Desert gourd: A potential bioenergy feedstock crop for marginal environments

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Introduction

Citrullus colocynthis (L.) Schrad., also known as desert gourd, is a member of the Cucurbitaceae family. It bears inedible, potentially toxic fruits with seeds having high oil content. In the United Arab Emirates, the plant often grows wild in sandy soils covering large areas and surviving

Figure 1: Collecting desert gourd

under hyper-arid desert conditions (Figure 1). Due to the growing interest in biofuels on one hand and the concerns on using prime lands and food crops (soybean, rapeseed, etc.) for their production, we studied desert gourd for its potential as a non-edible biodiesel feedstock crop for cultivation in arid and biophysically-marginal lands.

Material and methods

The study was conducted over a period of one year (November 2013-December 2014) at the International Center for Biosaline Agriculture (ICBA), Dubai, UAE and included 22 accessions collected from different

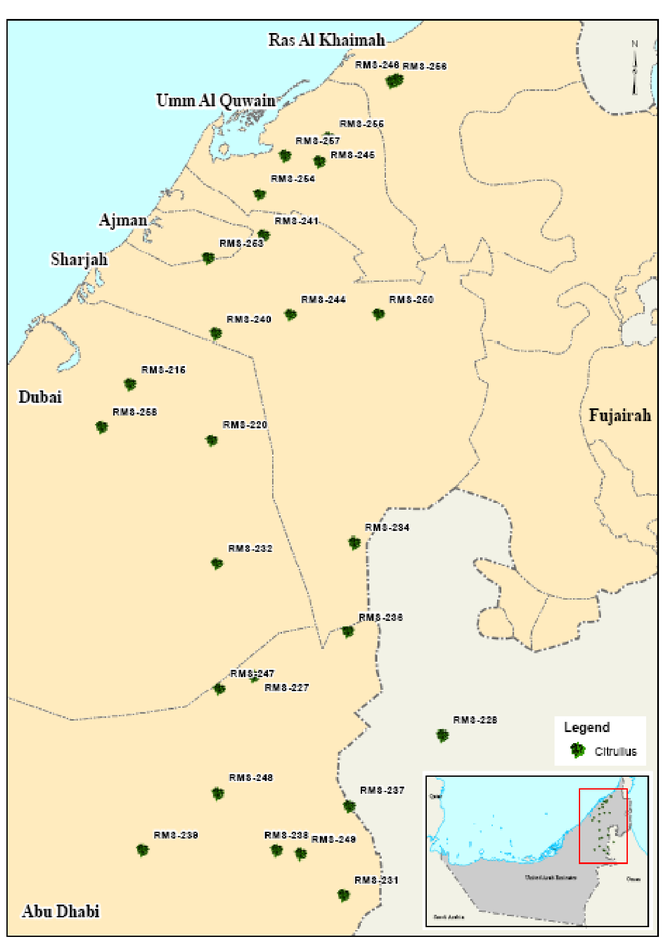

Figure 2: Desert gourd collection sites

locations within the UAE (see Figure 2) and five accessions obtained from the United States Department of Agriculture (USDA), sown in a randomized complete block design (RCBD) with three replicates. The seeds were planted in field plots each of four rows of 2 m. The distance between rows as well as between the plants within the row was 50 cm. The plants were irrigated twice a day by drip irrigation with low-quality municipal water that had an electrical conductivity of 0.3-0.5 dS m^{-1}. All the accessions were characterized for two exclusively qualitative (fruit and seed color) and 11 quantitative traits, such as branching, vine length, leaf, fruit and seed characteristics, based on data collected from five randomly selected plants from each plot. Oil was extracted following the conventional method of solvent extraction (n-hexane) with a Soxhlet apparatus using 50 g of seed from each plot. Saponification value and free fatty acid content were determined using standard American Society for Testing and Materials (ASTM) test methods and dynamic viscosity was calculated using a digital viscometer.

Results and discussion

The data showed considerable variability in morpho-agronomic traits as well as in oil quantity and quality among the accessions. The number of fruits per plant varied between 2 to 36, seed yield from 11 to 373 grams per plant, and the seed oil content from 7.8 to 43.8% of the seed weight.

