

## Feasibility of growing Stevia (*Stevia rebaudiana*) at Jabal Al-Akhdar, Sultanate of Oman

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### جدوى فموبتة ستيفيا (*Stevia rebaudiana*) في الجبل الأخضر، سلطنة عمان

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**ABSTRACT.** Oman is one of the top nine countries in the world with highest prevalence of diabetes. There is therefore more awareness among the people to take necessary precautions to preserve their health by reducing their sugar consumption and replacing it with low calorie sweeteners. Stevia is a natural herbal sweetener that is safe and does not have the neurological or renal side effects associated with some of the artificial sweeteners. A feasibility study to grow Stevia was undertaken after obtaining the seeds that were initially planted in greenhouse to study their growth habits under controlled conditions. The plants were then transferred to the field in Jabal Al-Akhdar at an elevation of 1079 m above sea level where temperatures were appropriate for Stevia growth in summer since it was within its tolerant temperature range. Two types of Stevia plants were transferred to JA for the three months field study; those that originated directly from seeds and those from transplant cuttings. Drip irrigation system with timer was installed with two laterals each having six emitters spaced 60 cm apart and each supplying 2 liters of water per day. Moderate fertilizer NPK was applied. Five out of six plants in each of the two plots grew very well to the end of the season. Some insects were attracted by the sweetness of the leaves but proper measures were taken to prevent damage. Results show that it is feasible to grow Stevia in JA in summer.

**KEYWORDS:** *Stevia rebaudiana*; growth conditions; soil type; Sultanate of Oman.

**الملخص:** عمان هي واحدة من أكثر تسع دول في العالم من حيث نسبة انتشار مرض السكري. ولذا فإن هنالك وعياً متزايداً بين الناس في اتخاذ الاحتياطات اللازمة للحفاظ على صحتهم وذلك عن طريق الحد من استهلاك السكر واستبداله بالمحليات قليلة السعرات الحرارية. ومن المعلوم أن ستيفيا هي عشبة طبيعية وآمنة يمكن استخدامها كبديل للمحليات الصناعية، وليس لهذه النبتة آثار جانبية عصبية أو آثار على الكلى كما هو الحال مع بعض من المحليات الصناعية. ولقد أجريت دراسة في جامعة السلطان قابوس حول إمكانية زراعة ستيفيا في سلطنة عمان وذلك بعد الحصول على البذور من مصادرها، وتم في البداية زراعتها في بيت محمي لدراسة عادات نموها تحت ظروف خاضعة للرقابة. ثم تم نقل النباتات إلى الحقل في الجبل الأخضر على ارتفاع 1079 متر فوق مستوى سطح البحر حيث كانت درجات الحرارة ملائمة لنمو ستيفيا في الصيف. تم نقل نوعين من نباتات ستيفيا إلى الجبل الأخضر وذلك لدراسة هذين النوعين لمدة ثلاثة أشهر؛ يختلف النوعان من حيث أن أحدهما قد نشأ مباشرة من البذور وأما الآخر فقد نتج من تقليص السيقان. تم تركيب نظام الري بالتنقيط مع وجود مؤقت في اثنين من الخطوط الفرعية بحيث أن كلا منهما به ستة نقاطات تبعد 60 سم عن بعضها البعض وتعطي كل منها لترين من الماء يومياً. تم إضافة نسبة متوازنة من أسمدة النيتروجين والفسفور والبوتاسيوم. ولقد لوحظ أن خمسة من أصل ستة من النباتات في كل من قطعتي الأرض نمت بشكل جيد جدا حتى نهاية الموسم. وقد جذبت حلاوة الأوراق بعض الحشرات ولكن تم اتخاذ التدابير المناسبة لمنع الضرر. وأظهرت النتائج أنه من الممكن أن تنمو ستيفيا في الجبل الأخضر في موسم الصيف.

