, is a largely self-pollinated crop, and cultivated on more than 40 million hectares of land worldwide, across both tropical and temperate regions (Vanderlip, 1993; ICRISAT, 2014).

Sorghum is commonly a crop that is believed to have undergone domestication first and probably in the Nile or Ethiopian (Valley) regions of North Africa, around 1000 BC (Kimber, 2000) before been taken to India and China (Jordan and Sullivan, 1982), then to Europe. According to Vanderlip, (1993), sorghum was introduced to USA in the middle of the last century.

The dispersal of the Bantu (black) sect of individuals through sub-Saharan Africa was not complete without the growing and marketing (production) of sorghum (Vanderlip, 1993).

Currently, the cultivation of sorghum spans the world over, and commonly in the warmer, temperate regions, standing quantitatively as the 5th largest and most essential grain (cereal) coming after wheat, maize, rice and barley (Vanderlip, 1993; ICRISAT, 1994; FAO, 2003). It is grown on subsistence basis principally as a rain-fed crop in the arid and semi-arid tropical regions of Africa and Asia. The crop is also produced by commercial farmers in the USA, Australia and Latin America (ICRISAT, 1994). According to the Food and Agricultural Organisation, the world yearly production volume of sorghum stands at over 60 million tons, out of which Africa alone crops greater than 20 million tons (FAO, 2003). This therefore quantitatively puts grain sorghum as the number two most significant cereal grain crop produce in the African sub-region after maize. Close to seventy percent (70%) of Africa's production of sorghum is accounted for by the following countries alone; Nigeria, Sudan, Ethiopia and Burkina Faso, found at the Northern part of Africa (FAO, 2003).

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The potential yield of sorghum grain is reported to be as high as 15 t/ha and above (ICRISAT, 1994; FAO, 2003). However, majority of farmers, especially in the Sub-Saharan Africa who cultivate the crop under subsistence farming have little or no options to finance the addition of inputs in its cultivation. This makes yields on sorghum grain fields of farmers in Asia and Africa in particular largely low (500 - 800 kg/ha). This is primarily as a result of biotic and abiotic factors including diseases (grain mold, anthracnose, ergot, root and stalk rots, and sorghum downy mildew) insect pests, parasitic weeds, low soil fertility or nutrient deficiencies, grain-feeding birds and various wild mammals, drought, aluminum toxicity and salinity in some regions (ICRISAT, 1994).

Cultivars of sorghum that are genetically resistant to diseases, insect pests and weeds such as Striga, and also tolerant to abiotic stresses, coupled with grains and stover that are quality and market-desired, would present economically relevant options for integrated crop management and production systems capable of enhancing incomes or livelihoods of producers of sorghum (ICRISAT, 1994).

Sorghum is significantly important to food security in Africa because, it is generally and uniquely drought tolerant as compared to other cereals and can survive periods of high temperature and can also withstand periods of water-logging (Doggetts, 1988; Osmanzai, 1992). Even though sorghum is still generally subsistent in Africa, it is progressively developing the base of successful food and beverage production industries. Sorghum in Africa is processed into a very wide variety of attractive and nutritious traditional foods, such as semi-leavened bread, couscous, dumplings and fermented as well as non-fermented porridges. Sorghum is the cereal grain of choice for the brewing of traditional African beers (Taylor and Robbins, 1993). Certain sorghum varieties or types are also used in making cakes, unleavened bread, wallboard, starch, dextrose, syrup, brooms, ethanol, high quality wax and even vodka and other alcoholic beverage (Taylor and Taylor, 2000).

Nonetheless, upsurge in production of sorghum has only been due to an increase in cultivated land area under production and not necessarily and significantly the total enhancement in general crop yields. Reported average grain sorghum crop yields stay under one ton/ha. This is possibly due to the fact that, sorghum cropped in Africa and Ghana, is to date primarily characterized by traditional, out-moded farming and management activities; characterized by low or no farm inputs and absence of improved planting varieties (Taylor and Dewar, 2000). The characteristic low yields of sorghum indicate farmers are unable to maintain any surplus sorghum for use by processing industries (Olatunji, 1993). It is against this background that the current study proposes to obtain general information about production and management practices of the crop in Navrongo, Ghana; assess the general production challenges and to find out the extent to which farmers' knowledge, perception and management practices influence the cultivation of sorghum.

This study would therefore provide an important first step at improving the crop, particularly in the Northern parts of Ghana, with majority producers, and provide a foundation to enhance increased cultivation, marketing and use in future, in order to ultimately contribute to food security.

MATERIALS AND METHODS

Physical Geography of Navrongo Municipality

According to the Navrongo Demographic Survey System (GSS, 2014; www.statsghana.gov.gh), Navrongo is sited in the Kassena-Nankana District of the Upper East region of Ghana. The district lies between latitudes 10 to 30' and 11 to 00' North of the equator and between longitudes 1 to 00' and 1 to 30' West of the zero meridian and covers an area of 1,675 square kilometers along the Ghana-Burkina Faso border. It measures roughly 50 km long and 55 km wide and has an altitude of 200m - 400m above sea level. The land is relatively flat and passing through it from Burkina Faso is the White Volta River, which feeds Lake Volta (the world's largest artificial lake) in the Volta region, south of Ghana (Binka *et al.,* 1994).

Located in the Guinea Savannah belt, the district's ecology is typically Sahelian (hot and dry), with the vegetation consisting mostly of semi-arid grassland interspersed with short trees. There are two main climatic seasons, the wet and dry seasons. The wet season extends from April to October, with the heaviest rainfall mainly occurring between June and October (Debpuur *et al*., 2000). The mean annual rainfall is 1,365 mm but the highest level is recorded in August. Similarly, the dry season is subdivided into the *Harmattan* (November to mid-February) and the dry hot (mid-February to April) seasons. Monthly temperatures range from 20^{o}C to 40^{o}C, with the mean minimum and maximum temperatures estimated at 22.8^{o}C and 34.4^{o}C respectively (Debpuur *et al*., 2000).

Population Characteristics of Navrongo Municipality

The population of the Kassena-Nankana district (Ghana Statistical Service, GSS, 2014; www.statsghana.gov.gh) as at October, 2014 was 109,944, a figure slightly below 1% of Ghana's population and around 10.5% of the total population of the Upper East region. The population density is 84 persons per sq. km. The district is generally rural (with about 72.2% of the population living in rural communities), whereas small 9.5% living in urban quarters (GSS, 2014).

Of the population 11 years and above, 56.3% are literate and 43.7% are non-literate (GSS, 2014). About 82.7% of households engage in agriculture. In the rural localities, 93.1% of households are agricultural households while in the urban localities, 56.8% are households are into agriculture. Most households (96.1%) in the Municipality are involved in crop farming, with Poultry (chicken; guinea fowls) as the dominant animal reared among others such as cattle, goats, sheep, pigs (GSS, 2014). The chief crop products under the agricultural sub-sector in the Municipality include groundnuts, sorghum, rice, guinea corn, millet, sweet potatoes, beans and tomatoes. Unfortunately, the rainfall pattern limits food cultivation to a single growing season and even though the Tono irrigation dam and a few dugout wells supply water for dry season farming, the major crop grown during this time is tomato. Weather conditions in the district can be very severe, resulting in either occasional floods or droughts and, therefore, poor crop harvests. This situation, among others, has resulted in the gross annual out-migration of the population over some years now (Binka *et al*., 1999; GSS, 2014).

Sampling Technique and Sample Size

A survey was carried out involving the use of questionnaires and interviews as well as focus group discussions. The study was undertaken in four (4), districts (Pungu, Gia, Biu and Kologo), selected by a simple random sampling selection technique and based on predominance in terms of sorghum production in the Navrongo Municipality. A total of hundred farmers were sampled from these areas with twenty farmers from each district.

Data Collection

Although both secondary and primary data were used, the study focused more on primary data. Data collection adopted the use of questionnaires and key informant interview with some key farmers and opinion leaders. Questionnaires composed of open-ended and close-ended questions.

Data Analysis and Presentation of Findings

Quantitative data collected was analyzed based on data or information gathered from general sorghum crop production, farmer management of the crop, constraints to the production of the crop, postharvest handling, uses and marketing among others. The analysis was based on descriptive statistics. Results from the data analysis were analyzed with SPSS (Version 16.0) and Microsoft Excel and findings presented in tables, graphs, pie charts and bar charts.

RESULTS AND DISCUSSION

DEMOGRAPHY OF RESPONDENTS

Gender

Table 1: Gender distribution of respondents

Gender	Number of responses	Percentage (%)
Male	61	61.00
Female	39	39.00
Total	100	100.00

According to the results of the study (Table 1), more than half (61.00%) of the sorghum farmers were males whilst the females constituted 39%.

Sorghum is a traditional crop that is cultivated by both males and females in communities. Women's participation in farm activities has always been dominant. From the current study, women were equally engaged in agriculture in these communities as their male counterparts. It was gathered from the interviews that although women assisted on family farms, they were actively involved in the production of other crops such as cowpea, groundnut, Bambara groundnut and soybeans, apart from sorghum (Kimber, 2000; Akpalu *et al*, 2013).

Age Distribution

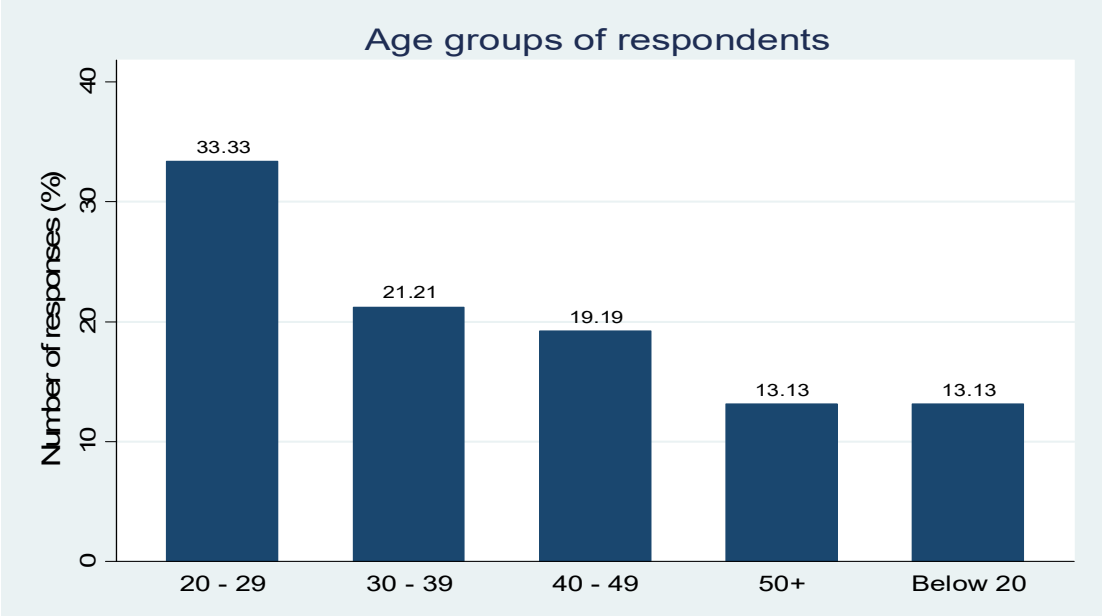

Figure 1: Age distribution of respondents

From Figure 1, the study observed that a majority 33.33% of the sorghum farmers were between the ages of 20 – 29; 21.21% were between 30 – 39 while 19.19% constituted the 40 – 49 age group. The aged (50+) and the teenagers (below 20 years) constituted 13.13% of the total sample size respectively. Though sorghum is generally cultivated by the elderly, results from the current study gave an indication that the youth have in recent times developed interest in its production; perhaps due to the ready market and comparatively high market price the crop commands. A research in Bambara groundnuts (Akpalu *et al.*, 2013) and groundnuts (Oppong-Sekyere *et al.*, 2015) corroborates the results found in the present study.

Marital Status

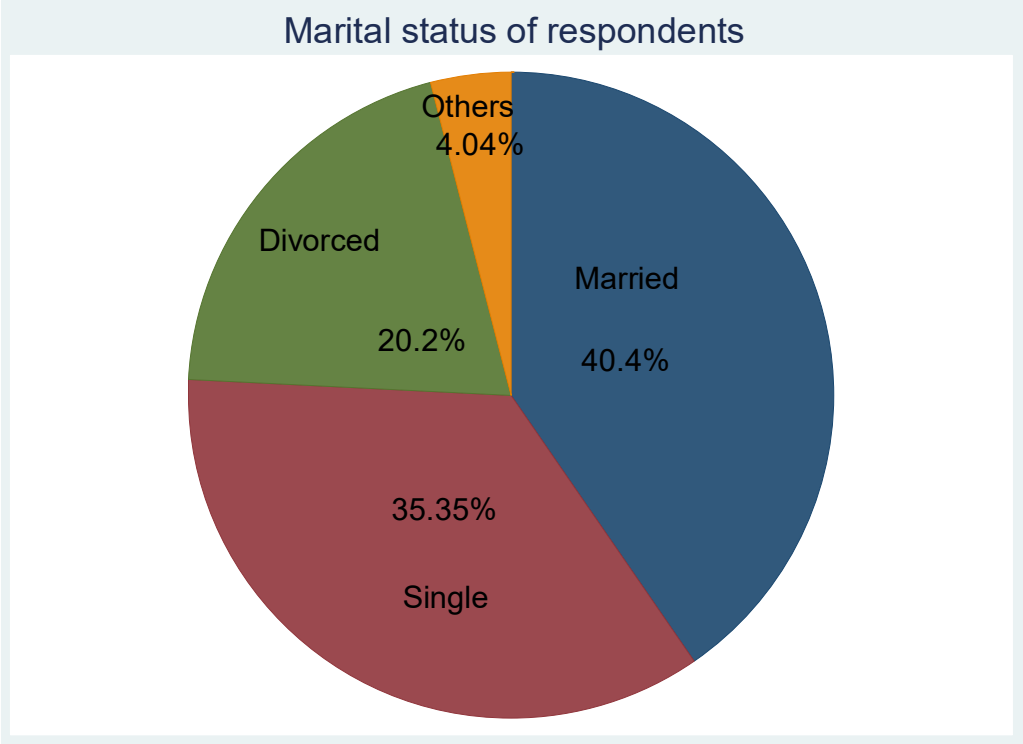

Figure 2: Marital status of respondents

Results from the study in Figure 2, indicate that, close to fifty percent majority (40.4%) of the sorghum farmers were married, 35.35% were single while 20.2% of them were divorced.
Sorghum is a traditional crop normally cropped by both sexes in the household. In the study districts, and indeed most parts of the Northern Regions of Ghana, women do not culturally owe lands. The lands are either for their husbands (who are the household heads) or the property of the entire family. Therefore, cultivation of traditional crops including sorghum by females or women would mean that the farm traditionally belongs to the husband. Thus, the results obtained in the present survey where married people were found to be more interested or involved in sorghum production. This brings to light the link and significance of such crops to the family or household needs and the fact that its production has remained under subsistence over the years. Many dishes are prepared from sorghum which generally is handled by women who take care of the family's nourishment and sustenance needs. This may also partially account for the more married women in sorghum production in the Municipality (Akpalu *et al*., 2013; Oppong-Sekyere *et al*., 2015).

Household Size

Table 2: Household size of respondents

Household size	Number of responses	Percentage (%)
1 – 4	34	34.00
5 – 9	38	38.00
10 – 14	15	15.00
15+	13	13.00
Total	100	100.00

According to the current study (Table 2), 38.0% of the respondents had a household size between five (5) and nine (9) individuals; 34.0% had between one and four whereas 15.0% of the farmers indicated that they had a household size between ten (10) and fourteen (14). However, 13.0% of the households had at least fifteen (15) members living together. The cultivation of sorghum, a traditional crop has remained largely under subsistence, therefore larger family sizes are required to supplement the production labour (Akpalu *et al*., 2013).

