

Research paper

Grapevine Research in Ethiopia: Achievements, Challenges, Opportunities and Future Prospects

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Grape and wine were known with the introduction of Christianity and used as “sacred” in the Ethiopian Orthodox Church. Vineyards were established by Italian troops who occupied part of the country and then distributed throughout the country. Awash Winery was established in 1956 and then grape cultivation was realized with establishment of state owned vineyards. Ethiopia has a tradition of wine making back to reign of the Queen of Sheba. The local wine called tedj, fermented beverages of honey and gesho leaves. Grapevine research started since 1980s at Debre Zeit Agricultural Research Center and developed grapevine technologies in the areas of variety development, vineyard management, crop protection and propagation techniques. Grapevine research programme has developed thirteen grapevine varieties and also maintained 130 grapevine germplasms. There are different small and large viticulture companies for wine and table grape but only two wineries produced their own high-quality wine. Even though, Ethiopians wine drinking habits is infrequent and drink mixed one, there is an increasing of wine demand. Grapevine industry is at infant stage, this is due to less attention for Research and development, lack of technologies and unfamiliarity with grape cultivation in the country. Ethiopia has unique and suitable agro-climatic condition for grapevine production and possibility of harvesting twice a year. Grapevine research and development should get emphasis to develop and/or adopt new technologies to full fill market niches, maximize production and productivity of grapevine.

Keywords: local wine making, tedj, grapevine, wine

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INTRODUCTION

Grape (*Vitis vinifera* L.) is one of the most important, demandable and remunerative fruit crops (Saniya, 2017, Amit *et al.*, 2013,). It has the earliest recorded history (Mukhtar *et al.*, 2011). It is one of the most widely grown fruit trees in the world, exploited for the production of fresh/table or juice, resin but the major use of grapes is in wine industry (Guo *et al.*, 2017, O.I.V., 2009). Grape is gaining popularity for its high nutritive value, excellent in

taste, multipurpose use and better economic returns (Kamiloglu, 2011). Even though, it is origin in temperate regions, it perform equally well in a tropical climate (Mahmoud *et al.*, 2015). In Ethiopia, it has cultivated in temperate, sub-tropical and tropical regions.

Viticulture is one of the major horticultural industries in the world (Saniya, 2017). The *Vitis vinifera* is the common species for wine production involving number of varieties adapted to different agro-climatic conditions (Veena *et al.*, 2015). The wine industry is experiencing

increase in consumption of wine globally, emergence of new grape growing and wine making regions in the world, the prevalence of affordable and quality wines, and correlation between moderate red wine consumption and health benefits (Veena et al., 2015).

Grapevine History in Ethiopia

Grape and wine were known in Ethiopia around the first century A.D. when they imported through the Red Sea Port of Adulis (Ethiopian Embassy, 2017). The use of raisin grape dates back to the introduction of Christianity and used as "sacred" in the Ethiopian Orthodox Church. However, grapevine introduction into Ethiopia is not well documented (Asfwa, *et al.*, 2013). Vineyards established near Addis Ababa and in the south-east by Italian troops who occupied part of the country from 1936 to 1941 and then later distributed nationally producing serious wine (Marie, 2016). The production of grapes for wine making had been established following the Italian invasion on small sized vineyards primarily by foreigners (Italians, Greeks and Armenians) and few Ethiopians in the mid-altitude areas (Ellen, Dukom, Abadir) and high-altitude areas (Gudar, and Ellaberet in Eritrea) mainly to sell fresh fruits to consumers and to a smaller extent to the local wineries (Asfwa, *et al.*, 2013).

Viticulture started with established of Awash Winery in 1956 (Solomon, 2016). Grapevine cultivation was realized in the mid-1970s and state owned vineyards were established in the Rift Valley. Planting materials were introduced from California and Germany (Asfwa, *et al.*, 2013). The establishment of Horticultural Development Corporation, commercial cultivation of grapes gained momentum up until the downfall of the Derge Regime. After the revolution, some of the vineyards have been abandoned /destroyed. The government maintained only a small vineyard at Kilinto 10 km from Ambo Town and 3 hectares at Guder. The small sizes (few hectares) that were scattered in different locations, which could not be placed as part of the state owned vineyards (Asfwa, *et al.*, 2013).