Table 1: Seed and oil yields in desert gourd

Identity	Seed yield (t/ha)	Oil yield (t/ha)
RMS 215	4.35	0.52
RMS 220	4.78	0.63
RMS 227	12.37	1.68
RMS 228	11.31	3.44
RMS 231	3.22	0.74
RMS 234	3.83	0.55
RMS 237	5.71	0.91
RMS 239	8.33	1.33
RMS 240	3.70	0.72
RMS 244	11.63	2.28
RMS 245	5.43	1.47
RMS 246	3.35	0.41
RMS 247	3.91	1.71
RMS 249	4.89	0.73
RMS 250	0.98	0.10
RMS 254	2.00	0.57
RMS 255	3.10	0.56
RMS 256	6.42	1.26
RMS 257	5.60	1.27
RMS 258	4.66	0.82
KMK1	14.95	1.41
KMK3	3.24	0.42
PI386024	1.55	0.41
PI388770	0.47	0.08
PI525080	4.95	1.37
PI525082	1.90	0.59
PI537277	2.98	0.39
Mean	5.17	0.98
Standard Deviation (+/-)	3.54	3.44

Extrapolated annual oil yield in several accessions exceeded 1 t ha^{-1}, the highest being 3.4 t ha^{-1} (Table 1). Oil from most accessions had desirable physicochemical characteristics such as low free fatty acid content (<0.5%) for biodiesel production. If the accessions are ranked on the basis of important characteristics such as oilseed yield, oil yield and number of fruits per plant, accessions KMK1, RMS 227, RMS 228 and RMS 244 are the

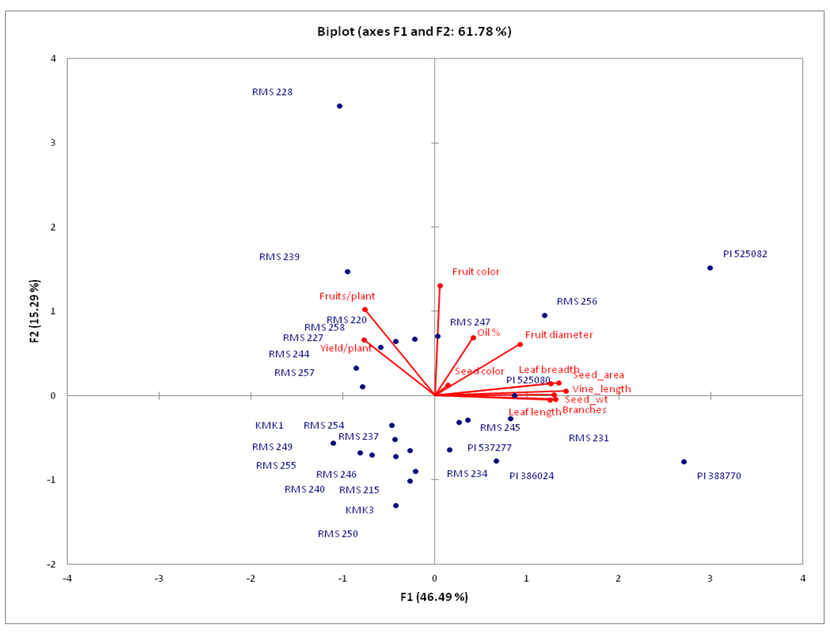

Figure 3: Biplot of principal component analysis

best performing among the 27 accessions studied. If oil quality is also taken into consideration, RMS 227 appears to be the most promising accession in this study. Principal components analysis showed that characteristics of economic importance such as the number of fruits per plant, seed yield and oil content, group together (Figure 3), suggesting the scope for genetic improvement of yields.

Conclusions

The results from this study show that desert gourd is an attractive candidate for development as a biodiesel feedstock crop. The extrapolated oil yield in some of the accessions was higher than in most other bioenergy crops – especially soybean and rapeseed, the two main globally cultivated biodiesel feedstock crops, with average oil yields of 0.5-0.6 t ha^{-1}. Many of the accessions in our study were also found to be higher yielding than Jatropha – a non-edible biodiesel crop with reported oil yields of 1.5 to 2 tons ha^{-1}. More importantly, compared to other biodiesel feedstock crops, desert gourd is likely to be tolerance to marginal growing conditions with lower water requirements because of its natural adaptation to desert environments. The wide range of variation found in this study for seed yield, oil quantity and oil quality provides opportunity to develop desert gourd into an economically-viable, non-edible, alternative biodiesel feedstock crop.

Key references

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