**الكلمات المفتاحية:** ستيفيا، خالية من السعرات الحرارية، جبل الأخضر، درجات الحرارة ملائمة، الري بالتنقيط

## Introduction

**S**tevia or "sweet herb" is a plant originating from mountainous regions of Brazil and Paraguay. In the sixteenth century, Europeans became aware of Stevia leaves which are 20-30 times sweeter than sugar. Its leaves can be dried and stored and can be used in raw form. Stevia has a short growth season and does not affect blood sugar levels and does not have the neurological or renal side effects associated with some of the

artificial sweeteners (Tanaka et al., 1997).

Stevia is commercially grown in many countries which include Paraguay, Brazil, Uruguay, Central America, China, Thailand, the United States. It is considered an important natural sweetener in both Japan and Korea, and has been safely used in these countries for decades. It is used to make sweet sauces, pickles, beverages, etc. Japan is one of the largest single consumers of Stevia in the world.

With using of Stevia, there have been no anomalies observed in cell, enzyme, chromosomal or other significant physiological parameters during toxicity tests. Stevia has not been associated with any form of cancer or birth defects (Brunsick, 2008).

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## Uses of Stevia leaves

Since it is a natural sweetener, Stevia has great potential of being used as sweetening agent in products like biscuits, jams, chocolates, ice-creams, baked foods, soft drinks, soda, candies and also common beverages like dip tea, coffee and herbal tea that are targeted particularly at the diabetics and also the health conscious consumers. The leaves can be used in chocolates and candies and does not encourage tooth decay (Megeji et al., 2005).

## Market Outlook

*Stevia* has a future potential for expansion. Because *Stevia* has generated considerable media attention and interest in recent years, producers could benefit from the growing consumer awareness of this crop. Stevia may prove to be profitable for small-scale growers who are willing to develop or cultivate a market through local farmers markets, other direct markets, or for wholesale to smaller distributors (Kerczicn et al., 1998).

Oman is ranked ninth among countries with the highest prevalence of diabetes in the world. As a result, people are becoming more aware of their health and sugar consumption is going down and is getting replaced by low calorie sweeteners (Al-Yaarubi, 2011).

As indicated above, *Stevia* is gaining more acceptance in many countries. Some of these countries import Stevia and many of them, particularly those having appropriate ecological conditions grow it. Different parts of Oman offer these favorable conditions at least in some parts of the year. The Jabal Al-Akhdar (JA) is a mountainous agricultural area in the North of Oman with elevation of 1079 m above sea level where temperatures are appropriate for Stevia growth in summer since it was within its tolerant temperature range. Some other areas in the north are close to sea level which could also have a potential of growing this herbal healthy sweetener in spring even as an intercrop between fruit trees like date palm, while in the South, which has monsoon season, it could be grown under any shaded area.

The objective of this project was to assess the feasibility of growing Stevia in the field in JA in summer.

## Methodology

### Climatological summary of the area

Since the objective of this project was to determine the feasibility of growing Stevia plants in the field in JA, the preceded greenhouse period of two months after germination study could be considered as an integral part of the project since it laid down the basis of producing transplants for the three months field study that was appropriately timed to start in June 2012. The project was hosted on one of the terraces in a family farm in Al-Manakher, Jabal Al-Akhdar. Climatological summary of the area was obtained from the Directorate General

**Table 1.** Soil texture profile in the study area.

Terrace	Sand (%)	Silt (%)	Clay (%)	Texture
Upper	52.8	27.8.8	19.4.8	loam
Lower	52.6	30	17.4	loam

**Table 2.** Soil pH and electric conductivity (EC) of the study area.

Terrace	Upper #1	Upper #2	Lower #1	Lower #2
EC (dS m <sup>-1</sup> )	0.91	0.61	9.61	11.41
pH	8.50	8.54	7.89	7.85

of Meteorology and Air Navigation of the Ministry of Transport and Communications to help estimate the three month period when Stevia transplants could be planted in the field in Al-Manakher, JA within its tolerant temperature range (TTR) of 20°C-37°C. The climatological summary of 2011 obtained was from Saiq weather station of the Ministry but was used to estimate Al-Manakher's climate because of its closeness to Saiq. Since the temperature range of an area for a given period of the year approximately repeats itself every year, the projected period selected for 2012 starting from early June to at least end of August was found to favorably fit *Stevia's* TTR.



