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GENERAL MECHANIZATION OF SHELLED HAZELNUT PROCESSING PLANTS

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Abstract: Anatolia is the most important centre of hazelnut in the world. The wild species that generate the source of culture varieties have spread from Anatolia. Hazelnut production in Turkey is generally carried out in the Black Sea Region. Turkey provides about 70 % of world production with hazelnut production of 550,000 tons / year according to the average of the last ten years. The fact that the shells of the nuts are broken efficiently without harming the fruit is very important in terms of protecting the economic value of these fruits. In this article, it has been tried to give the sequence of the hazelnut crushing mechanism which has an important place in this economic value.
Keywords: hazelnut, mechanization

1. INTRODUCTION

Hazelnut production in Turkey is generally carried out in the Black Sea Region. Turkey, while varying according to years provides about 70% of world hazelnut production (550,000 tons/year) according to the average of last ten years. Turkey is followed by Italy, Azerbaijan, USA, Georgia and Spain, respectively (Table 1).

Table 1. World hazelnut production (shelled) [ton]

Countries	2009	2010	2011	2012	2013	2014*	Rate (%)
Turkey	500,000	600,000	430,000	660,000	549,000	412,000	68
Italy	85,000	87,200	140,000	84,000	100,000	80,000	13
Azerbaijan	30,000	25,000	55,000	40,000	35,000	25,000	5
Georgia	27,000	40,000	30,000	28,000	40,000	35,000	4
USA	42,600	24,500	35,000	32,000	40,200	36,300	4.5
Spain	18,000	20,000	22,000	16,000	18,000	19,500	2.5
Others	20,000	27,000	27,000	25,000	25,000	25,000	3
Total	722,600	823,700	739,000	885,000	807,200	632,800	100

Hazelnut production is being fulfilled in 33 different provinces of Turkey. In 2014 year, 32 % of hazelnut planting areas are in Ordu, 17% in Giresun, 13% in Samsun, 10% in Sakarya, 9% in Trabzon and 9% in Düzce *(GTB Hazelnut Report.. 2015)*. When the general situation of the nuts in the world is examined, it is observed that wild varieties of hazelnut which is the most common breeding after almonds, are found in every region in the northern half and temperate climatic zone. Cultivars are mostly grown in Turkey, Italy, USA, China, Azerbaijan, Georgia. When the last 5 years' data are analysed, it is seen that the total hazelnut areas in the world have changed between 800 - 905 thousand hectares (Table 2).

Table 2. Hazelnut areas in the world [ha]

Countries	2009	2010	2011	2012	2013	2014*	Rate (%)
Turkey	642,866	667,865	696,964	701,407	762,144	701,141	77
Italy	70,256	70,492	70,492	57,992	70,492	71,200	8
Azerbaijan	22,193	23,242	23,242	23,968	23,242	23,000	3
Georgia	12,000	15,500	15,500	12,400	15,500	18,000	2
USA	11,614	11,938	11,938	11,890	11,462	12,500	1
Spain	14,536	13,803	14,067	14,000	15,000	15,000	2
Others	33,000	34,900	35,100	57,186	40,000	63,350	7
Total	806,465	837,740	867,303	878,843	877,840	904,191	100

Approximately 80% of this amount is in Turkey, 8% in Italy, 3% in Azerbaijan and 2% in Georgia (TMMOB. 2016). In addition to data on production quantities and areas, other important aspect of hazelnut is that of breaking of nuts such as hazelnut which are produced intensively in the world and especially in our country and that are broken efficiently without damaging the fruit in order to protect the economical value of these products. One of the main factors affecting the quality of hazelnuts is processing conditions *(Özdemir and Akıncı. 2004)*, because, as a result of the shell crushing process the damaged fruits lose their value. This situation is even more important in terms of products such as hazelnuts which have an important place in the Turkish economy *(Saraç I.. 2013)*. The hazelnut harvest in Turkey is usually carried out by hand and the harvested hazelnuts are brought to the factory immediately after they have been dried in large areas or immediately after sowing.