Educational Level

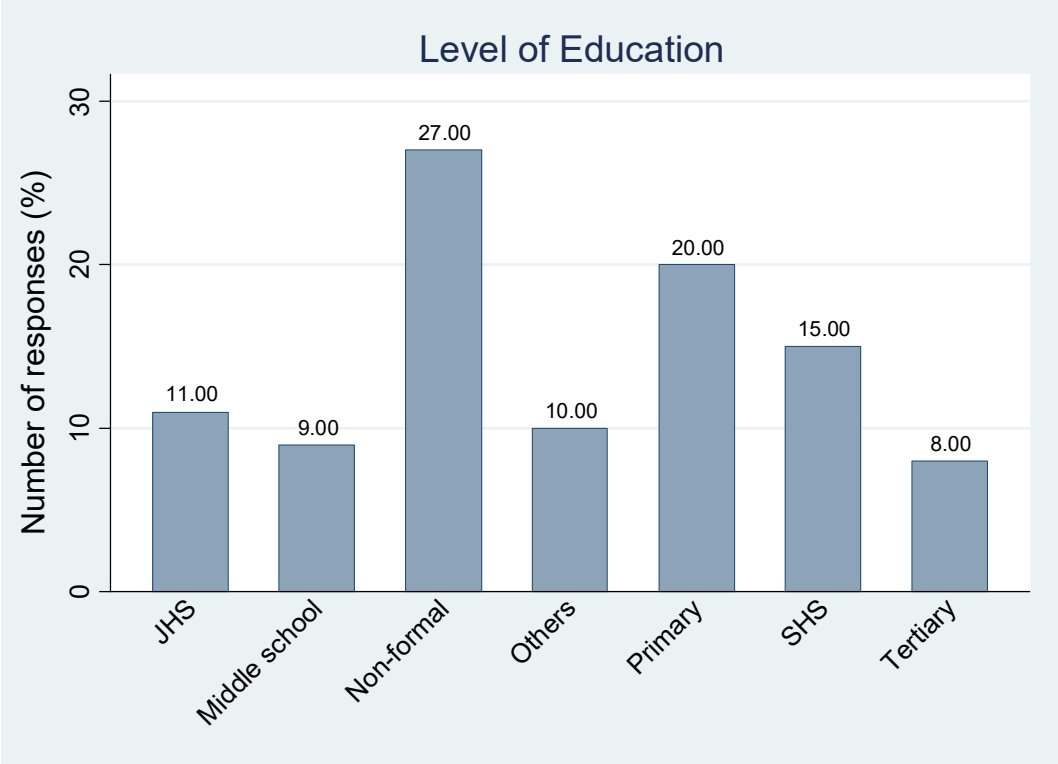

Figure 3: Level of education

The study revealed in Figure 3 that 27.0% of the farmers in the study communities had non-formal education while 20.0% had basic education. The Junior High School and Senior High School graduates who were farmers were a small 11.0% and 15. 0% respectively. Also, 9.0% and 8.0% of the respondents had obtained middle

school and tertiary education respectively. According to the Navrongo DSS basic output, educational attainment in the district is quite low. Education has both direct and indirect influence on crop production, attitude towards adoption of new production technologies etc. that results in yield improvement and a subsequent food security (Oppong-Sekyere *et al*., 2018). Low educational backgrounds could perhaps be a factor to low yields normally recorded by farmers (of Sorghum crop), which is generally a traditional crop in the Northern Ghana (Akpalu *et al*., 2014).

Religious Affiliation

Table 3: Religious affiliation of farmers

Religious affiliation	Number of responses	Percentage (%)
Islam	35	35.00
Christianity	37	37.00
Traditional worship	28	28.00
Total	100	100.00

From Table 3, a majority 37.00% of farmers indicated they were Christians, 35.00% were under Islamic religion whereas 28.00% of the respondents were affiliated to the traditional worship or religion. Even though Sorghum is a traditional crop, the cultivation of same over the years has been mixed across the religion. This is because, sorghum has proved not only as a traditional crop but also an economically marketable and viable crop produce that can generate sustainable income and thus ensure the family and the household's survival. Therefore, religion does not have significant influence on sorghum production in these communities (Debpuur *et al*., 2000). Sorghum is a crop that is very significant in the economy of Ghana. It can be traded both locally and on international markets (Oppong-Sekyere *et al*., 2018).

CROP MANAGEMENT AND PRODUCTION ACTIVITIES

Site Selection

The study revealed that, grain produces greatest yields on deep fertile well-drained loamy soils. Grain sorghum has an extensive root system and may be more tolerant than maize of soils with a shallow hardpan. According to Kimber, (2000), the best soils for other crops will also likely produce the highest grain sorghum yields.

Grain sorghum does best on deep fertile soils; however, it grows satisfactorily on most soil types as long as there is sufficient fertility and moisture. The month of May, according to the survey, is normally the optimum time to plant to get good seedling emergence and expected yields. A corn planter or grain drill is normally used for seeding or sorghum in the study areas. Manual seeding is also very common. Grain sorghum is normally cultivated in 15 or 30 Inch rows, even though it can perform in varied planting distances or width (FAO, 2003).

Because the study areas within the Navrongo Municipality of the Northern Savanna is generally dry, hot and humid, particularly during the planting and growing season, where other crops do not survive due to the drought or water stress, sorghum can tolerate the hot, dry conditions better, therefore sorghum comes across as the crop of choice, against other legumes such as soybeans, groundnut and cereals such as maize.

The study revealed that, grain sorghum grown under rotation generally results in increased grain yields than when cultivated year after year. The crop rotation plan needs to be measured carefully because, because sorghum may trail other crops readily, but not all crops trail it successfully and productively (FAO, 2003).

Planting Date

Farmers planted their sorghum over a varied and extensive collection of planting periods. Planting of sorghum was done normally in the morning but not until the soil temperature about 2 inches below the soil surface had warmed (65°F) slightly (Gomez, 1993).

Sorghum that is planted early takes benefit of sufficient rainfall that characteristically falls during the months of May and June and evades extreme heat and drought (Murty and Kumar, 1995).

Farmers also planting sorghum early to avoid some insect (sorghum midge, corn earworm and head webworms) stress.

Planting Depth

Farmers interviewed revealed that, sorghum seeds were planted as shallow as possible but careful enough to still obtain good soil-to-seed contact.

Farmers planted at a planting depth of 0.75 to 1 inch, early in the season (where possible) when the soil temperature is low and rainfall is likely to follow shortly after planting.

Farmers increased the planting depth of sorghum to about 1.5 inches later in the season when soil temperature is high (Murty and Kumar, 1995).

According to Murty and Kumar, (1995), sorghum seedlings can emerge when the seed is planted deeper than 1.5 inches, but the emergence is slow and final stand numbers may be reduced; before emergence, the plant is fully reliant on upon the food reserves in the seed from the endosperm for existence. Slow emerging plants risk depleting these reserves, which are essential to early plant growth immediately following emergence (Murty and Kumar, 1995). Planting into soils that are too dry for seed germination or are too wet for good seed furrow closure is not recommended and planting should be delayed until soil conditions improve (Murty and Kumar, 1995).

Total Land Size under Cultivation

Table 4: Number of acres of land cultivated

Number of acres of land	Number of responses	Percentage (%)
0 – 1	27	27.00
1 – 2	32	32.00
3 – 4	16	16.00
5+	16	16.00
None	9	9.00
Total	100	100.00

Thirty-two (32.0%) of the sorghum farmers indicated that they cultivated farm lands between one and two acres; 27.0% had at most one acre while 16.0% maintained up to four acres of farm land (Table 4). However, only 16.0% of the farmers actually had farm lands that were five acres or more. Agriculture is the main economic activity of the population of the Navrongo Municipality (GSS, 2014). According to the 2014 Ghana Statistical Service report, about 82.7% of households in the Municipality engaged in agriculture.

In the rural localities alone, 93.1% of households are agricultural households as against 56.8% in the urban localities who are into agriculture. Majority 96.1% households in the Municipality were involved in crop farming, with chicken, guinea fowls as the dominant animal reared among others such as cattle, goats, sheep, pigs (GSS, 2014). Moreover, the major agricultural crop products produced in the Municipality were groundnuts, sorghum, millet, guinea corn, rice, sweet potatoes, beans and tomatoes.

In general terms, agriculture in Ghana contributed over 40% of Gross Domestic Product (GDP) and employed about half of Ghana's labour force (Codjoe, 2006). This makes agriculture very significant to the economy of Ghana.

Varieties of Sorghum Cultivated

Table 5: Type (s) Sorghum landrace grown by farmer

Landraces	Number of responses	Percentage (%)
White	39	39.00
Red	61	61.00
Total	100	100.00

It is indicated in table 5 that majority of the sorghum farmers cultivated the red type of landraces (61.00%) whilst 39.00% of the respondents cultivated the white type of sorghum landrace.

Description of sorghum varieties or landraces grown by farmers

Sweet sorghum (*Saccharatun*): This variety of sorghum is tall and leafy with a richness of sweet juice in pith (Taylor and Taylor, 2002). Because of this, the stem is often chewed as sugarcane. It can be used as a source of syrup. It has also been used as silage for stock (Hugo *et al*., 2003).

Broom sorghum (*Techaicum*): These sorghum plants have very dry stem and has long and open inflorescence. Inflorescence is used as broom (Hugo *et al*., 2003).

Fodder sorghum: These are usually grown for forage or for silage, for feeding farm animals (Taylor and Robbins, 1993).

***Grain sorghum*:** Grain sorghum differs from sweet sorghum because they tend to be stocky and have dried piths which may be slightly juicy. Grain sorghum is mainly grown for grain (Gerik *et al*., 2003).

Sowing Period of Sorghum

Table 6: Best sowing period for sorghum farmers

Sowing period	Number of responses	Percentage (%)
April – May	20	20.00
May – June	56	56.00
June – July	20	20.00
July – August	4	4.00
Total	100	100.00

According to result of the current study shown in Table 6, more than half (56%) of the farmers sowed their seeds between May-June (best sowing period), 20% sowed between April-May and Jun–July respectively. Only 4% sowed their seeds between July-august due to climate change.

Cultivation of Sorghum as a main crop

Table 7: Sorghum cultivated as the main crop

Sorghum as main crop	Number of responses	Percentage (%)
YES	65	65.00
NO	35	35.00
Total	100	100.00

It was discovered from the current study in table 7 that, majority (65.00%) of the farmers cultivated sorghum as a main crop, while 35.00% of the respondents did not. This was because, according to the farmers, sorghum was their stable crop and could sustain the family for a longer period. Farmers indicated that they only cultivated the crop for consumption. A research study by Alhassan and Egbe, (2013) corroborates the findings in the present study.

Weed Control

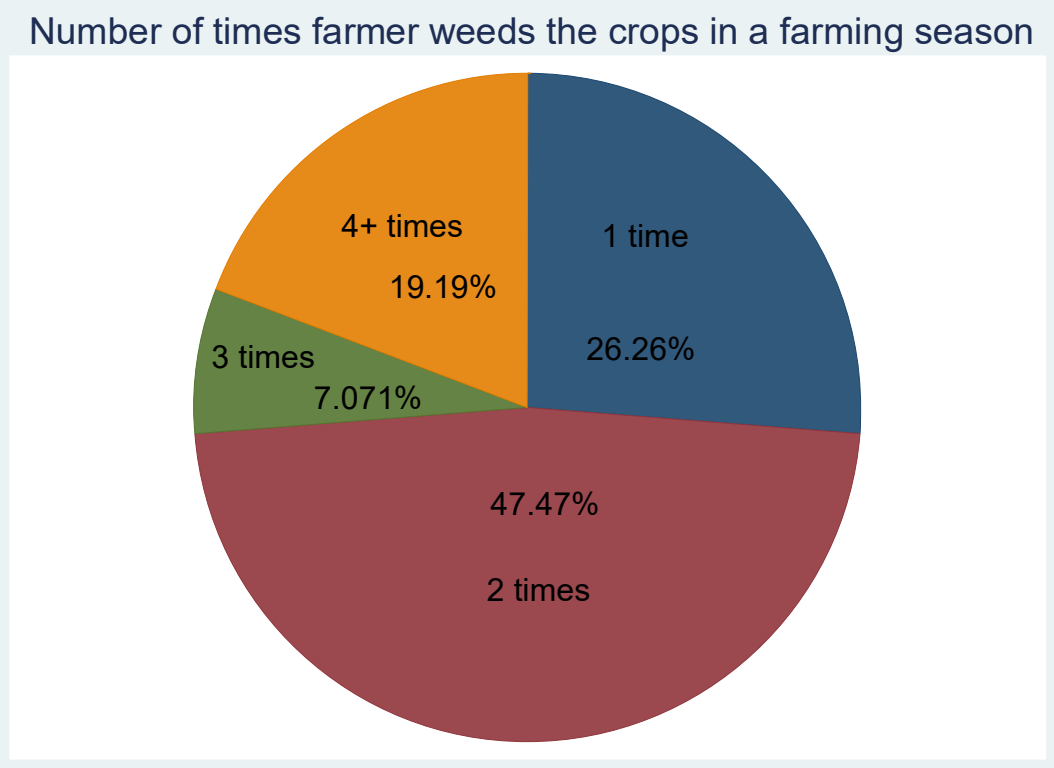

Figure 4: Number of times farmers weeded their farms in a farming season

Whilst, 47.47% of the farmers in the study weeded their farm lands two times before the end of the farming season, 26.26% only attended to their farms once. Also, 19.19% of them had their farm lands weeded about four times or more whereas a small 7.07% of the respondents did weed three times before the end of the farming season (Figure 4).

Disease and Pest Control

Table 8: Disease and pest attack on crops

Pest and disease attack on crops	Number of responses	Percentage (%)
YES	84	84.00
NO	16	16.00
Total	100	100.00

It was discovered from results of the study in table 8 that the destruction of sorghum crops by pests and diseases was the main concern by farmers as indicated by 84.0% of the respondents. The remaining16.00% of the farmers did not encounter any pest attacks. Pest and disease attack is one of the major drawbacks in the sorghum, grain legume production business, affecting yield on seasonal and annual basis. Until a serious attention is given it, yield would continue to dwindle (CGIAR, 2012; MOFA, 2007).

Pest management

Insects of potential importance include sorghum midge, corn earworm, fall army worm, sorghum webworm, European corn borer, and aphids. Several types of diseases attack grain sorghum, including seed rots and seedling blights, leaf diseases, smuts and root and stalk rots (Gerik *et al*., 2003)

Farmers indicate that, early weed control is important since sorghum seedlings are slow in growing and poor competitors with weeds. The tool box of herbicides labeled for grain sorghum is very small and pre-plant or pre-emergence herbicides are a necessary component of the weed control program. In addition, grain sorghum seed may need to be treated to provide safety to some herbicides. When this crop is planted in small fields, near trees or buildings, it may be vulnerable to bird damage. Bird-resistant varieties are available and these should be planted if a bird problem is expected (Gomez, 1993).

