Introduction

The history of hazelnut culture dates back 5000 years, and its origin spans from Caspian Sea shores to China, which includes northern Anatolia and the Caucasus. Historical documents record that hazelnut was growing in northern Turkey’s Black Sea coastal area approximately 2500 years ago, and it has been transported to many other countries during the last six centuries.

Hazelnuts have a very distinguished place in human health and nutrition by being one of the most important ingredients of the chocolate industry. They have properties that contribute to healthy diets by decreasing cholesterol, and they contain high quality vegetal fat (64.2%), protein (16.5%), carbohydrate (14%), rich minerals (phosphorous, iron and calcium), and vitamins (A, B1, B2, B6, C and E).

Particularly over the last 600 years hazelnut has an unparalleled tradition and an essential place in Turkish horticulture because of export-driven production and its use as a raw material in the food industry. They have properties that contribute to healthy diets by decreasing cholesterol, and they contain high quality vegetal fat (64.2%), protein (16.5%), carbohydrate (14%), rich minerals (phosphorous, iron and calcium), and vitamins (A, B1, B2, B6, C and E).

According to the statistical records, hazelnut production is found in 33 provinces to some extent, however, 95% of the total production occurs in the Sakarya, Giresun, Düzce, Samsun and Trabzon provinces (Figure 1).

Hazelnut is considered to be a strategic crop for the eastern Black Sea because it is the only income generating occupation for many people in this region. It is too challenging to grow other crops in this area because of the sloping land, high rainfall and high humidity. Hazelnuts, with their bushy habit, also help to control erosion in this region (Figure 2).
The majority of hazelnuts produced in Turkey are used in processing, 70% are used in the chocolate industry, 20% for pie and candy making, and only 10% are sold as an unprocessed product.

Harvest, drying and postharvest handling

Hazelnut harvest in Turkey takes place between August and September, and growers generally pick clusters by hand. From the first week of August, growers observe the hazelnut clusters to predict harvest time (Figures 3 and 4). Fruit drying has been carried out traditionally in natural conditions using solar energy. This causes some difficulties and defects in quality, especially in humid seasons. Research has been carried out to develop artificial drying systems to overcome this problem, however, outcomes from those efforts have not yet been widely put into practice.

Marketing and exports

Turkey has a lot of expertise in marketing hazelnuts, either as unprocessed products or processed products (of which there are at least 48 different types), in local and especially in export markets. There are over 300 companies specialised in storing and marketing
hazelnut and its products. About 60 of these companies export more than one million SUS in value annually. There are around 200 hazelnut processing enterprises, of which 25 have integrated facilities.

Today, in addition to accounting for 75% of the world production (around 580,000 t), Turkey is the top exporter of hazelnuts and hazelnut products, with 240,000-270,000 t kernels exported (85% of the world export) (Table 2). This represents between 1.7 and 2.8 billion SUS revenue annually for the last five years. Turkey exports its hazelnuts to more than 50 countries. The EU countries account for 85% of export destinations. Within that, approximately 50% goes to Germany, followed by Italy, France, The Netherlands and the UK. Outside the EU, Switzerland is the number one importer, using hazelnut products in their famous chocolate industry.

Both the natural nuts and kernels must pass very strict physical and chemical quality and hygiene control measures (Figures 5 and 6), and end products are packed mechanically. Product diversification is a high priority for the future, and new enterprises with sophisticated infrastructure are being encouraged because this development promotes consumption and increased exports of hazelnut products.

Important cultivars


Properties of some outstanding hazelnut cultivars (short descriptions)

There have been various publications characterizing Turkish hazelnut genetic resources, cultivars and breeding types, published in Turkish and in English (Ayfer et al., 1986; Çalışkan and Çetiner, 1997; Balık et al., 2016). Short descriptions of some very important Turkish hazelnut cultivars are given below.