Wine industry in Ethiopia

Ethiopia is known for its rich cultural heritage and mystical legends. But very few know about wine making (Ethiopian Embassy, 2015). The traditional wine making that stretches to the reign of the Queen of Sheba (Marie-Luce, 2016). Ethiopia has local wine called tedj, fermented beverages of honey and gesho leaves. Tedj is the most popular alcoholic beverage (Marie-Luce, 2016). The ancient wine-making tradition is now coexisting with a modern form of wine-making (Ethiopian Embassy, 2015 and 2017).

The wine distillation from fruit started southeastern Europe in Georgia. In Africa, Egypt is the first where it spread to Ethiopia (Ethiopia Grapes, 2019). The history of wine making in Ethiopia is as old as the history of the nation. The Axumite wine was found in one of King Ezana's early 4th century inscriptions. Axumite wine represented in the carvings on the base of the great standing obelisk at Axum (Solomon, 2106). The first modern winery started with establishment of Awash winery (Ethiopian Embassy, 2017). Currently, Ethiopia has grown its own grape and producing its own standardized high-quality wines (Marie-Luce, 2016). There are different grapevine producers in the Ethiopian such as Awash Winery PLC, Castel, winery PLC, Prime Meat and Food Processing PLC, Bulala PLC and Tona PLC. Among them, Castel and Awash are modern wine producers in Ethiopia.

Awash Winery is the longest established and has existed for 70 years in Ethiopia. The vineyard established on a mountain plateau 1,200 meters above sea level in the Oromia Regional State, Arsi zone, Merti Jeju (Jean-Baptiste, 2014, Marie-Luce, 2016). It was privatized in 2013 and expanded its vineyard 517 ha and two winery plants in Mekanissa and Lideta. This enabled to boost the production capacity (Marie-Luce, 2016). The winery produces four classic wine, white wines Awash and Kemila, red wines Gudar and Axumite. Recently launched new premium range wine is called Gebeta (Jean-Baptiste, 2014, Marie-Luce, 2016). The application of new technology and use international wine experts have proven conducive to the effectiveness of the vineyard and winery plants. In addition, there is also skill and knowledge transfer to local experts. The winery also grows a variety of food crops such as maize and tef (a local staple) for its community of workers (Marie-Luce, 2016).

Castel winery was established in 2007 (Marie-Luce, 2016) and the government provided 300 hectares of land rent free (Global Feasibility Study, 2010). The company started its operation in 2008 with 120 ha vineyard with quality and adapted grapevine varieties in Ziway (1,600 masl) (Ethiopian Press Agency, 2019). The construction of winery plant was completed in 2012 and the first bottled Ethiopian Rift Valley wine produced in 2014 (Marie-Luce, 2016). Castel has two brands, Rift Valley and Acacia. The winery ranges seven different types of products, two white wines; Rift Valley Chardonnay and Acacia Medium Sweet White and five red wines; Acacia Dry Red, Rift Valley Cabernet Sauvignon, Acacia Medium Sweet Red, Rift Valley Merlot and Rift Valley Syrah (Marie-Luce, 2016). Castel has plans to increase the vineyard up to 400 hectares (Global Feasibility Study, 2010).

Others vineyards: there are different small grapevine producers PLC in Ethiopia. Bulala Dikit PLC was established Oromia Regional State, Arsi zone, Merti in 80 ha with five varieties. Prime Meat and Food Processing PLC was established in Oromia Regional State at Debre Zeit city in 0.23 ha of vineyard with four varieties. Tona PLC was established in Oromia Regional State in Nekemet with chenine blanch variety. These vineyard do not have their winery plant to produce wine and they sell their grape to supermarket and wineries.