Fertilizer Application

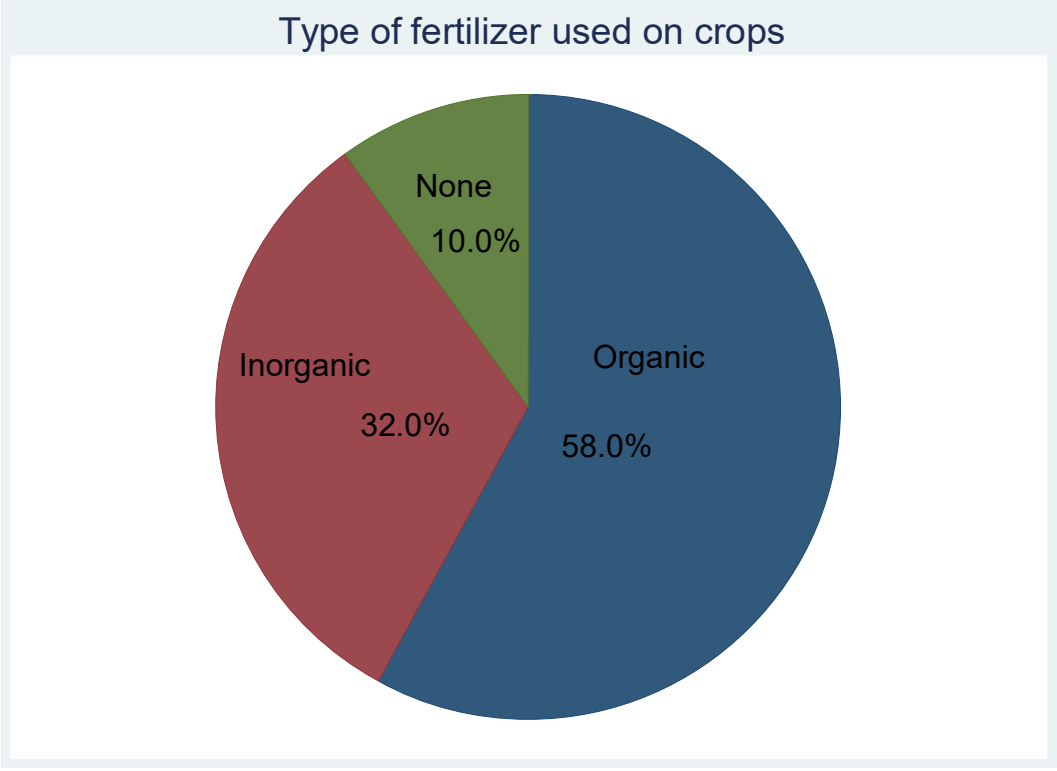

Figure 5: Type of fertilizer used on crops

Out of the hundred (100) respondents interviewed, regarding the use of fertilizer in the cultivation of sorghum, less than half (32.0%) preferred the use of inorganic fertilizer. A little above fifty percent (58.0%) used organic manure while 10.0% of the respondents used no fertilizer at all on their farms (Figure 5). Inorganic fertilizer is the most common fertilizer used by farmers, perhaps due to ease of handling and application. According to MacCarthy *et al*. (2009), 'fertilized systems were not visible in grain yield. The magnitude of grain losses were, however, higher with the climate change scenarios in both the no input system as well as when 40 kg N ha-1

was used'. 'This is probably due to the differences in temperature and in rainfall distribution and amount'. Comparing average grain yield between historical and climate change data indicates an average loss in grain yield of 22% for no fertilizer application and yield increase of 4% when fertilizer was applied over the simulation period (MacCarthy *et al*., 2009).

Access to Land for Sorghum Production

Table 5: Mode of access to land for sorghum cultivation

Access to land	Number of responses	Percentage (%)
Inheritance	64	64.00
Land lease	15	15.00
Purchase	9	9.00
Kinship	12	12.00
Total	100	100.00

The current study revealed that more than half of the sorghum farmers (64.00%) inherited their lands they used for sorghum production whereas 15.00% of the acquired their lands through lease. Twelve percent (12.00%) of the farmers acquired land through kinship. However, 9.00% purchased their own land for crop production (Table 9). The results confirm those of Akpalu *et al*. (2014) in a cowpea study in the Upper East Region of Ghana. This result has a great implication for large scale production of the crop, since land is becoming very difficult to acquire for agricultural use as opposed to industrial or building purposes.

Yield of Sorghum

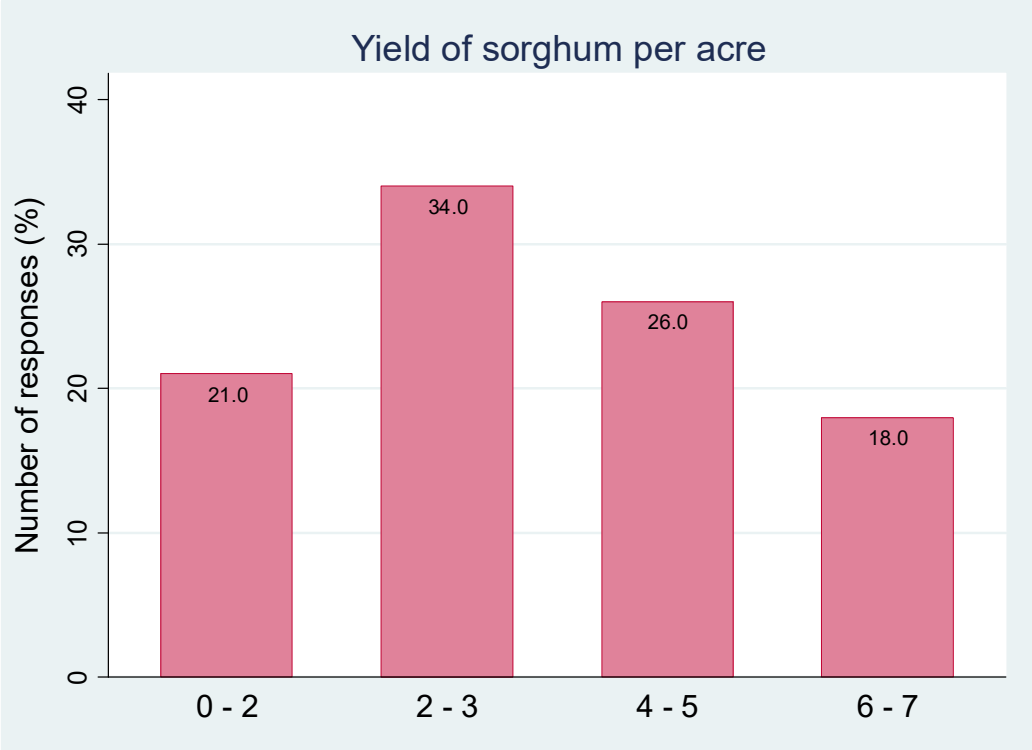

Figure 6: Yield of sorghum per acre

From the study in Figure 6, Less than half (34.00%) obtained yields of 2-3 bags per acre; 26.0% of the farmers recorded 4-5 bags; 0-2 bags where obtained by 21.0% of the farmers and 18.0% had 6-7 bags at the time of the study. Yield of sorghum and other grain legumes are always low due to poor farming practices adopted by farmers during production and in postharvest and storage activities (CGIAR, 2012; Akpalu *et al*., 2013). This has an implication for food security in the Region and the nation as a whole.

HARVEST AND STORAGE

According to the farmers, grain sorghum is harvested as early as possible after maturity. Harvest-aid treatments may also be used to hasten grain drying in the field. Prior to storage, the grain is dried by using either a heated or natural air drying system. Farmers indicated that, sorghum requires more drying time than corn (Gerik, *et al*., 2003). In addition, because sorghum packs more tightly than corn, farmers familiar with drying corn often

overburden artificial driers when attempting to condition sorghum. Excellent grain bin management is needed to condition and store grain sorghum.

USES OF SORGHUM

Table 10: Dishes of sorghum

Dishes	Number of responses	Percentage (%)
Raw	11	11.00
Boiled	88	88.00
Fried	1	1.00
Total	100	100.00

Results in Table 10 indicate that, a whopping 88% use sorghum as food (cooked), 11% consumed it raw whilst 1% fried it before eating. Other uses such as brewing of traditional beer called 'pito', dumplings, couscous, breads, pancakes, porridges, gruels as well as fermented, alcoholic products such as beers (opaque and cloudy) and fermented and non-alcoholic beverage products were also noted during the face-to-face interview.

Traditional Foods, Beverages and Uses of Grain Sorghum

The popularity and significance of grain sorghum across Africa may be evident from the idea that there exists confusing diversity of African traditional grain sorghum food and beverage products. Included in this are products and beverages of whole grain rice-type products, dumplings and couscous, breads and pancakes, porridges, gruels, opaque and cloudy beers, fermented beverages as well as non-alcoholic beverage products (Serna-Saldivar and Rooney, 1995; Murty and Kumar, 1995; WHO, 1996; Rooney and Waniska, 2000 and Taylor and Dewar, 2000).

MARKETING OF SORGHUM

Sales Point

Table 11: Sales point for the produce of sorghum

Sales point	Number of responses	Percentage (%)
Market	72	72.00
Home	28	28.00
Total	100	100.00

From the current study in Table 11, majority, representing about two-thirds (72.00%) of the sorghum farmers sold their products in the markets. The remaining 28.00% sold their produce at home. Sorghum is a commodity with high market demand. Farmers stored a percentage of their sorghum produce after harvest for home or family consumption while the remaining is sold in the market for extra income (Oppong-Sekyere *et al*., 2015).

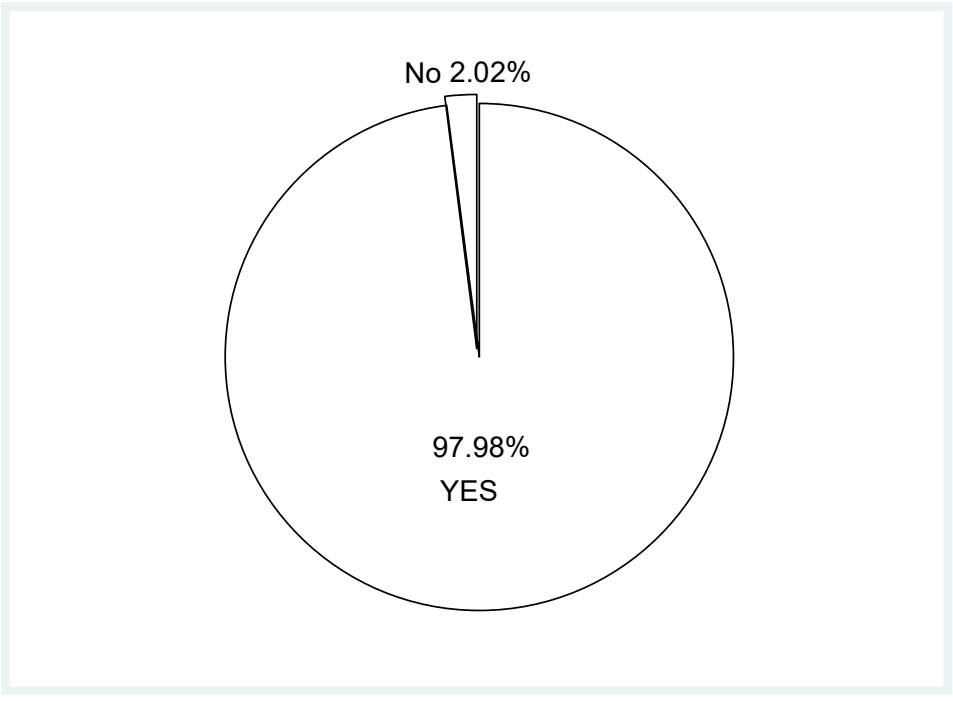

Figure 7: Ready market for sorghum

Results in Figure 7 regarding marketing of sorghum, indicates that there is ready market for sorghum, according to the farmers, because it has many uses; food and beverages. These include: 'pito', whole grain rice-type products, breads and pancakes, dumplings and couscous, porridges, gruels, opaque and cloudy beers, and non-alcoholic fermented beverages (ICRISAT, 1996).

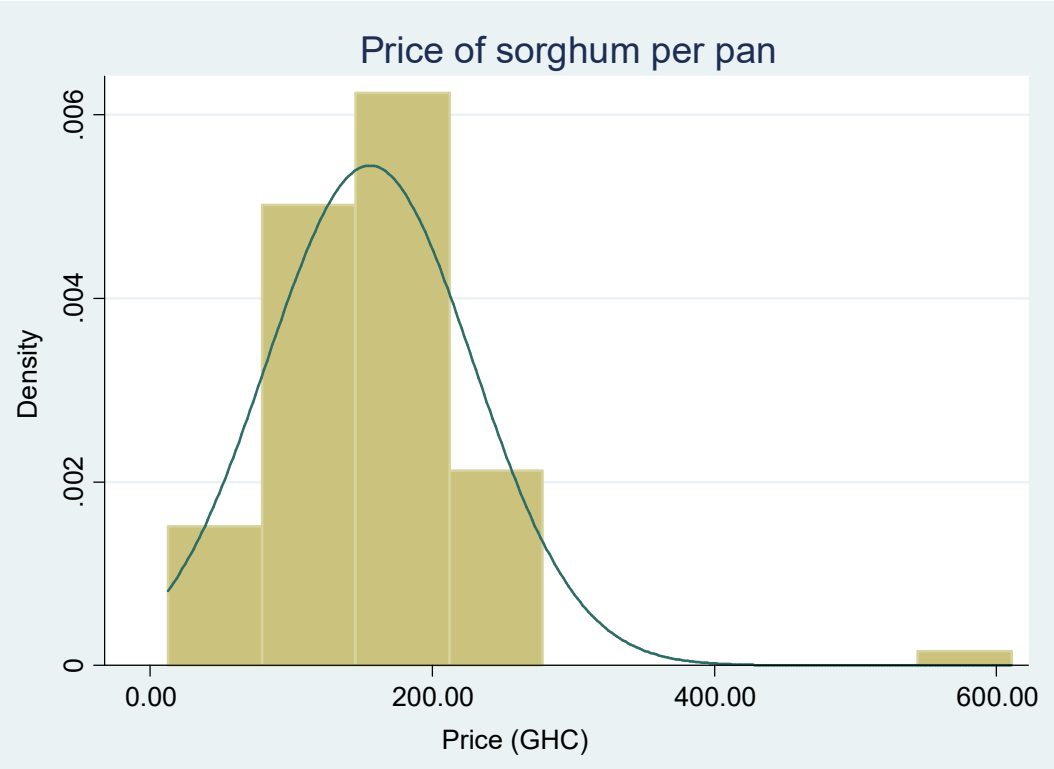

Figure 8: Price of sorghum per bag (100kg)

It was discovered from the study that majority of farmers sold their sorghum produce at GH₵155.86 per a 100kg bag, on the average (equivalent to $33). However, the price of sorghum per bag, as indicated by the farmers is skewed to the right. Meaning the price of a bag could be as high as Ghs600 ($125) depending on the year, type of market and the demand for the produce. The farmers indicated that, the price of sorghum fluctuates per a season and upon availability and demand, but price has always tilted to the higher side (ICRISAT, 1996; MOFA, 2014).

CONCLUSION

Sorghum production has the potential to empower the people economically and therefore should be well structured into a small or micro scale and ultimately into large scale enterprises to supply industries with grain sorghum seeds for processing it into food and other food products in order to contribute to achieving the targets set by the Sustainable Development Goals (SDG goals 2, 6, 12, 13). There should be a back-up service for sorghum produces not only to assess the output per acre but the viability of sorghum to improve likelihoods and technical support from project planning through monitoring and evaluation to its implementation to ensure the success of sorghum production in the Municipality, Region and the country as a whole.

Since the Navrongo Municipality has comparative advantage in agriculture (grain sorghum and other grain and legume crops) as a result of good geographical condition, it is expedient that District and Municipal Assemblies further develop and expand their policies to assist private individuals and groups to go into and or expand their agriculture ventures. The role of agriculture as basis for economic growth has been re-emphasized in the GPRS II document of the Ministry of Food and Agriculture (GPRS II, 2005) and in other technical documents, therefore the Municipality needs to take advantage of this to encourage people in sorghum production to help reduce poverty in the area. In addition, since there are several interventions that seek to make the individual acquire the necessary skills to become self-reliant; sorghum production should be re-examined, since they have the potential to reduce poverty through the acquisition of skills that can put one in a sustainable employment. It should also be noted that sorghum production should aim at promoting the development and growth of micro and small enterprises with the objective of adoption the cultural practices involves in sorghum production and equipping an individual with productive skills. Government agencies such as the National Board for Small Scale

Industries (NBSSI) and Rural Enterprise Project which aim at offering skill training and supporting farmers' with capital to undertake micro or small scale enterprises are encouraged to expand, enhance and further promote their efforts as per their mandates especially in the agro-based small-scale industries into the Navrongo Municipality.