‘Tombul’

This is the most important hazelnut cultivar grown in Turkey, and is particularly common in the Giresun province. It was selected by farmers from a natural hazelnut population during very old times. It represents the image of “Turkish hazelnut” because of its very high quality and it is extremely well-known in international markets. It has an alternate bearing tendency, however, stable, high yields are possible if good orchard management techniques are followed. Mature nuts are well-rounded and have a tidy shape, and its name comes from this physical appearance. Fruit length is approximately 18 mm, width is 17 mm, and kernel ratio is 50.52%. The nut flesh of ‘Tombul’ is white and bright. Nut size: 166 mm; kernel size: 126 mm; nut weight: 1.8 g; kernel weight: 10 g; nut/kernel ratio: 54.4%; protein content: 17.1%; fat content: 59.8%; harvest date: 10-15 August (Figures 7-9).

‘Sivri’

This is another very important traditional cultivar. Although it can be found in almost the entire hazelnut region, it is most commonly produced in the Giresun province. This cultivar is highly productive but it is sensitive to drought, and as a result, there is unacceptably high pre-harvest fruit drop in dry seasons. Nut size: 17.1 mm; kernel size: 13.2 mm; nut weight: 2.0 g; kernel weight: 1.0 g; nut/kernel ratio: 49.9%; protein content: 17.6%; fat content: 60.9%; harvest date: 10-15 August (Figure 10).

‘Çakildak’

This is a standard cultivar that is widespread in the Ordu province. It is also known as ‘Delisaya’ in the western Black Sea region and is produced in quite large quantities. It is quite tolerant to late spring frosts because it has very late bud burst compared with other cultivars. It adapts to almost all ecological conditions and has a very high yield and large nut size. However, the flavour is not so good. Nut size: 17.6 mm; kernel size: 13.8 mm; nut weight: 2.1 g; kernel weight: 12 g; nut/kernel ratio: 55.8%; protein content: 17.6%; fat content: 59.4%; harvest date: 20-25 August (Figure 11).
This is a large and attractive hazelnut cultivar mainly grown in the Trabzon vicinity. Its shell is reddish-brown and 17.9 mm wide. Nut size: 17.4 mm; kernel size: 12.6 mm; nut weight: 1.7 g; kernel weight: 0.8 g; nut/kernel ratio: 50-53%; protein content: 18.6%; fat content: 58.3%; harvest date: 15-20 August (Figure 12).

‘Palaz’
This is commonly grown in the Ordu and Samsun provinces, and can be easily distinguished by its tick-leaf tissue and long, split husk. Its main defect is that it is sensitive to many diseases and pests. Nut size: 17.5 mm; kernel size: 13.7 mm; nut weight: 2.1 g; kernel weight: 1.1 g; nut/kernel ratio: 51.4%; protein content: 17.4%; fat content: 61.0%; harvest date: 10-15 August (Figure 13).

Recently released cultivars

‘Okay 28’
This cultivar was developed in a breeding programme undertaken by the Hazelnut Research Institute by crossing ‘Tombul’ × ‘Kargalak’ cultivars, and was registered in 2012. Productivity and nut/kernel ratio are high. Bud burst is one week later than ‘Tombul’, which is important for late spring frosts. Nut size: 20.1 mm; kernel size: 15.4 mm; nut weight: 2.9 g; kernel weight: 1.5 g; nut/kernel ratio: 54.6%; protein content: 16.8%; fat content: 51.3%; harvest date: 15-20 August (Figure 14).

‘Giresun Melezi’
This is another hybrid of ‘Tombul’ × ‘Kargalak’ developed through cross-breeding by the Hazelnut Research Institute, and registered in 2012. Nut size: 19.4 mm; kernel size: 13.9 mm; nut weight: 2.4 g; kernel weight: 1.2 g; nut/kernel ratio: 51.7%; protein content: 20.4%; fat content: 58.5%; harvest date: 15-20 August (Figure 14).

‘Allahverdi’
This was selected by the Hazelnut Research Institute from the natural hazelnut populations of the Black Sea region, and registered in 2015. Bud burst is 15 days later than ‘Tombul’ which means it is more likely to escape late spring frosts. Compared with ‘Tombul’, ‘Allahverdi’ has more male flowers, pollination lasts one week longer, the empty fruit ratio is lower and the yield is double. It has light alternate bearing, and low sensitivity to drought, frost, diseases and pests. Nut size: 17.2 mm; kernel size: 12.2 mm; nut weight: 1.8 g; kernel weight: 0.8 g; nut/kernel ratio: 49.3%; protein content: 19.5%; fat content: 58.0%; harvest date: 10-15 August (Figure 15).