Table grape industry

Table grape production have been established recently in Ethiopia. The cultivation has been started in the drier regions, Luna, Almeta and Blen in Koka, Elfora in Meki and Ethio Grape in Mekele. Three companies such as Luna, Almeta and Elfora have started production in 2006. Raya Horti Farm which produces grape and other horticultural crops in Raya. Two other PLC Ethio Grape and Blen Flower poised to enter table grape market. The USAID provides technical support and agronomists to table grape projects (<http://nazret.com>, 2018). National table grape production and productivity at infant stage and insignificant to satisfy the demand of local and global table grape market. This due to lack of improved technologies, the producers is not familiar with table grape production and lack of attention for Research and development in the country (DZARC Fruit progress report 2019).

Consumption and Demand of grape

The wine drinking habits of Ethiopians is infrequent and drink mixed into one. They mix a bottle of wine with a bottle of beer and a bottle of Sprite in a large jug. This known in Amharic as “ande be ande” (one to one). As world per capital wine consumption lists, Ethiopia uses below one liter per year (0.09 liters per individual). There is an increasing of wine demand inside Ethiopia (Marie-Luce, 2016, FAO, 2010) and local demand is complemented by imports from South Africa, Italy and France. Local wines gained popularity over imported wines may be due, in part, to cost. The selling price of imported wines greater than locally produced. However, the foreigners and more affluent Ethiopians are more inclined to purchase imported wines (Marie-Luce, 2016). The data showed that import of wine is increasing significantly year on year (ERCA, 2015). Ethiopia is not take the advantage of increasing demand of global and local wine consumption (Global Feasibility Study, 2010).

Grapevine Research

Grapevine research were started at Koka Galila Palace compound (later on transferred to Nazeret Research

Center, now is called Melkassa Agricultural Research Center) with local collected and ten introduced germ plasmas from United State of America. In the early 1980s, grapevine research has been started at Debre Zeit Agricultural Research Center with introduced from different countries and local collected from vineyards. The center has given responsibility of national grapevine research project coordinator in the country. The German volunteer service program, an amateur German Viticulturist Arthur Zimmerman joined the center in 1982 and assisted grapevine research activities. He introduced over 100 exotic grapevine varieties from Europe and United States of America (Asfwa *et al.*, 2012).

Research Achievements

Debre Zeit Agricultural Research Center is the pioneer research center which had significant contribution for development of improved grapevine technologies (Asfwa *et al.*, 2012). Research has been conducted over year to develop grapevine technologies in the areas of variety development, vineyard management, crop protection and propagation technologies with the major achievement in the variety development on wine, raisin and table grape varieties and also vineyard management.

Germplasm Enhancement and Variety development

Germplasm Enhancement: This germplasm provides a good gene pool and excellent working material for specific breeding objectives. Grapevine germplasms have been introduced at different times, started from the time of the Italian occupation. However, the origins of some varieties are unknown and they are given local names based on color, shape and test of the berries. Since the late 1970s grapevine germplasms have been introduced from from abroad (USA and Germany) and local collected from vineyards (Awash, Castel, Alemeta EGudar, Dukem, and Elabered) and maintained in Merti Jeju and Debre Zeit center vineyards (Asfwa *et al.*, 2013). Debre zeit agricultural research center is the only center, conducting and coordinating grapevine research at country level. Currently, there are more than 130 grapevine germplasms have been maintained at Debre Zeit, and Merti Jeju.

Variety development: Grapevine has consisted of several varieties for different purposes viz., table/ juice, raisin, and wine. All varieties are not suitable to all the above purposes. The suitability of a grape variety is judged based on certain criteria which differ from one purpose to another purpose (Veena, 2015). Debre Zeit Agricultural Research Center has developed thirteen (13) grapevine varieties, eight wine for making in 2004, three for raisin in 2013 and two for table grape in 2019. Varieties were registered and/or released in Ministry of

Agriculture, Animal and Plant Health Regulatory Directorate. These varieties recommended for production for private vineyards, large and small scale vineyard. Some of these varieties has been under production in wineries' vineyard. However, private wineries have used imported varieties which do not have research information on adaptability and productivity in Ethiopia agro-climatic condition.