REFERENCES

Akpalu, MM, Salaam, M., Oppong-Sekyere, D and Akpalu, S.E. (2014). Farmers' Knowledge and Cultivation of Cowpea (*Vigna unguiculata* (L.) Verdc.) in Three Communities of Bolgatanga Municipality, Upper East Region, Ghana. 2014; British Journal of Applied Science & Technology (BJAST), Vol. 4(5). pp. 775 - 792, May, 2014. http://www.sciencedomain.org

Akpalu, MM. Atubilla, IA and Oppong-Sekyere, D. (2013). Assessing the Level of Cultivation and Utilization of Bambara Groundnut (*Vigna subterranea (L.) Verdc.*) In the Sumbrungu Community of Bolgatanga, Upper East Region, Ghana. International Journal of Plant, Animal and Environmental Sciences (IJPAES); 2013; Vol. 3(3). pp. 68 - 75, July-Sept., 2013. Available online http://www.ijpaes.com

Alhassan, GO and Egbe, M.O. (2013). Participatory Rural Appraisal of Bambara Groundnut (*Vigna subterranea* (L.) Verdc.) Production in Southern Guinea Savanna of Nigeria. Agricultural Science Volume 1, Issue 2 (2013), 18-31 ISSN 2291-4471 E-ISSN 2291-448X Published by Science and Education Centre of North America.

Binka, F., Gyapong, M., Amidini, A., Kubadze, F.A., Phillips, J.F., Macleod, B and Kajihara, B. (1994). English Language Instructions to Interviewers for the Demographic Data Component of the Navrongo Demographic Surveillance System. Documentation Note 2, (1994).

Binka, F.N., Ngom, P., Phillips, J.F., Adazu, K.F and Macleod, B. (1999). Assessing Population Dynamics in a Rural African Society; Findings from the Navrongo Demographic Surveillance System. (1999). *Journal of Biosocial Science* 31 375-391.

CGIAR (2012). CGIAR Research Program on Grain Legumes; Leveraging Legumes to Combat Poverty, Hunger, Malnutrition and Environmental Degradation. *www.GrainLegumes.cgiar.org* 15 August, 2012. Pp 229.

Codjoe, S. N. A. (2006). "Population growth and agricultural land use in two agro-ecological zones of Ghana, 1960--2010." International journal of environmental studies, 63, no. 5 (2006): 645-661.

Debpuur, C., Avogo, W., Abokyi, L., Akuma, I., Kondayire, F and Nazzar, A. (2000). NHRC 1999 Panel Survey: A Report of Key Findings. Community Health and Family Planning Project (CHFP). Documentation Note Number 43. Department of Food Science, University of Pretoria, Pretoria 2002, South Africa, E-mail: jtaylor@postino.up.ac.za

Doggett, H. (1996). Sorghum, 2nd Ed, Longman Scientific and Technical, Harlow, UK (1988). National Research Council. Lost Crops of Africa, Vol 1, Grains, National Academy Press, Washington, D.C. (1996).

FAO, (2003). Food and Agriculture Organization of the United Nations. 2003. www.fao.org 20 February (2003).

Gerik, T., B. Bean and Vanderlip, R. (2003). *Sorghum*, Texas Cooperative Extension Service. 2003. Field Crop and Forage Enterprise Budgets (University of Kentucky, 2005)

GSS, (2014). Ghana Statistical Service. www.statsghana.gov.gh

Gomez, M.I. (1993). Comparative evaluation and optimization of a milling system for small grains. In 'Cereal Science and Technology: Impact on a Changing Africa', (J.R.N. Taylor, P.G. Randall and J.H. Viljoen, eds), The CSIR, Pretoria (1993) pp. 463-474.

http://www.ca.uky.edu/cmspubsclass/tinymce/jscripts/tiny_mce/plugins/filemanager/files/adreum/budgets/archivedbudget/2006fieldcrop_budget.xls *interactive field crop budgets*

Hugo, L.F., Rooney, L.W and Taylor J.R.N. (2003). Fermented sorghum as a function ingredient in composite breads. Cereal Chemistry (2003) in press.

ICRISAT, (1994). International Crops Research Institute for the Semi-Arid Tropics. 1994. ICRISAT Now: Sowing for the Future, ICRISAT, Patancheru, India (1994).

ICRISAT, (1996). International Crops Research Institute for the Semi-Arid Tropics and Food and Agriculture Organization of the United Nations. The World Sorghum and Millet Economies, ICRISAT, Patancheru, India and FAO, Rome (1996).

Jordan, W.R and Sullivan, C.Y. (1982). Reaction and resistance of grain sorghum to heat and drought. In 'Sorghum in the Eighties, Vol 1,' (J.V. Mertin, ed), ICRISAT, Patancheru, India (1982), pp. 131-142.

Kimber, C.T. (2000). Origins of domesticated sorghum and its early diffusion into India and China. In 'Sorghum: Origin, History, Technology, and Production', (C. Wayne Smith and R.A. Frederiksen, eds), John Wiley & Sons, New York (2000) pp. 3-98.

MacCarthy, D.S., Sommer, R and Vlek, P.L.G. (2009). Modeling the impacts of contrasting nutrient and residue management practices on grain yield of sorghum (*Sorghum bicolor* (L.) Moench) in a semi-arid region of Ghana using APSIM (2009). *Field Crops Research* 113(2):105-115.

MoFA, (1997). Agriculture in Ghana. Facts and Figures. Policy Planning, Monitoring and Evaluation. Ministry of Food and Agriculture. Accra, Ghana.

MoFA, (2014). Statistics, Research and Info. Directorate (SRID), Min. of Food & Agric. - May, 2014

Murty, D.S and Kumar, K.A. (1995). Traditional uses of sorghum and millets. In 'Sorghum and Millets: Chemistry and Technology', (D.A.V. Dendy, ed), American Association of Cereal Chemists, St. Paul, USA (1995) pp 223-281.

Olatunji, O. (1993). Developed technologies for substitution of locally grown cereals in selected food products. In 'Cereal Science and Technology: Impact on a Changing Africa', (J.R.N. Taylor, P.G. Randall and J.H. Viljoen, eds), The CSIR, Pretoria (1993) pp. 509-523.

Oppong-Sekyere, D., R. Akromah, E. Y. Nyamah, A. D. Ninfaa, M. M. Braimah, M. M. Akpalu and A-R. S. Salifu (2016). Assessment of Postharvest Practices of Groundnuts in Northern Ghana Based on the Participatory Rural Appraisal Technique. *Journal of Scientific Research and Report,* 10 (5): 1-17.

Oppong-Sekyere, D., R. Akromah, M.M. Akpalu, A.D. Ninfaa, E.Y. Nyamah, M.M. Braimah and A-R. S. Salifu (2015). Participatory Rural Appraisal of Constraints to Groundnut (*Arachis hypogaea* L.) Production in Northern Ghana *Int.J.Curr.Res.Aca.Rev.*2015; 3(10): 54-76.

Oppong-Sekyere, D., Laary, J. K and Asumboya, G. (2018). Assessing Farmers' Knowledge, Perceptions, Varietal Preferences and Constraints to Groundnut Production, the PRA Approach. *International Journal of Research* 05 (21): 309-338

Osmanzai, M. (1992). Sorghum response to water deficit. In: 'SADC/ICRISAT Southern Africa Programs: Annual Report 1992', ICRISAT, Bulawayo, Zimbabwe (1992). Pp 8.

Rooney, L.W and Waniska, R.D. (2000). Sorghum food and industrial utilization. In 'Sorghum: Origin, History, Technology, and Production', (C. Wayne Smith and R.A. Frederiksen, eds), John Wiley & Sons, New York (2000) pp. 689-729.

Serna-Saldivar, S and Rooney, L.W. (1995). Structure and chemistry of sorghum and millets. In 'Sorghum and Millets: Chemistry and Technology', (D.A.V. Dendy, ed), American Association of Cereal Chemists, St. Paul, USA (1995) pp 69-124.

Taylor, J and Dewar, J. (2000). Fermented products: Beverages and porridges. In 'Sorghum: Origin, History, Technology, and Production', (C. Wayne Smith and R.A. Frederiksen, eds), John Wiley & Sons, New York (2000) pp. 751-795.

Taylor, J and Taylor, J.R.N. (2002). Alleviation of the adverse effects of cooking on protein digestibility in sorghum through fermentation in traditional African porridges. International Journal of Food Science and Technology 37 (2002) 129-138.

Taylor, J.R.N and Robbins, D.J. (1993). Factors affecting beta-amylase activity in sorghum malt. Journal of the Institute of Brewing 99 (1993).pp. 413-416.

Vanderlip, R. L. (1993). *How a Grain Sorghum Plant Develops*, Kansas State University, January (1993).

WHO, (1996). World Health Organization. Fermentation: Assessment and Research, WHO/FNO/FOS 96.1, WHO, Rome (1996).

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Improving the Functional Properties of the Arabian Women Headscarves by Plasma Treatment

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ABSTRACT

The basic requirements for good headscarves are no longer only aesthetically pleasing, but also related to the functional requirements that the head scarf should provide for the woman wearing it. Therefore, the study of the functional requirements of the head coverings of women in the Arab climate, which combines the heat in summer and cold winter is important to different dimensions in terms of selection of raw materials suitable for the manufacture of head covers and treatments to improve the head scarf to give a sense of comfort with the aesthetic appearance. The synthetic headscarf prevents the extraction of sweat and prevents air permeability, which causes many problems for women who wear it. In this study, polyester head scarf fabric will be treated with atmospheric pressure plasma to improve functional properties such as wettability, tensile strength, elongation, UV protection and protection from harmful bacteria to woman skin. The effectiveness of the treatment is assessed by using standard tests methods; first, the UPF test, second, the Antimicrobial test, finally, Infrared spectroscopy Analysis.

KEYWORDS: Headscarves, Plasma surface treatment; UV protection, Infrared spectroscopy Analysis, Scanning Electron Microscopy

1. INTRODUCTION

The head cover is one of the most effective clothing supplements that can be used in many styles. It is one of the easiest ways to add a distinctive touch to clothes and give them a hint of renewal and diversity. The headdress has the ability to change the shape of old clothes and to avoid looking at the body defects when placed near aesthetic areas in the woman's body. It is also used as a function of heating in the winter season.

Scarves come in different sizes, fabrics and shapes. A scarf's fabric defines its appearance, texture, and weather-suitability. Women are among the most affected by the danger of solar radiation, especially UV radiation so women should always pay attention to fabric when they're shopping for scarves. A lot of Headscarves made from different materials in the markets, some may be inappropriate in the way wear on the head or uncomfortable or inappropriate for use; so the study of the functional requirements of the fabrics used in the Headscarves manufacturing and attention to the requirements of the society is very important.(3)

There are at least 70% of women in Egypt, Arab countries and North Africa wear headscarves for social, religious and protective reasons and sometimes for other reasons such as decorating or protection from heat and solar radiation, which increases the need to provide fabrics with high protective properties against the thermal and radiation effects of (Ultraviolet - visual - infrared) radiation, where most women suffer in these areas of damage and skin diseases such as increase the secretion of sweat and inflammation of the scalp and hair loss and lack of vitamin D and so on, causing a real problem for Arab women and psychological and moral diseases. (3)

Synthetic fibers have become an integral part of the current textile industry. Polyester fiber has been most widely used for textile materials because of high mechanical strength, good stretchability, heat-setability, rapid drying, and wrinkle resistance. The main drawback of some synthetic fibers is the low surface energy that causes a weak sensitivity to moisture and dyeability. (6)

It is known that polyester fiber has an inherent hydrophobic nature and thus polyester products are lacking in stain-release, anti-soil redeposition, water and moisture wicking and anti-electricity in textile end-use. The hydrophobicity can also be a disadvantage for certain applications like dyeing and finishing. Chemicals treatments are often used to improve the hydrophilic nature of the polyester headscarves surface; however, the usage of chemicals is accompanied by a decrease in fiber strength and leads to environmental pollution. Therefore, we used plasma treatment to enhance comfort properties and mechanical properties. (6)

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Plasma technology is based on a simple physical principle. Matter changes its state when energy is supplied to it: solids become liquid, and liquids become gaseous. If even more energy is supplied to a gas, it is ionized and goes into the energy-rich plasma state, the fourth state of matter. (2)

Plasma treatment of textile is one of the most popular methods used for textile surface treatment; it is dry, pure and used lower energy consuming than valet ordinary treating. Plasma processing of polymers was used to get desired surface properties without interfering with material properties. Non-thermal plasma techniques were developed in the atmosphere to meet the need for the textile industry. (1)

Plasma treatment causes a desirable and exactly adjustable increase in the adhesiveness and wettability of surfaces. This makes it possible to use completely new materials and environmentally-friendly, solvent-free paints and adhesives industrially. Many chemical surface treatment processes can be replaced with plasma treatment. (2)

The significance of this paper is to discussion the influence of atmospheric pressure plasma modification on women headscarves. Comfort properties, UV protection and protection from harmful bacteria to woman skin have been investigated; Methodology was undertaken using a headscarves material, with fiber content of polyester.

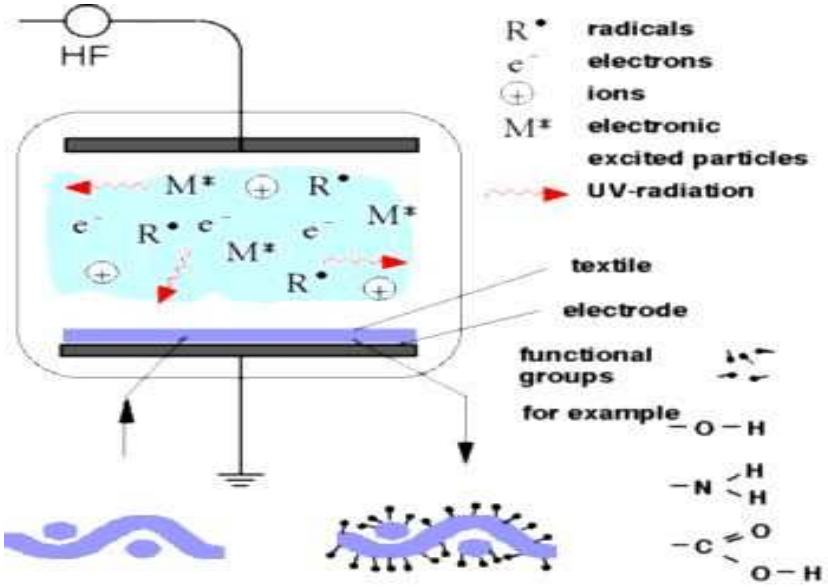


Figure (1) Working principle of plasma treatment (5)

2. MATERIALS AND METHODS

2.1 Fabrics:

Specifications of fabrics are given in table 1. Headscarves fabrics were procured from Tie shop.
Thickness obtained using thickness tester according to (ASTM D1777-96-2003).
Fabric weight obtained using digital sensitive scale according to (ASTM D3776-96-2003).