There were two specific objectives of this article. The first was to explain briefly hazelnut production of Turkey. The second was to give the sequence of the hazelnut cracking mechanism which has an important place in this economic value.

2. GENERAL PROPERTIES OF HAZELNUT CRUSHING PLANT

Firstly, in order to better define the hazelnut cracking and processing activities and to determine the specific properties of the produced hazelnut varieties, studies were made on the standardization of hazelnuts according to certain criteria *(Baş H. 1993)*. In this scope, descriptive hazelnut standards such as internal hazelnut, foreign matter, bitter nuts, brittle and wrinkled rotten nuts in Turkey are defined according to TS 3074. TS 3075 (TSE. 2016). While hazelnuts are divided into groups according to hazelnut trade and shapes (internal plump and pointed kernel and other), they are also divided into classes according to their characteristics such as extra, class 1 and second class. According to the size of the nuts, it is observed they are divided into dimensions. Especially in longitudinal, the difference between the largest and smallest diameters cannot exceed 2 mm. Depending on the smallest diameter in the method of separating the lengths for extra and class 1, any kind of sorting can be done by 2 mm difference *(Baş H. 1993)* (Figure 1).

Figure 1 - Sorting hazelnuts with sieves

Determination of the differences between hazelnut varieties and physical properties such as hazelnut size, shape, porosity, volume, density, limit speed and breaking force is necessary for the development of hazelnut processing machines. The functionality of most machines depends on their fruit size and shape. For example, sphericity is an important feature in that hazelnuts influence the easy of workability by the food industry. Due to this reason. varieties which are closer to fruit-shaped sphere than others can be grown. Studies have shown that mechanical properties play an important role in many technological processes and determination of fruit quality *(Aktaş et al. 2007)*. Numerous works have been dedicated to physical and mechanical parameters regarding different varieties of nuts. Braga *et al*. studied the mechanical behavior of macadamia nut under compression. Delprete and Sesana worked on mechanical characterization of kernel and shell of hazelnuts to improve the discrimination between conform and non-conform hazelnuts. Similarly, Güner *et al*. studied the mechanical behavior of hazelnut under compression loading.

3. HAZELNUT CRUSHING SYSTEM

In Turkey, hazelnut gardens have a structure that does not meet the standards due to variety and many types. This situation causes problems such as having many kinds of hazelnut which are not suitable for hazelnut standards and foreign market demands, which can easily be damaged on the market. Therefore, tolerances related to the quality of hazelnut, especially in exports are exceeded and as a result prices can fall. Crush breaking efficiency is not at the desired level during the crushing operations in many types of plants which are not in compliance with the standards. It is clear that the lack of standardization in hazelnuts will hamper the development of the mechanization level and reducing the cost of production in the future, as well as the current situation *(Demir and Beyhan.. 2000)*. It is observed that the most suitable crushing system for hazelnut is the mill system of Turkish hazelnut.

The fact that the system is cheaper and easier to establish than other systems increases the prevalence in Turkey. Hazelnut crushing factories in Turkey are working with mill system *(Pınar and Beyhan.. 1986*). (Figure 2).

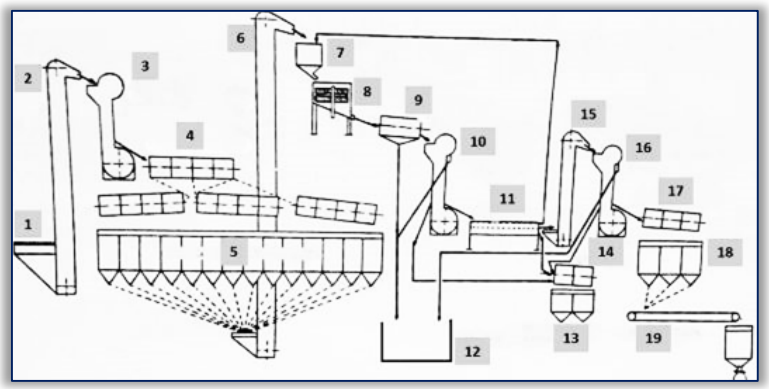

Figure 2 - Flow chart at hazelnut crushing plant: 1. Shelled hazelnut storage; 2. Elevator; 3. Pneumatic separation; 4. Classification sieve; 5. Shelled hazelnut storage under sieve; 6. Elevator; 7. Silo; 8. Crusher (stone); 9. Dust sieve; 10. Pneumatic separation; 11. Swinging sieve; 12. Dam of shell; 13. Wrinkled hazelnut storage; 14. Oblong sieve; 15. Elevator; 16. Pneumatic separation; 17. Nut sieve (kernel sieve); 18.Nut storage (kernel storage); 19. Conveyor.

