

Black carrot cultivation in Turkey

Carrot Aid study report from Southern Anatolia



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December 2012



Carrot Aid

Carrot Aid is a small private charity based in Denmark¹, comprising a board of 5 volunteers. Its aim is to assist with the promotion of carrot cultivation and domestic consumption in Ethiopia, as a means to improve nutrition and reduce the incidence of night blindness in mothers and children caused by vitamin-A deficiency. A recent (2010) nutritional survey of the country found that ca. 1% of children suffer night blindness in half of Ethiopia's provinces, with up to 14% of mothers affected in Tigray province.

This brief report follows a short visit by four of Carrot Aid's board members, Mette Wivel, Phil Clarke, Mikael Wivel & Marie Nørredam, to Southern Anatolia in Turkey from the 26th to the 29th November 2012.

Contacts were initiated with seed sellers, farmers and the directors of three carrot juice companies. From these meetings a brief outline of the current situation regarding black carrot cultivation in Turkey was gained, in order to apply some of this to an Ethiopian setting.

Phil Clarke spent a further two days in Ankara to talk to Turkish government officials about the project and to seek permission to export black carrot seeds.

The aim of the study trip was to:

- 1) learn about and document the status of black carrot cultivation on the southern Anatolian plateau,
- 2) acquire Turkish black carrot seeds for testing by the Ethiopian Institute of Agricultural Research (EIAR), with the eventual aim of introducing the seeds as a nutritional crop for own consumption by marginalized farmers,
- 3) to learn the laws governing the export of heirloom carrot seeds from Turkey,
- 4) to establish a functional supply chain for the export of black carrot seeds from Turkey to Ethiopia.

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Carrots in Turkey

Carrots were first domesticated in Iran or Afghanistan about 5000 years ago, and had already reached Turkey more than 1000 years ago. Most carrots in Turkey would have been black (in reality an intense purple) or yellow, and both forms are still cultivated from home-grown seeds.

During the 16th Century, Dutch horticulturists crossed domesticated carrots with their wild counterpart, resulting in an orange coloured carrot with a large and sweet tasting root that has subsequently spread worldwide. Orange carrots of Dutch origin are now widely cultivated in Turkey, particularly in Kasihani south of Konya and Baypazari NW of Ankara.

Until recently, black carrots (*siyah havuç* in Turkish) were only cultivated in any number in Turkey around Ereğli on the southern Anatolian plateau, probably due to the their demand as a key ingredient in the traditional fermented black carrot juice *Salgum Suyu* that is widely consumed in nearby Adana.

Location of the black carrot cultivation area visited by the Carrot Aid team.





Fermented black carrot juice – *Salgam Suyu* – is produced in Eregli by the local firm Günseven that has its own shop just out of town on the road to Adana. Salgam is effectively a black carrot vinegar, and two versions are sold – bitter with a yellow top, and hot with a red top (which is made with chilli). Salgam is also produced by other companies in Adana, using black carrots from the southern Anatolian plateau.

Efforts by Mr. Arif Yigit of the Erkon Konsantre A.S juice factory to promote black carrot juice as an organic food colourant have seen a huge increase in black carrot cultivation over the last 15 years, from 5000 to 200,000 tons per year. This has spread black carrot cultivation over a much wider area in southern Anatolia, from Kasihani through to Eregli-Konya. The demand for black carrots is expected to continue its strong growth if the EU decides to forbid the use of artificial e-numbers in the food industry.



Top left: the Erkon Konsantre juice factory on the Eregli-Konya road, Eregli.

Above: Proprietor Mr. Arif Yigit.

Left: A trailer containing the dry pulp remaining after the juice has been removed from the black carrots. The pulp is sold as animal feed for cattle, and is therefore being weighed.

Beta-Carotene and Anthocyanins

Black carrots are reported to have a huge range of beneficial compounds, notably:

- 12 times more antioxidants than orange carrots
- Cholesterol-lowering properties
- Rich in vitamin A, B and C

The Erkon Konsantre A.S. juice factory in Eregli has tested for anthocyanins in black carrots in a laboratory and found that these contain 28 times more than the orange carrot. Full details of the tests can be found on www.erkonsantre.com

Out of ca. 700 known natural carotenoids, α - and β -carotene are especially important because they can be converted to vitamin A (1). α -carotene and β -carotene constitute respectively 13 to 40% and 44 - 79% of the total content of carotenoids in carrots (2). The distribution of β -carotene is not homogeneously distributed in the carrot. In particular, the concentration of β -carotene is higher in the outer portion (phloem) relative to the inner part (xylem).