Grapevine germplasm in Ethiopia is not well studied for its diversity in yield and yield components, nutrition, physiology and pomological characters. Therefore, studying various research works on collected grapevine germplasms are an important task for grapevine research in Ethiopia. Currently, there are different grapevine ongoing research activities on different components such as; variety development, vineyard management, protection, multiplication and technologies demonstration.

Table 2: Lists of registered and/or released of wine, table and raisin grapes varieties in Ethiopia

No	Varieties	No. Cluster/vine	Weight/cluster (kg)	Yield/vine (kg)	Yield/ha (t)	Purpose
1	Awash Nigest	11.93	0.65	5.97	11.94	Table
2	Flame Tokay	9.69	0.77	6.23	12.45	Table
3	Thompson seedless	5.01	NA	4.66	9.66	Raisin & table
4	Black Corinth	9.28	NA	3.93	8.29	Raisin
5	Muscat of Alexander	4.23	NA	3.7	7.85	Raisin
6	Chenin blanc	18.4	0.20	4.00	8011	Wine
7	Cannonano	15.9	0.19	3.3	6600	Wine
8	Grinach blanc	14.5	0.21	3.16	6329	Wine
9	Grinach noir	12.9	0.19	2.48	4975	Wine
10	Ugni blanc	11	0.24	2.69	5396	Wine
11	Sangoves/tikur	8.9	0.23	2.35	4707	Wine
12	Black hamburg	7.9	0.21	1.5	3018	Wine
13	Dodoma altico	7.9	0.22	1.65	3320	Wine

*: NA= not available

Propagation Techniques

Fruit crops are mostly propagated by vegetative methods. Efforts have been made in development of grapevine in vitro protocol and cutting propagation techniques. Grapevine in vitro micro-propagation protocol were developed by Beza (2010) and Fikadu and Tileye (2019). Grapevine cutting were treated with long period chilling treatment showed low bud break and root formation while control and three day treatment had better result. Cuttings was treated with Cyanamid, Termitcide, and SKW 83010 (25g/L) showed a negative effect on bud break whereas the control had high percent bud break and healthy rooted cuttings (Asfaw et al., 2012). Grapevine has propagated using cutting with three up to six buds per cutting. Cuttings with more buds per can have better chance of bud breaks and root formation.

Vineyard Managements

Various agronomic packages have been recommended to improve the performance of released varieties. Fruit crops experiments conducted to generate best nursery

and field management practices (Daneil and Gobeze, 2012). Grapevine pruning and training system, physiology such as dormancy and bud break studies were conducted at Melkassa and Merti (Tessema et al, 1994).

The highest percentage of bud breaks occurred on close to tip end while fruitful bud position found above the forth node of the cane. This could be related to the greater percentage of bud break where the more fruitful buds resulted. Table grape varieties pruned to 6-7 node length cane would be more productive under Debre Zeit condition. The pruning season done in July and February under Merti and in August under Debre Zeit condition (Asfaw et al., 2012). The two cropping season with cane pruning had 285% fruit yield advantage and TSS: TA ratio over single cropping with spur pruning at Merti Jeju. The alternate bearing by two cropping season phenomenon might be mitigated with balanced pruning practice. The varieties were categorized as early, medium and late maturity. They had an average of 142 days and 1132 degree-days to reach maturity under Debre Zeit conditions. (Asfaw, 2012).

Crop-Max had no significant effect on productivity and fruit quality while Bio-fertilizer had positive effect on

some yield and yield component. The control vines showed relatively better disease tolerance than the Bio-fertilizer treated vine. The vineyards were assessed for major nutrients in soil and plant tissue, rift valley areas 8+ pH, Debre Zeit 6.5-7.5 PH and Gudar/Kilinto 6.43-6.72 pH and had low level of N, P and organic matter. This required immediate ameliorate of soil fertility to increase of production and productivity of vineyard.

The fertilizer must be applied based on the level of mineral elements presented in the soil. However, fertilizer was applied in blanket recommendation rate of 100 g Urea and 100 - 150 g of DAP per vine after pruning. Irrigation started soon after pruning and continued until variation and stop irrigation two weeks before harvest (Asfaw et al., 2012).