Table1
Specifications of fabric before treatment

Fabric structure	Fiber type	Warp/cm	Weft/cm	Weight (gm/m^2)	Thickness (mm)
Chiffon1/1	polyester	32	32	90	0.2

2.2. Experimental Methods

Application of atmospheric pressure plasma treatment of polyester fabric for improvement of headscarves specific properties:

The discharge can be produced between two electrodes one of them covered by two different dielectric material cement and glass, cell shown in Fig.2 consists of two metallic parallel square electrodes of 25x25 cm^2, 2mm gap space, separated by glass sheet through an O ring. The ground electrode stands on Acrylic sheet with inlet and out let opening for gas insertion and exhaustion. High voltage AC transformer (0-10kV) generates a 50 Hz sinusoidal voltage was used as a power source for driving discharge. (7)The live electrode is stain steel has radius 15 cm and the other electrode is covered by porous material as a dielectric with thickness 1 mm. (6)
The discharge situation should be adapted to being in the glow mode through setting the used voltage and current.

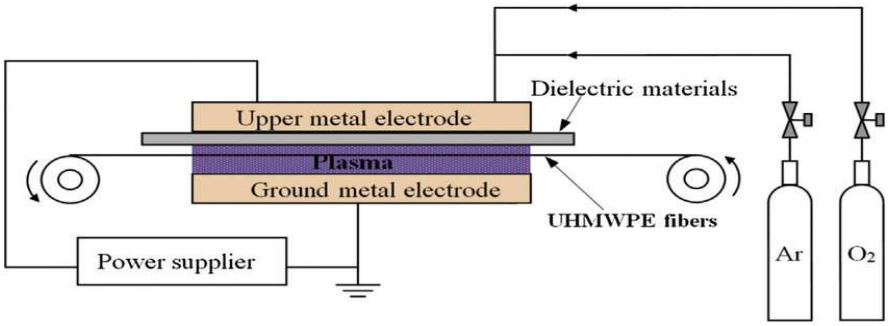


Fig. (2): The diagram of DBD discharge treatment

Polyester fabric was exposed to atmospheric pressure glow discharge plasma (APGD) at different currents and times with different gases Oxygen, nitrogen and air. Exposing time variables were 5 min, while discharge current variables were 3, 5, 7 and 10 mA.

The headscarf fabric was cut and then scoured with acetone for 10minutes to remove contaminants on the fabrics surface. After that, the headscarf fabric was rinsed with deionized water for 5minutes. Water was extracted from fabrics in a hydro extractor for 3 minutes. Lastly, the fabrics were dried in an oven at 60℃ for 10minutes.

After scouring the fabrics, the fabrics were conditioned under the standard atmospheric pressure at 65% +/- 5% relative humidity and 21℃+/- 1℃ for at least 24 hours before other procedure processed.

The investigation involves the application of different gases oxygen; nitrogen and air to polyester headscarf in order to improve the fabric physical properties such as wettability, tensile strength, elongation, IR- spectroscopy Analysis as well as surface morphology were also investigated.

The tensile strength test and the water drop test were applied.

The duration required for the drop of water to be absorbed into the fabric is pointed to as absorbency amount. In order to determine the changes in the chemical structure of polyester headscarf fiber as a result of plasma treatment, the untreated and plasma treated samples were studied by IR- spectroscopy Analysis.

The scanning electron microscope photomicrograph was registered to study the changes in the surface morphology of plasma treated fabrics.

3. RESULTS AND DISCUSSION

Effect of atmospheric pressure plasma on the physical and mechanical properties of polyester headscarf fabric, Time exposure 5 min:

3.1. Infrared spectroscopy Analysis:

The results are illustrated in figures (3, 4, 5 and 6). In the spectrum of the nitrogen plasma- treated fabric fig. (4), some new peaks were observed compared with untreated sample spectrum :2443.06cm characteristic of NH_2 groups, 1378.36 cm^{-1} characteristic of C-N aromatic amine , 1234.64cm characteristic of secondary amine C-N stretch , 1227.57 characteristic of C-N aliphatic amine and 1455.18 cm^{-1} characteristic of aromatic tertiary amine C-N stretch, As well some other peaks with intensity at 3368.64 cm^{-1} , 3357.85 cm^{-1}, 3053.9 cm^{-1} characteristic of hydroxyl group H-bonded OH stretch were also observed.
Fig. (5) Shows that a new absorption band with peak intensity at 1462.86 cm^{-1}, characteristic of carboxylate groups was observed.
In addition, the intensity of the hydroxyl group (-OH) peaks like 3648.27 cm^{-1} and 3231.15 cm^{-1} were outstandingly higher than that in figure (3) this increase in the absorption intensity indicates the introduction of more hydroxyl

groups as a result of oxygen plasma treatment, also it can be observed the absorption peak at 2032.58 cm^{-1} characteristic of carbonyl compound groups (C=O).

The rate of the oxygen containing groups such as –COOH, -C-OH and C=O increased on the surface of the treated fabric. This effect may be referring to the fact that some of the C-C bonds in the polyester fabric surface could be broken by the oxygen plasma treatment. Then the carbon radicals, formed by the removal of hydrogen atoms from the polyester chain

The introduction of these polar groups converts the nature of the fabric from hydrophobic to hydrophilic, as shown in figure (6), some new absorption band with peak intensity at 3298 .64 cm^{-1} characteristic of hydroxyl group H-bonded OH stretch was observed. Furthermore the intensity of the carboxylic acid salt group (-COOH) peaks like 1302.68 cm^{-1} 1403.92 cm^{-1} and 1834.46 cm^{-1} were higher than that in untreated sample spectra. Also, the intensity of the amine group ($-NH_2$) peaks like 2358.81 cm^{-1}, 2223.82 cm^{-1} 2406.63 cm^{-1} were also higher than that in untreated sample spectrum, which means additional functional groups induce to the fabric surface as a result of air plasma treatment.

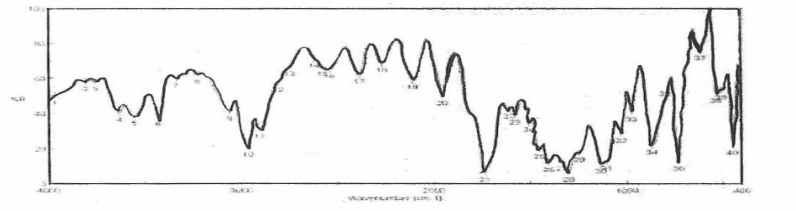


Fig. (3) IR analysis chart of untreated polyester headscarf fabric

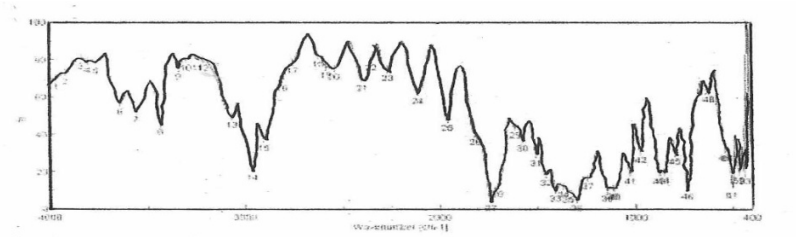


Fig. (4) IR analysis chart of treated polyester headscarf fabric with nitrogen plasma

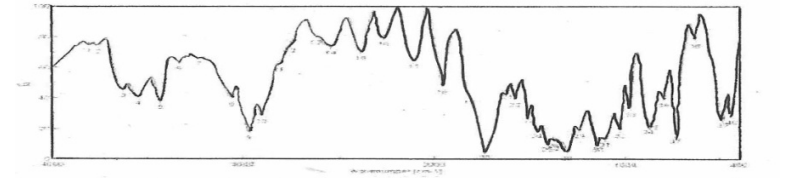


Fig. (5) IR analysis chart of treated polyester headscarf fabric with oxygen plasma

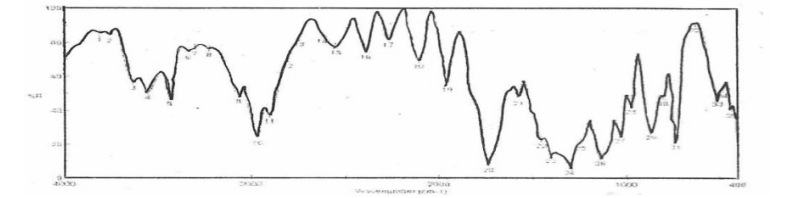


Fig. (6) IR analysis chart of treated polyester headscarf fabric with Air plasma

3.2. Wettability

Wettability expressed as wetting time of untreated and treated fabrics was measured; table (2) shows the wetting times of the polyester headscarf fabric modified by different gases under different discharge current.

Table (2):
Wetting time of polyester fabric modified with different Glow discharge gases:

Discharge current (MA)	Untreated sample	Wetting time (sec.)		
0	3.07	Air	O2	N2
3		0.72	0.82	1.02
5		0.68	0.71	0.85
7		0.61	0.65	0.79
10		0.58	0.61	0.72

It can be easily observed that the plasma treated fabrics exhibited a significant enhancement in the hydrophilicily and water absorption irrespective of gas types used under the study.
The improved wettability of polyester fabric as a result of plasma treatment is in good agreement with the results of IR analysis. It could be concluded from table (2) that increase the discharge current is accompanied with decrease in the wetting time for plasma treated samples.

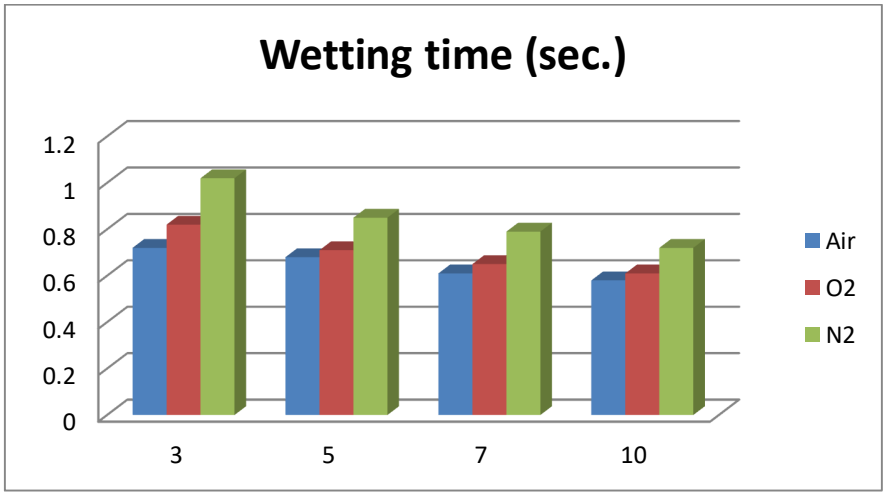


Fig. (7) Wetting time chart of treated polyester headscarf fabric

The improved wettability of polyester treated fabrics can be attributed to the increase in ion bombardment on the fabric surface which leads to formation of surface- free radicals, increasing the amount of active species formed on oxidation, besides increasing surface and increasing surface roughness according to the kind of gas used in glow treatment.
The wettability of plasma treated polyester fabric increases in the order of Air> O2 >N2.
this increase in the surface wettability is due to formation of several hydrophilic groups (e.g.,-NH,-CN,-N:N,-C=O,-COOH,-C-OH,-CHO) Beside chain scission, etching, and increasing surface roughness.

Plasma treatment resulted in improvement in hydrophilicity of polyester film which was treated along with polyester fabric in air DBD.
As seen in Figure 8, an apparent decrease in water contact angle took place after 15 min plasma treatment, which suggest that a strong increase in wettability of the polyester headscarf fabric surface induced by DBD. Water contact angle was reduced from 85.7° for untreated to 29.5°, which indicate the formation of polar groups such as CO, COO, OH, etc as consequences of plasma treatment which make polyester surface more hydrophilic. (8)

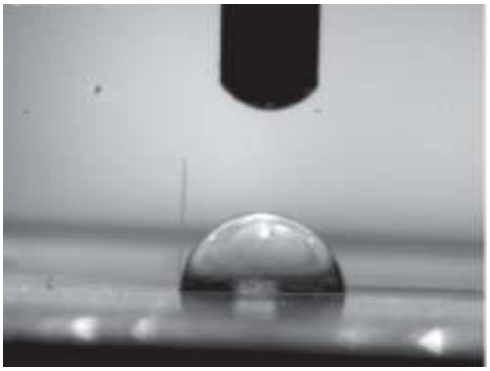
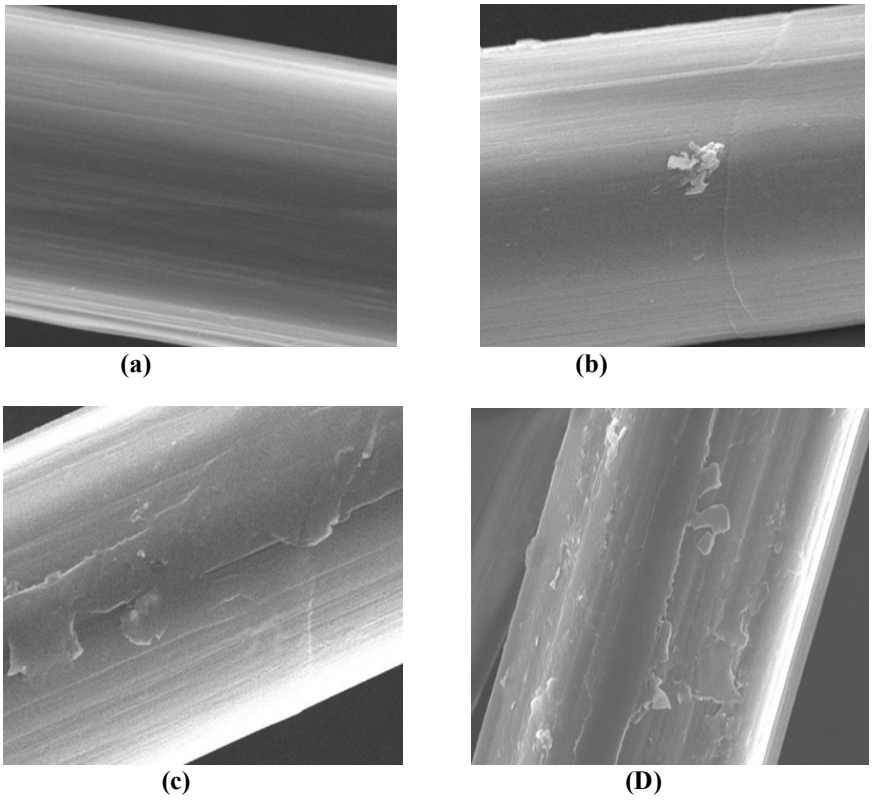


Fig. (8) Contact angle of untreated polyester Headscarf fabric

fig. (9) Contact angle of treated polyester headscarf fabric

3.3. Scanning electron microscopy (SEM):

SEM Measurements Figures 10, 11, 12 and 13 show the SEM micrographs of the plasma treated polyester fabric and the untreated fabric. Surface morphology changes significantly after plasma treatment. It can be showed from Figures 10 that the untreated polyester fibers look distinct and very smooth, however Figures 11, 12 and 13 show several grooves on the surface of the fibers, with the existence of some pores and voids. These results may be due to the removal of some material by etching and roughening effect caused by the bombardment of ions/ electrons in the plasma on the fabric surface, causing surface roughness.



(a) **(b)**

(c) **(D)**

Fig. (10): SEM micrographs of the polyester headscarf fabric (a) untreated, (b) Oxygen plasma, (c) air plasma, (d) nitrogen plasma.

3.4. Tensile strength

Treated and untreated samples were subjected to measurement of tensile strength. The results are illustrated in table (3).