5. RESULTS

— Calibration of hazelnut

Shelled hazelnuts are poured on the ground floor or in the basement of the factory. Here the hazelnuts are delivered to the numbered sieves with the help of elevators. In the first stage, the hazelnut is cleaned by passing through a dust trap. Cleared nuts pass through cylinders with a diameter of approximately 1.5 m. which are bedded on both sides with holes 10 mm to 15 mm in diameter (Figure 3).

Figure 3 – General view of sieves

Then, shell nuts below 15 mm are brought to a second classification with the help of elevators. Hazelnuts are passed through 10.11.12.13 and 14 mm hole classification sieves respectively starting from the entrance part. At the bottom of each section there are small holdings where nuts passing through the sieve can be collected. In this classification system used for shell nuts calibration, it is important the functions of dimensioning such as the number of sieve revolutions, the size of the sieve, the slope angle of sieve and the distance between the holes. *(Baş H. 1993)*.

— Crushing of Hazelnuts

Hazelnuts collected in numbered warehouses are sent to mills with transmission channels. The mill consists of two stones, the lower stone and the upper stone. The diameters of both stones are between 750-850 mm on average. They have the same taper to work with each other (Figure 4). The system has a fixed stone on top and a rotating stone on the bottom. The bottom stone rotates with an average of 120 rpm. The shelled nuts are broken at the outermost part of the stone in a part about 60 mm wide. The conic section of the inner zone that can reach this region, is greater. The taper width is very small. Crushed hazelnuts come out with the effect of centrifugal force of stone together with inner and shells. Then, the broken nuts are conveyed to the separate compartments as the inner and the shell in the closed channels with the ventilation system.

Figure 4 – General view of the lower stone and the upper stone

— Sizing of the inner nuts

The inner hazelnut calibration is the same as the method for calibrating the shelled hazelnuts. The only difference here is that the sieve holes are in the diameter between the upper and lower diameters of the inner nuts. The differences between the inside of the hazelnut, the cylindrical sieve and the regions on it are divided into diameter groups as well. Classification of hazelnuts has become an indispensable stage in hazelnut trade.

Figure 5 – Selecting foreign materials via hand and laser system

— Selection of inner hazelnut

Lastly, unbroken or cracked hazelnuts are re-sieved for the last time. The inner hazelnuts are moved on bands rotating at a heavier speed, which are designed to be 450-550 mm wide and different lengths according to the structure of the factory before packaging. At this time, wrinkled, broken, bruised, rotten, crusty and other foreign materials are selected by the workers standing on both sides of the band (Figure 5). With the developing technology in recent years, this operation has been done with some sort of laser separation machines in some enterprises (Figure 6), saving considerable amount of labour cost.

Figure 6 – Hazelnut storage

Especially in the integrated facilities, hazelnuts collected in the internal hazelnut storage are filled with nuts which can vary between 40 and 80 kg and are made ready for transportation.

4. CONCLUSION

Although there are no major mechanization problems in hazelnut operations in Turkey, especially the level of damaged rate is still not at the desired level.

Classification of hazelnut is much more important than crushing. Classification of the nuts according to their diameter values will ensure that the crushing range. For this reason, in recent years new factories in Turkey have been classifying different diameters with 0.5 mm sensitivity instead of 1 mm diameter for better classification.

In addition, the start-up of the use of laser sorting machines resulted in a significant reduction in labor costs. In addition, it is possible to do business on this site much faster and with fewer incentives.

Also, it can be said that researches on hazelnut crushing facilities will be useful in order to reduce the amount of damaged hazelnut.

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