Research and development activities

The first institution responsible for hazelnut research and development in Turkey was the Hazelnut Research Institute, which was established in 1936 in the Giresun province. This institute undertakes R&D activities on cultivar development, improving growing techniques and orchard management, plant health, harvest and postharvest technologies, socio-economic aspects of hazelnut industry, and extension & training.

Other institutions dealing with hazelnut research and innovation include:

- Black Sea Regional Research Institute of the Ministry of Food, Agriculture and Livestock in Samsun province,
About the authors

Sahin Anil is an associate professor in Horticultural Sciences at the General Directorate of Agricultural Research and Policy (GDAR). He is a senior researcher in pomology and research manager of horticulture, and has been serving for more than 42 years at the Ministry of Food, Agriculture and Livestock. He was Deputy Director General of GDAR between November 1995 and September 1996 and between February and November 1999, and Department Head of Horticultural Research between May 2003 and March 2005 and between September 2010 and August 2011. Dr. Anil has been Country Contact Person, Governing and Management Board member and Work Package leader in EU funded ERANET projects, namely ARIMNet and CORE ORGANIC, for the last eight years. Currently, he is a Ministerial Advisor located at the GDAR. He is a member of the International Society for Horticultural Science (ISHS). E-mail: sanil@tagem.gov.tr

Haydar Kurt has a PhD degree in hazelnut growing techniques. He worked at the Hazelnut Research Institute from 2000 to 2001 as research staff, between 2001 and 2004 as Deputy Director, and from 2004 to 2005 as Acting Director. Since 2010, he has been working at the General Directorate of Agricultural Research (GDAR) as the coordinator of Nut Crops Research programme. E-mail: hkurt@tagem.gov.tr

Aysun Akar is a hazelnut specialist. E-mail: aysun.akar@tarim.gov.tr

Cigdem Bulam Kose has been working in the Plant Health Department of the Hazelnut Research Institute since 2006. She is currently serving as the deputy Director of the Institute. Her specialty is hazelnut pests. E-mail: cigdem.kose@tarim.gov.tr

New R&D challenges

• Determining new suitable crossing parents that have high tolerance to biotic and/or abiotic stresses, and developing stress-tolerant cultivars with advanced breeding methods such as marker-assisted selection;
• Development of new cultivars with no alternate bearing (or very little), high yields, and superior quality, using innovative breeding techniques including mapping, marker-assisted selection, and transformation;
• Improving fruit set and nut/kernel ratio and decreasing empty nut ratio through pollination and fertilization studies;
• Developing innovative methods for mass propagation of hazelnut saplings with reasonable cost;
• Improving mechanical harvest and fruit drying techniques;
• Improving postharvest technologies;
• Implementation of CIS and Remote Sensing technologies to more accurately estimate total production, and forecast biotic and abiotic stresses.

Titles of reports of some important research projects undertaken and published by the Hazelnut Research Institute between 1998 and 2014:

• Report of hazelnut genetic resources project (1998);
• Hazelnut cultivar development by cross-breeding (1999);
• Yield trials for new hazelnut cultivar candidates obtained from selection studies (1999);
• Studies on the relationships between carbohydrate metabolism and alternate bearing tendency with respect to pruning and fertilization (1999);
• The establishment of a data base for production, production costs and marketing of hazelnut in Turkey (2006);
• Economic analysis of hazelnut producing holdings in Giresun, and determination of growing and marketing problems (2012);
• Development of new hazelnut cultivars through selections from ‘Tombul’ hazelnut populations in Giresun and Trabzon provinces (2012);
• Determination of the effects of rejuvenation pruning on the yield and quality at old hazelnut orchards (2013);
• The impact assessment of research and development programmes on the hazelnut industry (2013);
• Determination of the farmers’ behaviours to the agricultural insurance implementations, issues and suggestions in the eastern Black Sea region (2014);
• Socio-economic analysis of new hazelnut strategy (2014).