Table (3):
Effect of plasma glow discharge current on the tensile strength of Polyester headscarf fabric:

tensile strength			
untreated sample	68		
Discharge current (mA)	Air	O2	N2
(3)mA	68	61	67
(5)mA	66	63	64
(7)mA	65	58.5	62.5
(10)mA	64.5	57.5	63

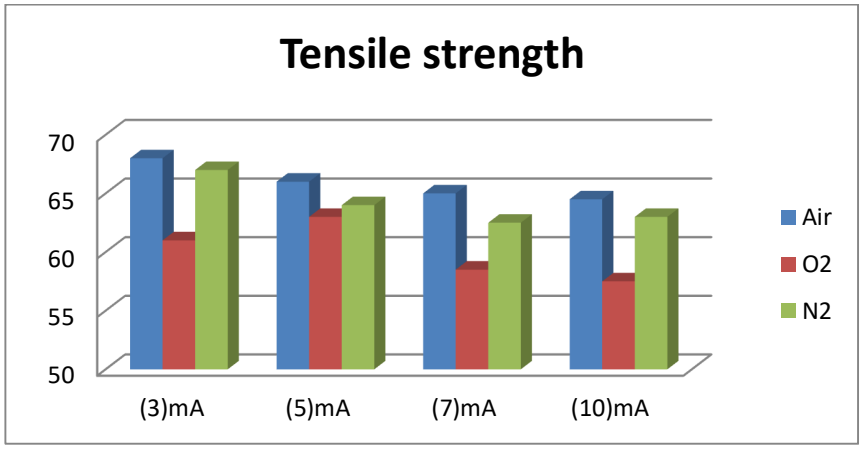


Fig. 12: Effect of plasma glow discharge current on the tensile strength of polyester headscarf fabric

Table3 and figure (12) Shows that the treatment of plasma caused a little reduce in the rate of the tensile strength in comparison with the untreated fabrics.
Long plasma treating produced deep cracks on the samples, on the other hand, higher discharge current or longer treatment time during plasma treatment may caused lose in tensile strength properties.

3.5. Ultraviolet protection factor:
it was determined using UV-VIS double beam spectrophotometer according to the standard (ASTM D6604-2000) and AATCC test method [AATCC 183-2000]. And the results showed in table 4:

Table (4):
Effect of plasma glow discharge current on the Ultraviolet protection factor Of polyester fabric:

Ultraviolet protection factor			
untreated sample	75.2		
Discharge current (mA)	Air	O_2	N_2
(3)	121.6	158.9	195.4
(5)	151.2	173.3	213.4
(7)	163.4	181.2	226.2
(10)	172.3	198.3	241.7

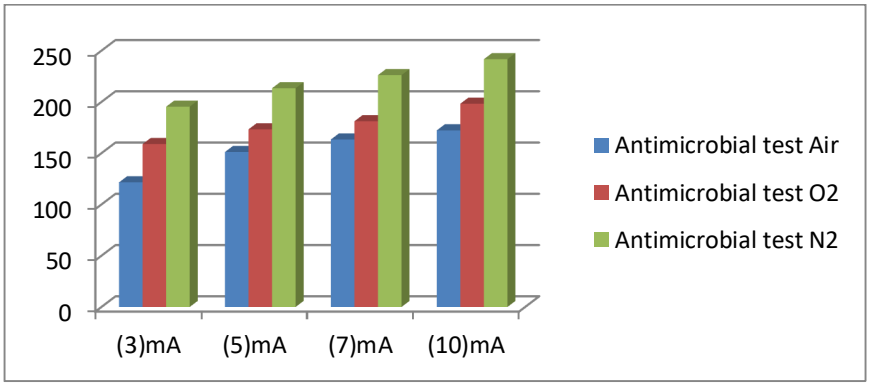


Fig. 13: Effect of plasma glow discharge current on the Ultraviolet protection factor of polyester headscarf fabric

It's clear that after the treatment of the polyester fabrics with plasma glow discharge current the Ultraviolet protection factor values increased significantly. This improvement is preferable in the woman scarves. It gives sufficient protection for women skin against UV protection.

3.6. Antimicrobial test:

The examination was done by using a modified Kirby-Bauer disc diffusion method, and the results are illustrated in table 5:

Table 5:
Results for antimicrobial activity Disc diffusion method

Antimicrobial test Escherichia coli (G^-)				
Untreated	0			
Inhibition zone diameter (mm / 1 cm Sample) Escherichia coli (G^-)	Discharge current (mA)	Air	O_2	N_2
	(3)	6	12	18
	(5)	7	12	16
	(7)	7	15	19
	(10)	9	17	19

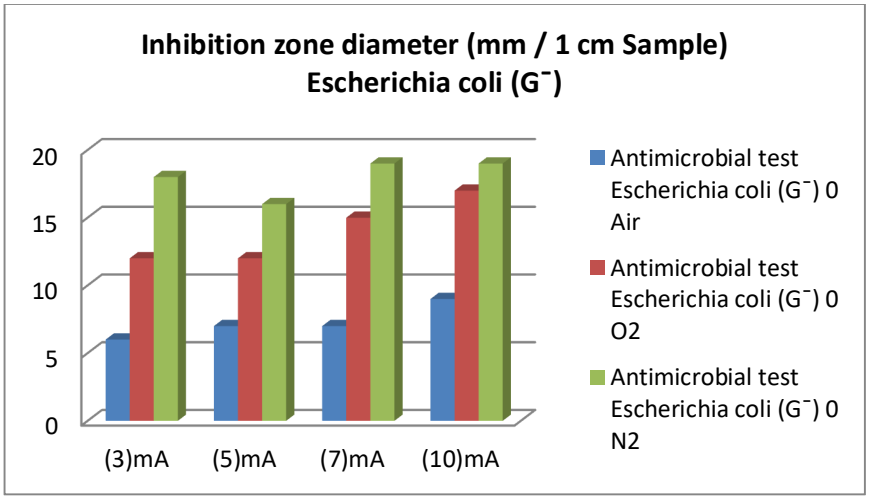


Fig. 14: Antimicrobial test Escherichia coli (G^-)

Antimicrobial test Staphylococcus aureus (G+)				
Untreated	0			
Inhibition zone diameter (mm / 1 cm Sample) Staphylococcus aureus (G+)	Discharge current (mA)	Air	O_2	N_2
	(3)	8	12	12
	(5)	11	14	16
	(7)	12	15	16
	(10)	12	15	18

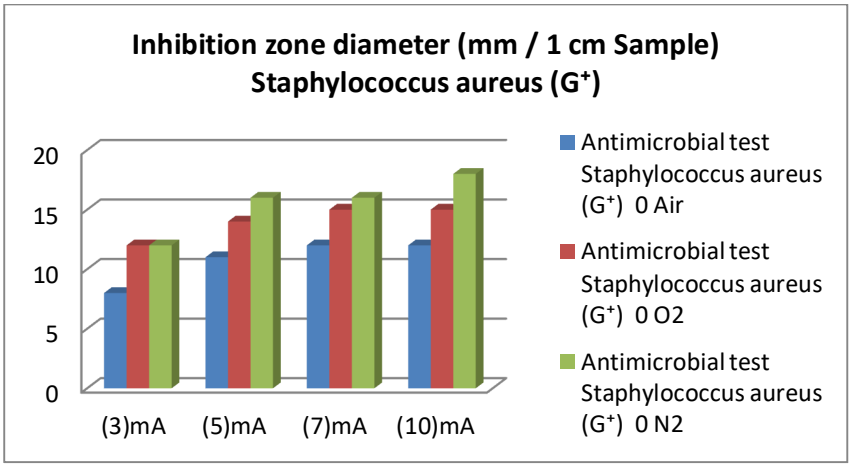


Fig. 15: Antimicrobial test Staphylococcus aureus (G+)

As shown from the results for the untreated sample, it doesn't have any influence on the antimicrobial effectiveness, however for the treated Samples, It's obvious that the diameters of the inhibition zones determined in millimeters were ranging from 6 – 19 millimeters refers to the improvement in antimicrobial efficiency for the polyester women head scarf.

CONCLUSION

Treating polyester women head scarf with atmospheric pressure glow discharge plasma (APGD) has a significant effect on performance and functional properties.N2 treatment at low current, 3mA with 5min duration, showed a better resultant data, for polyester women head scarf. Plasma treatment caused formation of some new functional groups like, OH, COOH, CO, NH2 these additional groups were detected by Infrared analysis. The UV blocking and anti microbial properties has successfully achieved after treatment. The plasma treated fabrics exhibited a significant enhancement in the hydrophilicily and water absorption irrespective of gas types used under the study.

REFERENCES

[1] Modification of Polyester and Polyamide Fabrics by Atmospheric Pressure Glow Discharge Plasma-Asmaa A Salem1 and Nasser , Polymers from Renewable Resources, Vol. 5, No. 3, June 2014

[2] https://www.plasmatreat.com/plasma-treatment/plasma-pretreatment.html
Scarf Materials: A Guide to Scarf Fabrics. August 24, 2010.
https://www.scarves.net/blog/scarf-materials-a-guide-to-scarves-fabrics.

[3] Plasma Modification of Technical Textiles, April 14, 2016 , Martin McCoustra and Robert Mather, Heriot-Watt University and Power Textiles Ltd.

[4] Improvement on Hydrophobicity of Synthetic Textiles by Plasma Treatment Research Journal of Textile and Apparel– A Review C.H. Kwong, S.P. Ng, C.W. Kan.2016

[5] Modification of polyester fabric via plasma treatment, Reem Mohammed Attia, PhD faculty of applied arts, 2016.
[6] Bahira G. Gabr1 and Nasser N.Morgan, International Journal of Scientific Research Engineering & Technology (IJSRET), ISSN 2278 – 0882 Volume 5, Issue 2, February 2016
[7] Surface Modification of Polyester Fabric by Non- Thermal Plasma Treatment and its Effect on Coloration Using Natural Dye
https://www.researchgate.net/publication/265421881_Surface_Modification_of_Polyester_Fabric_by_Non - [accessed Jul 08 2018].
[8] C.H. Kwong, S.P. Ng and C.W. Kan, Improvement on Hydrophobicity of Synthetic Textiles by Plasma Treatment, Research Journal of Textile and Apparel, 2018.

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"*In vitro* propagation of the rare *Pulicaria incisa* DC. Plant"

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ABSTRACT

A high frequency and rapid *in vitro* propagation protocol has been established for the propagation of *Pulicaria incisa* (Lam.) DC. (Asteraceae). *P. incisa* is a very rare and multipurpose medicinal shrub native to Egypt. It is used medicinally by Egyptian Bedouins for the treatment of heart diseases and several serious diseases. The infusion of the plant was evaluated for using as a functional beverage for inhibition and treatment of brain injuries and neurodegenerative diseases. This plant is severely affected by uncontrolled overcutting and overgrazing due to its high palatability for animals. In the present study, shoot tips and stem nodal segments of *P. incisa* were taken as a source of explants. The highest percentage of survival was obtained in winter. Explants were cultured on Murashige and Skoog (MS) media supplemented with different concentrations of N^6 – (2 – isopentenyl) adenine (2iP) individually or in combination with β – naphthalene acetic acid (NAA) for the establishment and multiplication stage. MS medium supplemented with 0.25 mg l^{-1} 2iP was found to be the best treatment for growth induction of both explants. The regenerated shoots were successfully subcultured for six subculture passages with four weeks intervals. Various auxin concentrations [(NAA and indole – 3 – butyric acid (IBA)] were used for root induction. Half strength MS medium supplemented with 2 mg l^{-1} IBA was the best rooting medium. Rooted shoots of *P. incisa* were transferred to the greenhouse and showed about 70% survival. The represented *in vitro* propagation protocol for *P. incisa* offers a chance for germplasm conservation and mass production of this valuable medicinal plant.

KEYWORDS: Shaay gabali, wild tea, aromatic, tissue culture, micropropagation, conservation.

INTRODUCTION

Medicinal plants are widely distributed in many parts all over the world and useful in the treatment of many diseases and health improvement over the past hundreds of years. They are playing an important role in traditional medicine and pharmacological industries (Dakah *et al*., 2014).

Family Asteraceae, previously known as Compositae, is one of the biggest families of the flowering plants, containing approximately 1530 genus and about 23000 species. This family compresses about 10% of the world flora. Plants of family Asteraceae have been widely reported for their biological activity due to their huge chemical constituents (Chaib *et al*., 2017).

Genus *Pulicaria* contains about 80 species, distributed in North Africa, Asia and Europe. Many essential oils with useful pharmacological activities were isolated from various *Pulicaria* species (Shahat *et al*., 2017). In Iran, *Pulicaria* genus is commonly used as a medicinal plant, herbal tea and flavoring agent (Chaib *et al*., 2017).

Pulicaria incisa (Lam.) DC. sub species *incisa* is a very rare desert plant; growing in Egypt (Boulos, 2009). It is known in Arabic as "Shaay gabali" and in English as "wild tea". *P. incisa* plant has an excellent aromatic smell and reported for its essential oil. The plant infusion is consumed as a substitute of tea**.** It has been collected by Egyptian Bedouins for the treatment of heart diseases and several serious diseases in traditional medicine (Ewais *et al*., 2014).

P. incisa contains tannins, flavonoids, linoleic, oleic and palmitic acids. So, it was used in Sudan as an ingredient for manufacturing a local perfume (Abd El-Gleel and Hassanien, 2012). Biological studies on the plant revealed its antispasmodic, antimicrobial, antitumor and antioxidant activities. It contains high amounts of unsaturated fatty acids, which used in decreasing total cholesterol, total lipid and triglyceride levels. So, it has been proposed as a potential hypocholestremic agent (Elmann *et al*., 2013). The infusion of the plant was evaluated for using in the prevention of neurodegenerative diseases and for treatment of brain injuries (Elmann *et al*., 2012).

The natural propagation of *P. incisa* plant in Egyptian deserts are facing many stresses as a result of the severe environmental conditions, rainless and overexploitation of the plant resources

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(uncontrolled overcutting and overgrazing) due to its high palatability for animals which led to the rare production of the plant seeds (Shaltout *et al*., 2010).

Tissue culture is an effective technique used for *in vitro* propagation of plants, which are difficult to propagate naturally, production of disease free plants, somatic hybridization, improve the genetic make-up of commercial plants and production of haploid plants. Also, it is played a vital role in secondary metabolites production, napthoquinones, pigments, shikonin, sweeteners, flavors, natural colorants and pharmaceuticals. Moreover, plant tissue culture is used in research for biochemists, geneticists, plant breeders, plant pathologists and other researchers (Gaurav *et al*., 2018).

Hence, this study is aimed to establish an efficient plant propagation protocol through direct organogenesis from shoot tips and stem nodal segments of *P. incisa*. To the best of our knowledge, this is the first report on the micropropagation of the wild *P. incisa* plant.

MATERIALS AND METHODS

This research was carried out in the Plant Tissue Culture Unit in the Department of Plant Genetic Resources, Desert Research Center.

1. Plant material and sterilization

Plant specimens were collected from wild plants of *P. incisa* (Figure 2a) grown in Saint Catherine Protectorate, South Sinai, Egypt and identified by Dr. Ibrahim Abdelrafee Elgamal, Nature Conservation Sector, Egyptian Environmental Affairs Agency, South Sinai, Egypt. Shoot tips and stem nodal segments were used as explants. The Explants were washed under running tap water for 30 min. Shoot tips were sterilized by soaking in 1% sodium hypochlorite solution for 25 min., whereas stem nodal segments were sterilized by soaking in 2% sodium hypochlorite solution for 30 min. Some drops of Tween 20 (w/v) were added to both explants during sterilization. Finally, all explants were washed five times with sterilized distilled water. Explants were implanted vertically on a sterilized nutrient medium.