**Figure 1.** Three of the *Stevia* plants growing on a terrace at Al-Manakher in JA. The fine mesh net used to protect the plants from insect attack is visible in the background.

## Land preparation

Land was plowed initially with a disc plow or harrowed to break down the clods. One of the two terraces measuring 4m x 2m each was reserved to grow 12 plants with spacing of 60 cm between each plant.

## Soil type

The texture of soil samples from two terraces were determined using the hydrometer method and soil pH and electrical conductivity of the saturation extract were determined. Table 1 shows that the texture of the upper and lower terraces are both loamy. This is the most moderate texture in terms of aeration and water-holding capacity. It is very suitable for *Stevia*. Table 2 shows that the salinity level of lower terrace had very high salinity level which is unsuitable for most crops while that of upper terrace had low salinity level that is suitable for most crops including *Stevia*.

## Irrigation system

A drip irrigation system with timer was installed with two laterals each having six emitters spaced 60 cm apart as recommended for *Stevia* spacing. So there were 12 emitters growing on the terrace. The timer was set to daily irrigate the plants morning and afternoon for a 15-minute duration each providing 2 liters of water per day.

## Germinating *Stevia* seeds

According to Ever *Stevia* Canada (ESC) Inc., the company from which the seeds were obtained, there are two conditions for favorable germination of *Stevia*: (1) acidic pH (5.5-6.5) condition and (2) simultaneously a lot of aeration and high moisture availability for its root system. Acidic pH of water was obtained by drop wise addition of concentrated nitric acid to water while shaking until the pH of around 6.0 was reached. There was no problem of incompatibility using nitric acid since it is a nitrate source which is a plant nutrient but at a very low concentration and for very short time i.e. until germination of *Stevia* seeds took place.

Combination of high aeration and high moisture availability around the *stevia* root system was accomplished by using jiffy-7 (compacted peat moss) after its expansion following its water absorption from the water pool in the container, then grooving it in the middle to form a 2 cm top layer to accommodate sand and laying the seed on surface of sand and slightly compressed to have intimacy with the sand particles providing both good aeration as well as moisture from the surrounding jiffy-7. This way the seeds were simultaneously facilitated with plenty of aeration through sand particles and also through which plenty moisture flow from the surrounding high water holding capacity jiffy-7.

The first batches of seeds were germinated at the end of January 2012 in air-conditioned room in CAMS at

25°C with ample light. It took 4 days for the seeds to germinate. They were irrigated initially with diluted Hoagland nutrient solution for about one week and later at full strength until one month. This was then followed with NPK compound fertilizer blended with trace elements in irrigation water. At 2-month age, the usual time for transplanting *Stevia* plants in the field, the seedlings were transferred to temperature-controlled greenhouse at Agricultural Experiment Station (AES) on SQU campus where they were transplanted into larger pots. These plants could not have been grown in the field at AES or JA since the temperatures were outside the range of 20-37°C. The plants were intended to remain in the greenhouse throughout their 5-month growth to maturity. Throughout their growth in the greenhouse, temperature control was set between 24°C and 25°C. The second batch of seeds were germinated in greenhouse at AES early April 2012 for later transplanting in the field at Al-Manakher, JA in early June 2012.