It is not yet known for certain how much β -carotene the Turkish black carrot contains. The owners of the juice factories in Eregli and Karaman are on the understanding that black carrots do not contain as much beta-carotene as orange carrots, while the World Carrot Museum in the UK reports on its website www.carrotmuseum.co.uk that black carrots contain 30-40% more beta-carotene.

From a brief search of scientific literature, one study has been found which describes the content of β -carotene in purple carrots to be about 2-fold greater than in orange carrots (3). The carrots in this study are not well described regarding their genetic origin, and the number of different types of orange and purple carrots in the study is limited. Another study describes a totally opposite picture (4), where fully described orange and dark orange carrots are found to contain approx. 2-4 times more β -carotene than the purple variants (4). These results are confirmed by a recent study based on the analysis of 118 genetically described carrots of different colours (5), where the average content of carotenoids in orange carrots is found to be 9.3 mg/100g and in purple carrots to 2.1 mg/100g (5).

Given that β -carotene accounts for 44-79% of the total carotenoids in carrots (2), we can estimate the average content of β -carotene in orange carrots to be 4.1 to 6.5 mg/100g and for purple carrots 0.9 to 1.7 mg/100g. The vast majority of orange genetic variants in this study (5) contain a higher level of carotenoids in comparison to the purple variants.

Carrot Aid will try to test the β -carotene content of Turkish black carrots.

References

- (1). Arscott, S. A.; Tanumihardjo, S. A. Carrots of Many Colors Provide Basic Nutrition and Bioavailable Phytochemicals Acting as a Functional Food. *Comprehensive Reviews in Food Science and Food Safety* **2010**, 9 (2), 223-239.
- (2). Simon, P. W.; Wolff, X. Y. Carotenes in typical and dark orange carrots. *Journal of Agricultural and Food Chemistry* **1987**, 35 (6), 1017-1022.
- (3). Alasalvar, C.; Grigor, J. M.; Zhang, D.; Quantick, P. C.; Shahidi, F. Comparison of volatiles, phenolics, sugars, antioxidant vitamins, and sensory quality of different colored carrot varieties. *J. Agric. Food Chem.* **2001**, 49 (3), 1410-1416.
- (4). Sun, T.; Simon, P. W.; Tanumihardjo, S. A. Antioxidant phytochemicals and antioxidant capacity of biofortified carrots (*Daucus carota* L.) of various colors. *J. Agric. Food Chem.* **2009**, 57 (10), 4142-4147.
- (5). Baranski, R.; Allender, C.; Klimek-Chodacka, M. Towards better tasting and more nutritious carrots: Carotenoid and sugar content variation in carrot genetic resources. *Food Research International* **2012**, 47 (2), 182-187.

Black Carrot Horticulture

The internet contains only scant information in English on the techniques used for growing black carrots in Turkey. Even in Turkey there has until recently been little interest by their scientific community to study black carrots.

Some time was therefore spent to try to learn about black carrot horticulture through discussions with local farmers. Given the language barrier and the lack of detailed background knowledge by the Carrot Aid team on horticulture and crop genetics, the following information should be considered with care as some details may have been misinterpreted or misunderstood.



Field of black carrots in flower ca. 10 km WNW of Eregli on the Eregli-Konya road, 28th November 2012.

Sowing and harvesting

Carrots on the southern Anatolian plateau near Eregli-Konya (1500 m asl) are sown in March, 3 abreast on raised furrows about 30 cm wide with a 20 cm gap between furrows. 100g of seed is needed for 250 m² of soil.

Tuber roots first develop in May. These are then harvested from October through to December, before the onset of the hard Anatolian winter when the ground becomes solid from frost. Frost damaged carrots become mushy when thawed, and cannot be used to produce juice.

According to a seed supplier in Adana, black carrots require 3 months (75 days) from sowing to reach harvest maturity. Two more months are then required to produce flowers followed by seeds. The warm Mediterranean climate on the Cilician plain around Adana allows for two crops in a year, compared to just one on the Anatolian plateau.



Black carrots planted during a second season for seed production, staggered three abreast on a raised furrow, 28th November 2012.

Seed production

Black carrot seed production requires a continuous selection to ensure that a high concentration of the purple/black colour continues from one generation to the next. Carrots from non-hybrid seeds include a fairly high percentage with a deep red core, often with a white ring running through its length. Occasional white/pale yellow carrots occur in the crop. Without active selection, the black carrot crop would over time express a gradually reduced concentration of colour (and therefore of anthocyanins and other valuable nutrients) as well as an increasing percentage of the 'albino' tubers.

Carrots from F1 hybrid seeds have been widely grown in 2012 for the first time. These display consistent dark purple/black colouration throughout.