2. Culture medium and conditions

Shoot tip and stem nodal segment explants, about 3 cm long, were cultured on Murashige and Skoog (MS) medium (Murashige and Skoog, 1962) supplemented with 3% sucrose, 100 mg l^{-1}myo-inositol and gelled with 3 g l^{-1}phytagel. Different plant growth regulators (PGRs); auxins [β – naphthalene acetic acid (NAA) and indole – 3 – butyric acid (IBA)] and cytokinin [N^6 – (2 – isopentenyl) adenine (2iP)], at different concentrations, were added individually or in combination to the medium to evaluate the effect of PGRs on shoot establishment, multiplication and rooting. PGRs free MS medium was used as control. The pH of the medium was adjusted to 5.7 – 5.8 before autoclaving at 121°C under a pressure of 1.1 $kgcm^{-2}$ for 15 min. All cultures were incubated in a culture room at a temperature of 26 ± 2°C with a 16 h photoperiod under cool white fluorescent tubes of 2 k lux light intensity.

3. Effect of season on survival and browning

Plant specimens of *P. incisa* were collected in autumn, winter and spring and cultured on PGRs free MS medium for four weeks to determine the best season of plant collection for micropropagation. The survival and browning percentages were recorded for shoot tips and stem nodal segments.

4. Establishment stage

For the establishment of *P. incisa*, shoot tips and stem nodal segments were cultured on MS medium supplemented with 2iP individually at concentrations of 0.1, 0.25 and 0.5 mg l^{-1} or in combination with 0.1 mg l^{-1} NAA. PGRs free MS medium was used as control. Growth induction percentage (%), the mean number of shoots/explant, mean length of shoots (cm) and callusing percentage (%) were recorded after four weeks of culturing.

5. Multiplication stage

The established shoots were subcultured every four weeks onto the best medium of the establishment stage (MS medium supplemented with 0.25 mg l^{-1} 2iP). The mean number and length of shoots were recorded at each passage of subculturing onto the fresh growth medium up to the 8^{th} subculture.

6. Root induction

Multiplied shoots were transferred to half strength MS medium supplemented with different concentrations (0.25, 0.5, 1.0 and 2.0) of auxins (IBA and NAA), added individually for *in vitro* root

induction. Half strength MS medium without PGRs was used as control. The percentage of rooted shoots (rooting %), mean number of roots/shoot and mean root length (cm) were recorded after six weeks.

7. Acclimatization

Rooted shoots were removed from the culture medium and washed in sterilized distilled water. Then they were transferred to plastic pots containing a sterilized mixture of sand and soil (1:1 v/v), covered with a plastic cap in the greenhouse. The plantlets were irrigated regularly. The plastic caps were gradually opened within four weeks to complete acclimatization of the plants.

8. Experimental design and statistical analysis of data

All experiments were carried out by a completely randomized design. Experiments were repeated twice and the treatments had at least 15 replicates. For statistical analysis, analysis of variance of the data was carried out using ANOVA program. The differences among means for all treatments were tested for significance at 5% level using Duncan's multiple range test (Duncan, 1955). Means followed by the same letter are not significantly different at $P \leq 0.05$.

RESULTS AND DISCUSSION

1. Effect of season on survival and browning in *P. incisa* plant

Browning is mainly a result of the release of phenolics from the cutting ends of the explants. It is a natural defense mechanism in plants in response to pathogen invasion that shows the phytotoxic effect. The produced oxidized compounds may not only negatively affect the explant development, but also may cause its death (Das and Rahman, 2016).

In the present study, shoot tip and stem nodal segment explants of *P. incisa* were collected during three different seasons (autumn, winter and spring).

It is clear from Table 1 that the two explants gave different responses according to the season of collection. Spring gave significantly the lowest survival percentage and the highest percentage of browning for both types of explants. While winter gave the highest values of survival percentage for both types of cultured explants. The highest percentage of survival was 62.8 and 77.4% for shoot tips and stem nodal segments collected in winter, respectively. Martini and Papafotiou (2013) observed during the *in vitro* propagation of the rare wild *Malosorbus florentina* that the browning of the explants was the highest in March and April and declined after June. While in winter, the release of phenolics was completely not observed. The browning of the explants was affected by the season of collection for many plants, such as in apple shoot tips (Wang *et al*., 1994; Modgil *et al*., 1999 and Dobranszki *et al*., 2000).

Also, it is observed from data in Table 1 that the survival percentage was higher for stem nodal segments, compared to shoot tips during all tested seasons. While, browning percentage during different seasons were higher in shoot tips than stem nodal segments. Similar to this observation, shoot tip explants of 'Koroneiki' olive trees and *Malosorbus florentina* exhibited higher browning rates and total phenol and polyphenol oxidase activity compared with nodal explants (Martini and Papafotiou, 2013).

It can be concluded that the best time to collect the plant specimens of *P. incisa* for *in vitro* culture was during winter to obtain the optimum percentage of survival.

Table 1. Effect of seasonal variations on the survival and browning of *Pulicaria incisa* cultured *in vitro* on MS medium after four weeks.

Season	Months of collection	Explant type			
		Shoot tip		Stem nodal segment	
		Survival (%)	Browning (%)	Survival (%)	Browning (%)
Autumn	October-November	35.0^{b}	65.0^{b}	49.6^{b}	50.4^{b}
Winter	January-February	62.8^{a}	37.2^{c}	77.4^{a}	22.6^{c}
Spring	March-April	20.7^{c}	79.3^{a}	34.6^{c}	65.4^{a}

2. Establishment and multiplication

MS medium supplemented with various concentrations of 2iP (0.1, 0.25 and 0.5 mg l^{-1}) individually or in combination with 0.1 mg l^{-1} NAA were used for the establishment of *P. incisa* shoot tip and stem nodal segment explants.

Data in Table 2 reveal that MS medium supplemented with 0.25 mg l^{-1} 2iP was the best medium for the establishment of *P. incisa* shoot tips (Figure 2b). It gave the highest percentage of growth induction (83.4%), the highest value of the mean number of shoots (10 shoots/explant) and the highest mean length of shoots/explant (5.4 cm). The percentage of growth induction was maximum and insignificantly different in three media; PGRs free MS medium and media supplemented with 0.1

or 0.25 mg l^{-1} 2iP. Minimum percentage of callusing formed at the cut surfaces of the cultured explants was obtained in the same three media. Excluding the control MS medium, the medium supplemented with 0.5 mg l^{-1} 2iP or 0.1 NAA plus different concentrations of 2iP gave the lowest number of shoots/explant and the maximum amount of callus formed at the cut surfaces of explants (Table 2).

Table 2. Effect of PGRs (2iP and NAA) in MS medium on the establishment of *Pulicaria incisa* shoot tips cultured *in vitro* after four weeks.

Growth regulators conc. (mg l^{-1})		Growth induction (%)	Mean number of shoots/ explant	Mean shoot length (cm)	Callusing (%)
2iP	NAA				
0.00	**0.0**	82.0^{a}	2.7^{e}	4.0^{b}	23.0^{f}
0.10	**0.0**	83.0^{a}	8.5^{b}	4.6^{ab}	29.5^{e}
0.25	**0.0**	83.4^{a}	10.0^{a}	5.4^{a}	30.0^{e}
0.50	**0.0**	60.4^{b}	7.2^{bc}	4.5^{ab}	43.0^{d}
0.10	**0.1**	59.1^{b}	6.7^{cd}	4.3^{ab}	73.0^{c}
0.25	**0.1**	59.1^{b}	4.0^{de}	3.1^{c}	81.4^{b}
0.50	**0.1**	58.3^{b}	2.0^{e}	2.9^{c}	92.3^{a}

Table 3 clears that media supplemented with 2iP individually at any concentration gave the highest growth induction percentages and they were insignificantly different. As in shoot tip explants; MS medium supplemented with 0.25 mg l^{-1} 2iP individually was the best medium for the establishment of *P. incisa* stem nodal segment (Figure 2c). This medium gave 89.5% of growth induction, 7.3 shoots/explant and 5.3 cm mean length of shoot (Table 3). Increasing the concentration of 2iP (individually), increased the mean shoot number and length until reaching the concentration of 0.25 mg l^{-1} then they decreased at 0.5 mg l^{-1}. The same observation was noticed for the number of shoots in the presence of NAA in the culture medium.

The second best medium was MS medium supplemented with 0.1 mg l^{-1} 2iP which gave 88.0% of growth induction, 6.0 shoots/explant and 5.0 cm mean length of shoot.

Also, by increasing the 2iP concentration either individually or in the presence of NAA, the amount of undesirable callus formed at the explants cut surface was increased.

Table 3. Effect of PGRs (2iP and NAA) in MS medium on shoot establishment of *Pulicaria incisa* stem nodal segments cultured *in vitro* after four weeks.

Growth regulators conc. (mg l^{-1})		Growth induction (%)	Mean number of shoots/ explant	Mean shoot length (cm)	Callusing (%)
2iP	NAA				
0.00	**0.0**	88.5^{a}	4.3^{bc}	3.9^{b}	10.4^{g}
0.10	**0.0**	88.0^{a}	6.0^{ab}	5.0^{a}	20.0^{f}
0.25	**0.0**	89.5^{a}	7.3^{a}	5.3^{a}	32.0^{e}
0.50	**0.0**	89.0^{a}	3.3^{c}	3.6^{bc}	52.1^{d}
0.10	**0.1**	77.0^{b}	3.0^{c}	3.5^{bc}	66.3^{c}
0.25	**0.1**	75.0^{b}	2.7^{c}	3.0^{d}	76.6^{b}
0.50	**0.1**	73.6^{b}	2.0^{c}	3.3^{cd}	85.3^{a}

From Tables 2 and 3, it can be concluded that for the establishment of *P. incisa* plant using shoot tips or stem nodal segments; MS medium supplemented with 0.25 mg l^{-1} 2iP was the optimum treatment with low callusing percentage. The formation of callus may be a result of high endogenous hormonal levels in the plant. Therefore, the establishment of *P. incisa* needs only low concentrations of 2iP without adding auxin, even at low concentrations.

The same results were presented by Jin *et al*. (2014), who obtained a high number and length of shoots per explant on MS medium containing low concentrations of cytokinin (0.1–0.2 mg l^{-1} BA) during the direct regeneration of the medicinal plant *Pogostemon cablin*. They found that adding auxin (NAA) even at low concentrations resulted in slower shoot development and growth with the formation of callus at the cut surfaces as compared to cytokinin alone.

Similarly, Rout *et al*. (2008) observed that the addition of auxin into the cytokinin containing medium decreased not only shoot multiplication but also led to the production of compact callus at the cut surfaces of the *Acacia chundra* explants.

Also, similar observations were found in *Pterocarpus santalinus* (Lakshmi *et al*., 1992), *Acacia auriculiformis* (Mittal *et al*., 1989) and *Acacia mangium* (Nanda *et al*., 2004).

For further multiplication, the established shoots of *P. incisa* were transferred to the best medium for the establishment of both shoot tips and stem nodal segments (MS medium supplemented with 0.25 mg l^{-1} 2iP). Multiplication of *P. incisa* yielded a large number of shoots (Figure 2d) through eight subculture passages at four weeks interval. The survival percentage gave 100% during all subculture passages. The number of shoots increased after each subculture and showed no sign of

decline until the 6th subculture passage. After that; the number of multiple shoots began to decrease with increasing subcultures. In the 6th subculture, the highest mean number of shoots reached 13.6 (Figure 1). In this concept; Lodha *et al*. (2015) successfully multiplied the endangered medicinal shrub, *Cadaba fruticosa* by culturing the established shoots in the same medium used in the establishment stage.

Re-culturing the established shoots to a fresh medium is a successful way to produce new shoots in a short time by renewing the juvenility of dormant meristematic cells (Sanchez *et al*., 1997). This practice was successfully employed in a number of arid plant species (Rathore *et al*., 2005; Lodha *et al*., 2014 and Patel *et al*., 2014).

Yadav and Singh (2012) reported that the rate of shoot multiplication of the medicinal plant *Glycyrrhiza glabra* depended on the number of subcultures and the average number of shoots per explant increased with each successive subculture cycle. A similar observation was also documented in *Aegle marmelos* and *Rauvolfia serpentina* (Ajithkumar and Seeni, 1998 and Alatar, 2015).

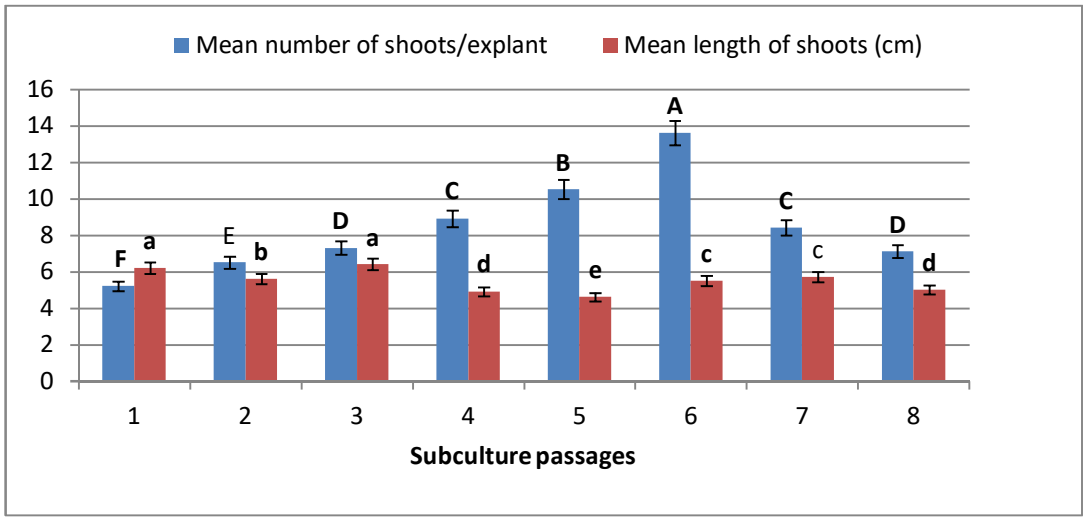

Figure 1. Effect of subculture passages on the mean number and length of the multiplied shoots of *Pulicaria incisa* on MS medium supplemented with 0.25 mg l^{-1} 2iP for four weeks.

3. Rooting and acclimatization

There are evidences that the endogenous and exogenous auxins trigger rooting in the plants during a sexual propagation (Siddiqui and Hussain, 2007; Kumar *et al*., 2009 and Babu *et al*., 2018). Different synthetic auxins like NAA and IBA are commonly used to promote root development in *in vitro* propagation. Auxin triggers the hydrolysis of the starch and the mobilization of nutrients and sugars at the base ends of the cuttings during the regeneration of adventitious roots (Babu *et al*., 2018).

Data in Table 4 reveal that addition of different concentrations of IBA or NAA to half strength MS medium led to the increase in the rooting percentage than the control medium (1/2 MS medium without PGRs). The increase in the concentration of both tested auxins increased the rooting percentage and mean number and mean length of roots. IBA was more effective in root induction than NAA. Maximum rooting percentage (80.2%), maximum mean number of roots (26.8 roots/explant) and the highest mean length of roots (14.9 cm) were achieved when explants were cultured on MS medium supplemented with 2 mg l^{-1} IBA (Figure 2e). Sixty nine percent of rooting was obtained when explants were cultured on MS medium supplemented with 1 mg l^{-1} IBA, which considered the second best medium. Also, it gave the next best number of roots (18.5 roots/explant) and the next highest length of root (13.6 cm).

The superiority of IBA in promoting root development is supported by Kumar *et al*. (2018), who developed ninety percent rooting of *Vitex negundo* (an important medicinal plant), on half strength MS medium supplemented with 0.75 mg l^{-1} IBA. Also, Reshi *et al*. (2017) found that shoots of *Anisochilus carnosus* rooted on MS medium supplemented with 2 mg l^{-1} IBA.

Rooted shoots of *P. incisa* were transferred to the greenhouse (Figure 2f). About 70% of the acclimatized plantlets were survived after four weeks of transferring into a mixture of sand: soil (1: 1 v/v). All of the transplants showed normal development.