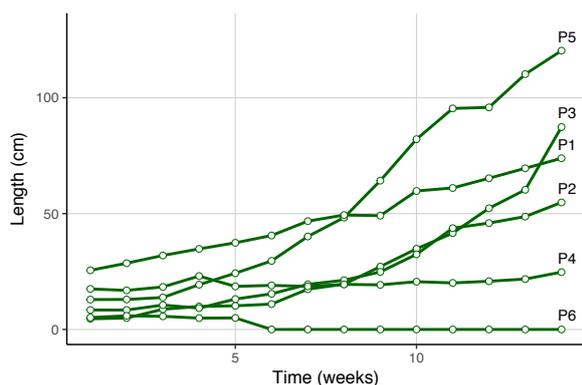
Propagation of mature plants as transplants for JA By the end of May the plants originating from the first batch of seeds reached maturity and those that survived were three. They were propagated by cuttings to produce more *Stevia* plants for transplanting on JA terrace in Al-Manakher. The idea of propagating more *Stevia* plants by cuttings was tried and it produced favorable results. It involved dipping the cuttings into rooting hormone and planting them into a vermiculite-perlite mixture with potting soil in a closed glass box (1m x 1m x 1m) at 28°C and opened every 3-4 days for spraying some water. After four weeks the cuttings had very good root formation. The new plants were taken to Al-Manakher for transplanting on 24th June, 2012 on one of the terraces where transplanting *Stevia* seedlings from seed took place on 2nd June, 2012 on the same terrace. As mentioned above, the size of the terrace was 4m by 2m.

## Shading screen

Unlike in its country of origin, *Stevia* cannot withstand direct sunlight in our region due to its higher solar intensity but does very well with ample diffused light both in greenhouse as well as in the field within its required temperature range of 20-37°C. The greenhouse at AES had automatically sufficient shading but the plants growing in the field at Al-Manakher needed 60% shading screen.

## Plant Protection

Precaution was taken at the very beginning to avoid *Stevia* leaves from being subjected to pesticide spray since they are the overall yield component of the plant and consumed in raw. Pesticide accumulation in the leaves could have a direct health risk. So, a mosquito net (Fig. 1) was used to cover the plants from pest attack. As a matter of fact, small grasshoppers were noticed to have attacked some of the leaves a few days after transplanting at the terrace in Al-Manakher. Immediate



**Figure 2.** Plants from subplots I and II that originated from seeds. There was a general trend of increased growth with time. Plant 6 died after week 5.

action was taken to make sure that the edges of the net was well laid down on the ground to avoid any entrance of pest into the sweet *Stevia* leaves. Removal of weeds was done manually.

## Results and discussion

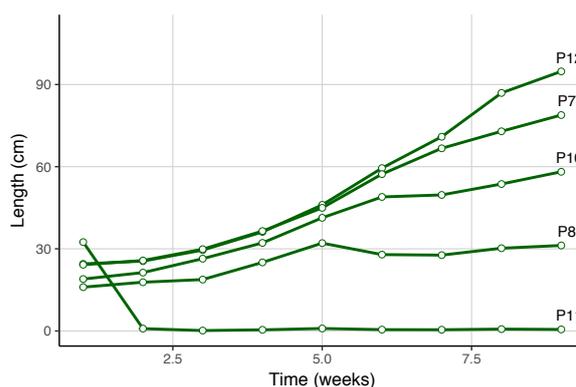
### Taking Stem Growth Measurements of Stevia Plants

Since the economical part of the plant are the leaves it is very important to achieve highest vegetative growth. The development of the plant was monitored by taking observations of the height of the plant and counting the number of leaves of different lengths each week. The leaves from 3 cm to 5 cm were considered as small leaves, from 5 cm to 7.5 cm medium leaves and 7.5 cm and higher as large leaves. The number of large and medium leaves impact on photosynthesis process contributes more to the plant growth. The small leaves contribute less to rate of growth. There were four subplots and each subplot contained three plants (see Figures 2 and 3). The plants from subplots I and II originated from seeds.

The results show that *Stevia* could grow and complete its growth to maturity in Jabal Akhdhar. The plants were harvested on 10 September 2012.

## Conclusion

Oman has a potential for growing Stevia except in summer as intercrop with date palms or other fruit trees. However, for JA, as mentioned above, Stevia can be grown in summer when temperatures from June to September are more favorable and similar to where Stevia initially originated. Commercial production of Stevia should be given consideration by the private sector in Oman.



**Figure 3.** Plants from subplots III and IV that resulted from propagation of mature Stevia plant stems. There was general trend of increased growth with time except for plant 11 that died at second week.

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