During harvesting in October to December, the best carrots (in terms of size, shape and external colour) are separated out. The vegetative tops of these are then removed, together with about 5 cm of the topmost part of the tuber root. This allows the farmer to see a complete cross-section of the carrot's internal colour profile. Carrots which do not have a consistent black/deep purple colour are discarded. The lower part of the selected carrot tubers are then stored through the winter in an earth mound during which they lie dormant. The following spring, in March, these seed crop carrots are replanted. Flowers and then seeds develop over the coming months and mature in August at which time they are ready for harvesting.



Black carrots display a degree of cytoplasm male sterility (CMS), whereby the male organs on the flower heads of about 5% of the plants are sexually sterile (through the failure to produce functional anthers). Farmers avoid these plants when collecting the seed heads, for although their female sex organs are able to receive pollen and produce seed, all of these will be male sterile.

Seed collection is conducted by removing flower heads by scissor and leaving these to dry in the sun. The seeds are then shaken off the heads and stored in dry conditions out of direct sunlight ready for planting the next year.

The technique described above can produce 20 grams of black carrot seeds (known as *siyah havuç tohumu* in Turkish) for each gram planted.



The range of colours displayed by natural black carrots (above) and hybrid black carrots from imported seeds (left), which are more consistently black/purple.

Seed suppliers

Contact to a seed supplier was established in Adana: Yasin Gayiru (0533 473 2676). One tin of 100g seeds costs 50 LTR for black carrot seed compared to 10-12 LTR for orange carrots. Carrot Aid acquired 10 tins for testing in Ethiopia.

In Eregli contact to the Günseven family farm was established. 1 kg of black carrot seeds cost 200 LTR and was acquired by Carrot Aid.

Other Turkish seed suppliers include:

www.pinaper.com

www.zengardentr.com (2.8 TL for 200 seeds of yellow carrots)

www.e-fidancim.com

www.infarming.com (hybrid black carrot seeds only)

www.depoya.com



Different hybrid purple and yellow carrots marketed in Turkey by Bejo seeds of Holland.

Pests

The White Moth *Besmia tabaci* (known as *Beyaz sinak* in Turkish) and to a lesser extent mites are the main pests associated with black carrots. These can be combatted with a pesticide called Mospilan, requiring about 40 gr. per 1000 m².

In practice black carrots on the southern Anatolian plateau are very little affected by pests, which allows them to be grown organically. This would be a major benefit to impoverished Ethiopian farmers, as they can then avoid the expense of having to use pesticides.



Details about the pesticide Mospilan, sold in Adana.

Taste

Although orange carrots are regarded as being sweeter, black carrots nonetheless have a sweet taste and are sold as a salad vegetable in Eregli. Their juice is very sweet and rich red in colour, similar to beetroot juice.

Black carrots are reported to be more woody than orange carrots and we could confirm that they are hard and crunchy when very fresh. They appear to soften relatively quickly, indicating that they may not store well.



Black carrots sold for domestic consumption in a supermarket in Eregli.

Export regulations

Carrot Aid visited the Customs and Excise office (Gumruk) and the Ministry of Agriculture and Rural Affairs office (Tarım ve Köyisleri Bakanlığı) in Ankara, where government officials were able to provide the following information on exporting heirloom black carrot seeds:

1. Black carrot seeds are not (yet) on the list of prohibited products that are not allowed to be exported from Turkey. But the Ministry of Agriculture expects them to be on that list during the next few years.
2. Phytosanitary certificates must accompany the export of seeds if these are required by the import country (Ethiopia).
3. Export of items can only be done by filling in an export declaration from a customs office, or through companies that are registered with a local export association.



Implications for artisanal carrot cultivation in Ethiopia

Assuming it has a high content of beta-carotene, the Eregli black carrot appears to have a huge potential as nutritional crop for artisanal agriculture and domestic consumption in Ethiopia that could make a real difference in combatting vitamin-A deficiency among the poorest rural farmers. This carrot is pest tolerant, grows in a hot upland climate and can produce its own seed for successive years, and contains a lot of vitamins and other beneficial compounds.

Carrot Aid's main concern is whether it will be possible to adapt the seed production method to the Ethiopian context. Although the Eregli black carrots can theoretically produce seeds during a single growing season, the need to ensure continuous gene enhancement means that in practice seed carrots are left dormant in the soil during the cold winter, re-planted the following spring, and seeds harvested the following August. In the Ethiopian context it may be possible to utilize the two rainy seasons to immediately replant selected seed carrots such that these will bear seed in the second growing season.



Black and orange carrots for sale at the Yuregir Carsisi wholesale market in Adana.