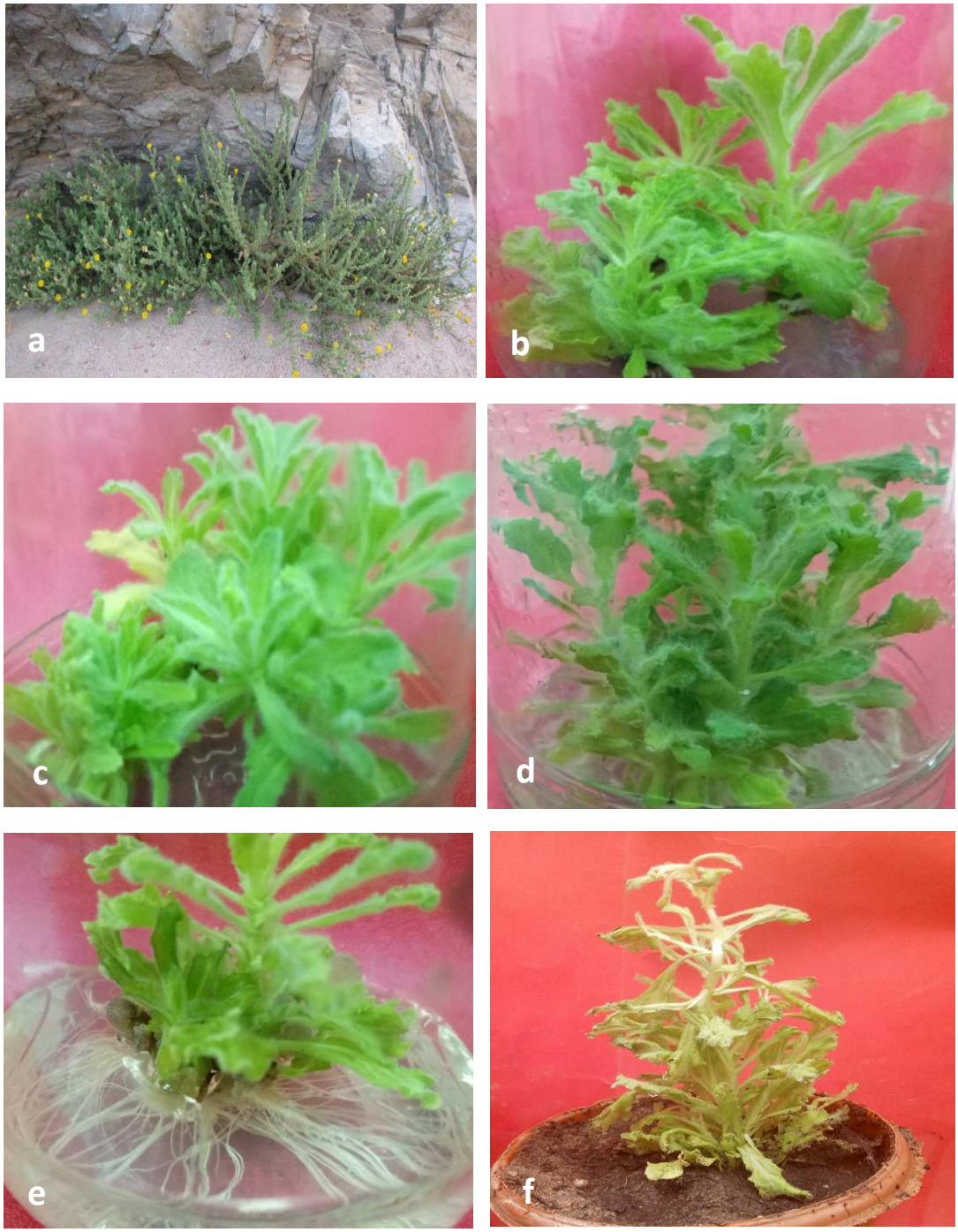

Figure 2. Micropropagation of *Pulicaria incisa*; a. *P. incisa* grown in Saint Catherine, Sinai; b. Shoot tip establishment; c. Stem nodal segment establishment; d. Multiplied shoots after six passages of subculturing; e. *In vitro* rooting; f. *In vitro* derived plantlet after four weeks of acclimatization.

Table 4. Effect of 1/2 MS medium supplemented with different concentrations of IBA or NAA on the rooting of *Pulicaria incisa* shoots after six weeks.

Growth regulators conc. (mgl^{-1})		Rooting (%)	Mean number of roots/shoot	Mean root length (cm)
IBA	NAA			
0.00	**0.00**	10.3^{e}	3.9^{cd}	7.5^{c}
0.25	**0.00**	45.0^{c}	8.3^{cd}	11.6^{b}
0.50	**0.00**	53.3^{c}	11.3^{c}	13.1^{ab}
1.00	**0.00**	69.0^{b}	18.5^{b}	13.6^{ab}
2.00	**0.00**	80.2^{a}	26.8^{a}	14.9^{a}
0.00	**0.25**	21.7^{d}	1.3^{d}	1.6^{e}
0.00	**0.50**	26.7^{d}	1.8^{d}	2.8^{e}
0.00	**1.00**	36.7^{cd}	3.0^{cd}	3.0^{e}
0.00	**2.00**	40.0^{cd}	9.0^{cd}	5.25^{d}

In conclusion, an *in vitro* propagation protocol discussed here can be applied for large-scale production of *P. incisa* plants using shoot tip and stem nodal segment explants. Winter season is the most suitable for the specimens collection. MS medium supplemented with 0.25 mg l^{-1} 2iP is optimum for the establishment and multiplication of this plant. Half strength MS basal medium supplemented with 2 mg l^{-1} IBA is the best for root induction.

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REFERENCES

Abd El-Gleel, W. and Hassanien, M.F.R. (2012). Antioxidant properties and lipid profile of *Diplotaxis harra*, *Pulicaria incisa* and *Avicennia marina.* Acta Aliment., 41(2): 143–151.

Ajithkumar, D. and Seeni, S. (1998). Rapid clonal multiplication through *in vitro* axillary shoot proliferation of *Aegle marmelos* (L.) Corr., a medicinal tree. Plant Cell Rep., 17: 422–426.

Alatar, A.A. (2015). Thidiazuron induced efficient *in vitro* multiplication and *ex vitro* conservation of *Rauvolfia serpentina* – a potent anti-hypertensive drug producing plant. Biotechnol. Biotechnol. Equip., 29(3): 489–497.

Babu, B.H., Larkin, A. and Kumar, H. (2018). Effect of plant growth regulators on rooting behavior of stem cuttings of *Terminalia chebula* (Retz.). Int. J. Curr. Microbiol. App. Sci., 7(8): 2475–2482.

Boulos, L. (2009). Flora of Egypt Cheklist: Alhadara Publishing, Egypt.

Chaib, F., Allali, H., Bennaceur, M. and Flaminic, G. (2017). Chemical composition and antimicrobial activity of essential oils from the aerial parts of *Asteriscus graveolens* (FORSSK.)LESS. and *Pulicaria incisa* (LAM.) DC.: Two Asteraceae herbs growing wild in the Hoggar. Chem. Biodiversity, 14, e1700092.

Dakah, A., Zaid, S., Suleiman, M., Abbas, S. and Wink, M. (2014). *In vitro* propagation of the medicinal plant *Ziziphora tenuior* L. and evaluation of its antioxidant activity. Saudi. J. Biol. Sci., 21: 317–323.

Das, D.K. and Rahman, A. (2016). Phenolic compositions of Litchi shoot tips and zygotic embryos collected in different months and their effects on the explant browning and its control. Advances in Anthropology, 6: 73–92.

Dobranszki, J., Abdul-Kader, A., Magyar-Tabori, K., Jambor-Benczur, E., Buban, T., Szalai, J. and Lazanyi, J. (2000). *In vitro* shoot multiplication of apple: Comparative response of three rootstocks to cytokinins and auxin. Int. J. Hort. Sci., 6: 76–78.

Duncan, B.D. (1955). Multiple range and multiple F tests. Biometrics, 11: 1–42.

Elmann, A., Telerman, A., Mordechay, S., Erlank, H. and Ofir, R. (2012). Antioxidant and astroprotective effects of a *Pulicaria incisa* infusion. Oxid. Med. Cell. Longev., Article ID 157598.

Elmann, A., Telerman, A., Erlank, H., Mordechay, S., Rindner, M., Ofir, R. and Kashman, Y. (2013). Protective and antioxidant effects of a chalconoid from *Pulicaria incisa* on brain astrocytes. Oxid. Med. Cell. Longev., Article ID 694398.

Ewais, E.A., Abd El-Maboud, M.M. and Haggag, M.I. (2014). Studies on chemical constituents and biological activity of *Pulicaria incisa* subsp. Incisa (Asteraceae). Report and Opinion, 6(9): 27–33.

Gaurav, N., Komal, Juyal, P., Tyagi, M., Chauhan, N. and Kumar, A. (2018). A review on *in vitro* propagation of medicinal plants. J. Pharmacogn. Phytochem., 7(6): 2228–2231.

Jin, H., Deng, C.Z. and He, H. (2014). Effect of explant types and plant growth regulators on direct regeneration in medicinal plant *Pogostemon cablin*. Plant Omics Journal, 7(5): 322-327.

Kumar, A.B.S., Lakshman, K., Jayaveera, K.N., Vamshi Krishna, N., Manjunath, M., Suresh, M.V., Shivatej, Reddy, H. and Naik, S. (2009). Estimation of rutin and quercetin in *Terminalia chebula* by HPLC. Asian J. Research. Chem., 2(4): 388–389.

Kumar, A., Fayaz da M., Bhat, M.H. and Jain, A.K. (2018). An efficient protocol for *in vitro* regeneration of *Vitex negundo* an important medicinal plant. Biosci. Biotech. Res. Comm., 11(2): 256-262.

Lakshmi, S.G., Sreenatha, K.S. and Sujata, S. (1992). Plantlet production from shoot tip cultures of red sandalwood (*Pterocarpus santalinus* L.). Curr. Sci., 62: 532–535.

Lodha, D., Rathore, N., Kataria, V. and Shekhawat, N.S. (2014). *In vitro* propagation of female *Ephedra foliate* Boiss. & Kotschy ex Boiss.: an endemic and threatened Gymnosperm of the Thar Desert. Physiol. Mol. Biol. Plant, 20: 375–383.

Lodha, D., Patel, A.K. and Shekhawat, N.S. (2015). A high frequency *in vitro* multiplication, micromorphological studies and *ex vitro* rooting of *Cadaba fruticosa* (L.) Druce (Bahuguni): a multipurpose endangered medicinal shrub. Physiol. Mol. Biol. Plants, 21(3): 407–415.

Martini, A.N. and Papafotiou, M. (2013). Season and explant origin affect phenolic content, browning of explants and micropropagation of ×*Malosorbs florentina* (Zucc) Browicz. Hortscience, 48(1): 102–107.

Mittal, A., Agarwal, R. and Gupta, S.C. (1989). *In vitro* development of plantlets from axillary buds of *Acacia auriculiformis*– a leguminous tree. Plant Cell, Tissue Organ Cult., 19: 65–70.

Modgil, M., Sharma, D.R. and Bhardwaj, S.V. (1999). Micropropagation of apple cv. Tydeman Early Worcester. Sci. Hort., 81: 179–188.

Murashige, T. and Skoog, F. (1962). A revised medium for rapid growth and bioassays with tobacco tissue culture. Physiol. Plant., 15: 473– 479.

Nanda, R.M., Das, P. and Rout, G.R. (2004). *In vitro* clonal propagation of *Acacia mangium* Willd. and its evaluation of genetic stability through RAPD marker. Ann. For. Sci., 61: 381–386.

Patel, A.K., Phulwaria, M., Rai, M.K., Gupta, A.K., Shekhawat, S. and Shekhawat, N.S. (2014). *In vitro* propagation and *ex vitro* rooting of *Caralluma edulis* (Edgew.) Benth. & Hook. f.: an endemic and endangered edible plant species of the Thar Desert. Sci. Hortic., 165: 175–180.

Rathore, J.S., Rathore, M.S. and Shekhawat, N.S. (2005). Micropropagation of *Maerua oblongifolia* - a liana of arid areas. Phytomorphology, 55: 241–247.

Reshi, N.A., Sudarshana, M.S. and Girish, H.V. (2017). *In vitro* Micropropagation of *Anisochiluscarnosus* (L.)Wall. Journal of J Appl. Pharm. Sci., 7 (7): 98–102.

Rout, G.R., Senapati, S.K. and Aparajeta, S. (2008). Micropropagation of *Acacia chundra* (Roxb.) DC. Hort. Sci., 35(1): 22–26.

Sanchez, M.C., San-Jose, M.C., Ferro, E., Ballester, A. and Vieitez, A.M. (1997). Improving micropropagation conditions for adult-phase shoots of chestnut. J. Hortic. Sci., 72: 433–443.

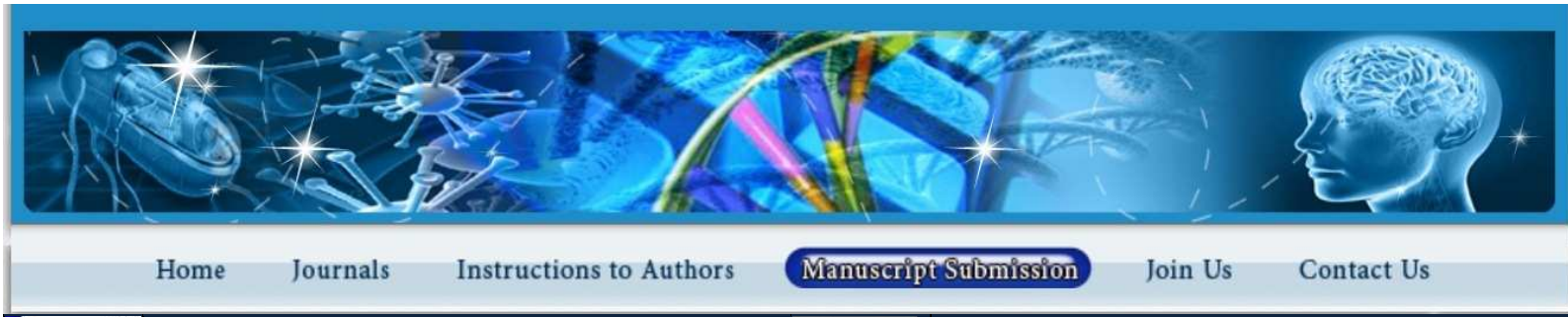
Shahat, E.A., Bakr, R.O, Eldahshan, O.A. and Ayoub, N.A. (2017). Chemical composition and biological activities of the essential oil from leaves and flowers of *Pulicaria incisa* sub. *candolleana* (Family Asteraceae). Chem. Biodiversity, 14, e1600156.

Shaltout, K.H., Sheded, M.G. and Salem, A.I. (2010). Vegetation spatial heterogeneity in a hyper arid biosphere reserve area in North Africa. Acta Bot. Croat., 69(1): 31– 46.

Siddiqui, M.I. and Hussain, S.A. (2007). Effect of indole butyric acid and types of cuttings on root initiation of *Ficus hawaii*. Sarhad J. Agric., 23(4): 919–925.

Wang, Q.C., Tang, H.R. Quan, Y. and Zhou, G.G. (1994). Phenol induced browning and establishment of shoot-tip explants of 'Fuji' apple and 'Jinhua' pear cultured *in vitro*. J. Hort. Sci., 69: 833–839.

Yadav, K. and Singh, N. (2012). Factors influencing *in vitro* plant regeneration of Liquorice (*Glycyrrhiza glabra* L.). Iran. J. Biotechnol., 10(3): 161–167.

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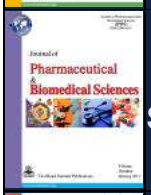
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