Post-harvest and quality of grape

Grapevine varieties were evaluated on utilization and quality aspects (Senayit et al., 1994). The varieties were evaluated by Awash Winery for wine quality under Debre Zeit condition. The chemical analysis (pH, sugar, total acidity, volatile acidity and color intensity), sensory evaluation (juice yield, percent total mass) and taste (aroma, bouquet and odor) were done. Eleven out of fourteen varieties, recommended for quality wine making and promoted to further agronomic studies (Asfaw et al., 2012). The grape quality (pH, sugar, total acidity) of ten wine making varieties and six table grape varieties were evaluated by castle winery in 2018 and 2019 (DZARC Fruit report, 2019).

Crop Protection

Fungicide is one of the most effective tools for control of downy and powdery mildews diseases in grapevine. Efforts have been done in assessing several fungicides efficacy test in 1983/84 cropping seasons Dukom Vineyard. Twenty-five fungicides for downy mildew and sixteen fungicides against powdery mildew. Among tested chemical, Ridomyl MZ showed best control of downy mildew disease. The use of proper chemicals to control the major diseases coupled with sound cultural practices showed successful results in all visited vineyards. The vineyards were surveyed and assessed on different diseases. They have common disease (powdery mildew and downy mildew) and the cultural practices adapted at the respective vineyards. The types of chemicals used to control these diseases, the rate, frequency and time of application were recorded as practiced in each vineyard (Asfaw, 2012).

Technology Multiplication and Promotion

The Centre has distributed number of planting materials to investors, research centers, Universities churches,

organizations and other interested individuals. Rooted-cuttings of grapevine varieties have been distributed to farmers in Upper Awash, Adwa, Koka, Weliso (Asfaw et al., 2012), Bahir Dar Univeeristy, Debre Markos University, Belblity Monastery, Weldiya University, Ambo University, Chero Research Center, Wolga private farm (DZARC Fruit research report 2019).

Challenges and gapes for grapevine industry

Grape production had been limited to lack of awareness and technical know-how for grape production (Asfwa, et al., 2013). Ethiopian Viticulture has faced different challenges, such as biotechnology, inputs, facilities, and local packaging companies. Raw material shortage and accessing foreign currency were another challenges affecting wine production (Marie-Luce, 2016). The absence of sound guidelines for streamlining the arts and science of commercial grape production (Asfwa, et al., 2013). The overall wine production situation in Ethiopia has very little impact on the global wine trade (Marie-Luce, 2016). This is due to lack of improved technologies, limited familiarity for grape cultivation and less attention for Research and development in the country. Grapevine research has very limited and/or nearly zero emphasis in Ethiopian National Agricultural Research system and in the Government. There is weak grapevine research and development coordination between research institutes, companies and Universities. Even though, the crop has feasible economic return, expert market and hard currency exchange, the sector may not resulted significate economic contribution in country.

Potentials and Opportunities

Ethiopia has an ample potential for grapevine production and productivity. There is a possibility to harvest twice a year in drier regions of the country. This is due to the proximity to the equator (Marie, 2016, Asfwa et al., 2013). This unique agro-climatic condition and fertile soil allows to capture higher prices in international market. Taking advantage of growing local and global demand, the export and investment incentives and favorable climate, the viticulture sector in Ethiopia is rapidly expanding. (Global Feasibility Study (2010) reported that preliminary financial analysis indicated that vineyards were established in Ethiopia become viable. The profitability of two Ethiopian wineries are a pioneer to encourage other investor for grape investment in Ethiopia.

Future direction

Grapevine research needs to develop and adopt new technologies to maximize yield and quality of wine and table grape production and productivity in Ethiopia. The

Research Institute, police makers, Wineries and Agricultural office give emphasis on grapevine research and development to satisfy increasing demand of wine and table grape in Ethiopia. The government should encourage the establishment of grape production and wineries, support the existing towards sustainable quality grape and wine production. The grapevine industry are process-driven agriculture as a means of achieving sustainable economic development, expand through developing and adaptation of research technologies. Therefore, grapevine research and development needs strong coordination between research institutes, companies and Universities

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