Plant Protection Central Research Institute of the Ministry of Food, Agriculture and Livestock in Ankara;
• Marmara Research Centre of the Turkey Scientific and Technological Research Council;
• Agricultural Faculty of Ondokuz Mayis University in Samsun province;
• Agricultural Faculty of Ordu University in Ordu province;
• Agricultural Faculty of Ankara University.
New books, websites

Book reviews

The books listed below are non-ISHS-publications. For ISHS publications covering these or other subjects, visit the ISHS website www.ishs.org or the Acta Horticulturae website www.actahort.org


Kiwifruit is one of the few new fruit to be commercialised over the past century – others being macadamia, avocado and blueberry. Much of the early commercial development of this crop occurred in New Zealand, particularly during the latter half of the 20th century, and production rapidly followed into other countries around the world, including Italy, France, Greece, Chile, Japan and the USA. These developments were based on a very limited range of germplasm and almost entirely on one cultivar, ‘Hayward’.

The origin of kiwifruit is, in fact, China, which has a rich diversity of species within the genus Actinidia. However, access to germplasm and understanding of the diversity of this genus outside of China has been very limited until recently. Further, the successful commercialization of kiwifruit in other countries has resulted in Chinese fruit growers and scientists being more aware of the value of this germplasm within China, along with the opportunity to establish a commercial industry within that country. Accordingly, both scientific and commercial activities have accelerated over the past 30-40 years. Nonetheless, much of the information that has resulted from such developments has been published mainly in Chinese and has been difficult to access elsewhere.

‘Kiwifruit: The Genus Actinidia’ has, for the first time, summarised in English much of the published scientific knowledge secured on this crop in China, along with details about the Chinese industry. It includes references to research elsewhere in the world, especially in New Zealand and in Italy. The book is authored by Professor Hongwen Huang, Director, Wuhan Botanical Garden, Chinese Academy of Sciences, Wuhan, China, in association with 24 other contributors from a number of other research institutes and universities across the country.

The book is presented in eight chapters: Systematic and Genetic Variation of Actinidia; Species; Natural Distribution of Genus Actinidia; Domestication and Commercialisation of Actinidia; Biology; Genetic Improvement, and Cultivar Development; Main Cultivars in Commercial Production; Cultivation and Management; and Harvest and Storage. The real value of this text is the comprehensive information that is presented on the different Actinidia taxa, their distributions, the relationships between them and their commercial potential (Chapters 1, 2 and 3). This includes detailed discussion about the taxonomic and nomenclatural changes that have recently occurred (and will no doubt continue to occur in this extensive genus).

Chapter 1 provides an excellent presentation about the challenges involved in the taxonomic treatment of the genus. It includes very good summaries of previous attempts at classification of species and of the revisions that have recently occurred. Topics such as ploidy variation, pollen characteristics, flower morphology and sex variation (all Actinidia taxa are functionally dioecious) and the evolution of particular species are very well covered.

Chapter 2 in particular is richly illustrated with color photographs showing details of the vegetative, floral and fruit characteristics of each of 106 species and varieties within the genus, and detailed maps showing their current distribution within China. Chapter 3 further develops the information about species distribution by defining, in detail, the ecological characteristics of each of the regions where the species are located naturally. This information would have been enhanced had some photographs been included showing the Actinidia germplasm in these natural locations (noting that three such images are included later in the text in Chapter 5). Chapter 6, which describes in detail characteristics of main cultivars that are currently used in commercial production, is also very informative in that it includes descriptions of those involved within the industry in China (which differ somewhat from those used in other countries). This section, too, is well illustrated with excellent color photographs.

The other chapters involving domestication, commercialization and the management of commercial crops, although important, are of less value than the chapters outlined above. More detailed information on those topics is available from other countries in more comprehensive texts on the pre- and postharvest management of this crop. Nonetheless, the information is valuable in that it provides detail of production practices in

References

Balik, İ.H., Balık, S.K., Beyhan, N., and Erdoğan, V. (2016). Turkish Hazelnut Cultivars (in Turkish and English) [Trabzon, Turkey: Hazelnut Promotion Group].