Acknowledgements

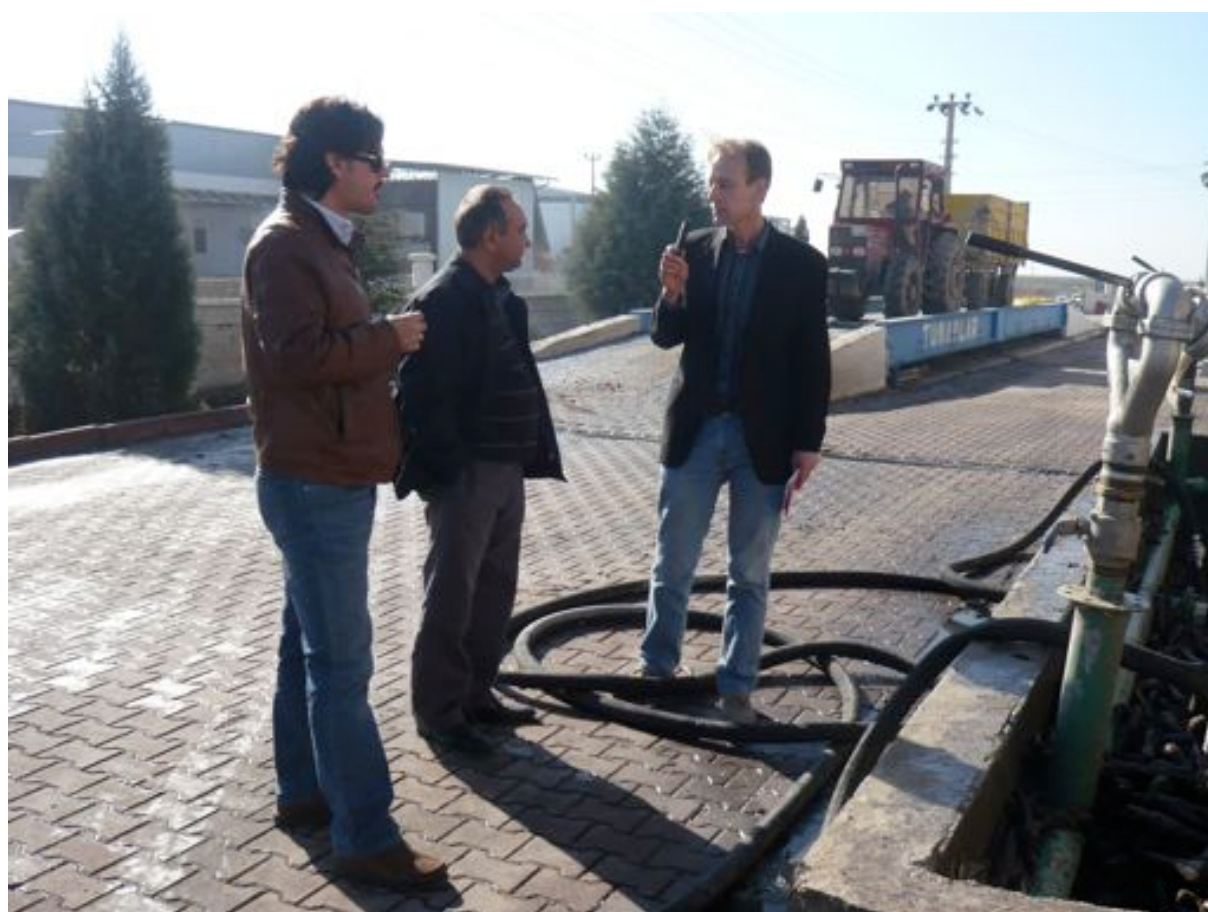
Special thanks to our guide, translator and driver Aytug Karatas (below left) for three very enjoyable and productive days in Cilicia and southern Anatolia. Without his able assistance, the Carrot Aid team would have accomplished only a fraction of the findings presented here.

Arif Yigit (below, centre) and Menmev Yigit of the Erkon Konsantre juice factory in Eregli, Nedim Günseven of the Günseven Salgum factory in Eregli and Celalettin Unsay of the Karmey juice factory in Karaman provided much useful information about black carrot horticulture.

Thanks to Director General Mevlüt Gümüş, Agricultural Engineer Hasan Çelen and interpreter Kübra Keskin of the Ministry of Agriculture in Ankara for giving their time and useful advice.

Nicolai Ballin of the Danish Veterinary and Food Administration (*Fødevarestyrelsen*) researched and wrote the section on α - and β -carotene.

Landowners Fatih and Feridun Günseven of Eregli provided many details about black carrot seed production techniques.





A line of trucks filled to the brim with black carrots ready to be juiced at the Aroma juice factory in Karaman, 27th November 2012. Black carrots are now grown on an industrial scale in southern Anatolia, to supply the rapidly growing demand for organic black carrot juice as a food colourant that is exported worldwide. Photo © Mikael Wivel.