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MOISTURE LOSS DYNAMICS IN HAZELNUTS UNDER SUN AND SHADE CONDITIONS

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SUMMARY

The purpose of the research - The research aimed to investigate the dynamics of moisture loss in hazelnuts under different drying conditions. The goal was to compare the effectiveness of sun and shade drying and to analyze how different genotypes, including the local 'Ata-baba' cultivar, respond to these treatments.

The methodology of the research - Hazelnut samples ('Ata-baba' and two genotypes) were collected from orchards in Lekit village, Gakh district of Azerbaijan. Drying treatments were arranged so that genotype 1 was dried only in shade, genotype 2 only in sunlight, and 'Ata-baba' under both conditions. Nuts were weighed individually twice daily until a constant weight was achieved, and percentage moisture loss was calculated.

The practical importance of the research - The study provides practical recommendations for hazelnut producers to choose effective drying methods that minimize biochemical deterioration and preserve kernel quality.

The results of the research - Sun drying was significantly more effective, with nuts reaching constant weight within 5–6 days, while shade drying required longer. Total moisture reduction ranged from 19.33% in genotype 1 (shade) to 27.94% in 'Ata-baba' (sun). Initial drying rates were also higher under sun conditions, highlighting both environmental and genetic influences.

The scientific novelty of research - This is the first comparative study in Azerbaijan that systematically evaluates the combined effect of drying conditions and genotype on hazelnut moisture loss.

Keywords: Hazelnut, Moisture loss, Drying methods, Ata-Baba cultivar, Genotypes

Introduction

Drying is one of the oldest processing methods and involves the evaporation of both free and bound water from moist material (Karam, 2016; Turan and İslam, 2019).

Despite the development of numerous preservation techniques in recent years in line with technological progress, drying continues to be one of the most widely applied and preferred methods, as it effectively lowers the moisture content of foods to levels that inhibit microbial growth and spoilage (Köse, 2018).

As one of the main quality indicators, the moisture content of hazelnut fruits must be below 12% in the whole nut and below 6% in the kernel. At harvest time, the moisture content of ripe fruits that have fallen to the ground ranges between 16-30%. In rainy months, this amount is even higher (Sirin, 2004; Solar and Solar, 2016). Since moisture distribution in the raw material greatly affects the roasting process (Fontana, 2014), having moisture spread evenly can be viewed as a desirable quality characteristic (Vrtodušić 2022).

It is well understood that when the moisture level is high, it creates favorable conditions for the growth of micro-fungi. These fungi release enzymes that break down carbohydrates into their basic building units. High moisture can also cause lipids to undergo hydrolysis, leading to the formation of free fatty acids. In nuts, such chemical changes often cause the product to develop a bitter flavor, which is undesirable for consumers and can negatively affect different industrial uses of the nuts (Silvestri, 2021).

In an experiment, mold developed least when the nuts were incubated in dry conditions – either placed on wire screens or on dry soil. The greatest mold growth occurred on nuts kept on moist soil, showing a significantly higher incidence compared to those on air-dried soil or wire screens. When humidity was high but the nuts were not in direct contact with moisture, those placed on wire screens showed noticeably more mold than nuts kept in completely dry environments (Pscheidt, 2019).

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When hazelnuts are kept at high moisture levels and elevated temperatures, they can quickly become rancid. Researchers have identified more than 100 different mould species on hazelnuts, and some of them can produce harmful toxins under certain conditions. Two species of particular importance are *Aspergillus flavus* and *Aspergillus parasiticus*, both of which are capable of producing aflatoxins – highly toxic compounds. Aflatoxins are the most common toxins found in hazelnuts. They usually form when mould grows on the nuts in the field, but their levels can continue to rise during storage (Kibar and Öztürk, 2009).

There are two forms of drying: natural and artificial. Natural drying is carried out using sunlight and is economically efficient; however, depending on environmental conditions, the duration and rate of drying may vary (Maisnam, 2017). Among sun-drying techniques, drying hazelnuts on concrete ground is recognized as more effective than using grass surfaces (Turan, 2018).

Maintaining market supply with superior products remains a critical necessity (Kaya, 2011). For lipid-rich commodities, the speed of drying plays a decisive role in maintaining postharvest quality. Hazelnuts are particularly sensitive, as any delay in moisture reduction after husk removal increases the risk of biochemical changes. To preserve quality, the kernels must be dried rapidly to a safe threshold of less than 6% moisture. Extended drying periods, especially under direct solar exposure, accelerate lipid hydrolysis, resulting in elevated free fatty acid levels and subsequent product deterioration (Wang, 2018; Turan and İslam, 2019).

The primary purpose of this research was to compare the efficiency of sun and shade drying methods in reducing moisture content of hazelnuts and to evaluate how different genotypes respond to these treatments. Since drying directly affects lipid stability, free fatty acid development, and overall kernel quality, understanding the dynamics of moisture loss under varying conditions is essential for improving postharvest practices. By quantifying moisture reduction rates across environments and cultivars, this study aims to identify the most suitable drying approach for hazelnut production in Azerbaijan, thereby supporting both quality preservation and market competitiveness.

Materials and methods. The study was initiated on 20 August, with samples collected in their husks from three different orchards located in Lekit village, Gakh district of Azerbaijan. The material comprised the ‘Ata-baba’ cultivar along with two distinct genotypes. Drying treatments were arranged as follows: genotype 1 was dried only under shaded indoor conditions, genotype 2 was dried only under direct sunlight, while the ‘Ata-baba’ cultivar was subjected to both treatments.

For each case, 20 hazelnuts were selected; 10 were subjected to the respective drying condition, while the remaining 10 were reserved for comparison. In the sunlight treatment, nuts were placed on a concrete surface, and each nut was weighed individually twice daily using a precision balance with an accuracy of 0.01 g. The same procedure was applied in the shaded treatment, where nuts were placed on a dry wooden surface under room conditions. The sun-dried samples were transferred indoors during the night and returned outdoors during the day.

In both drying environments, the process was continued until a constant weight was achieved. Moisture content reduction (%) was calculated using the following formula:

$$\text{Weight Loss}\ (\%) = \frac{W_i - W_t}{W_i} \times 100$$

where W_i is the initial weight and W_t is the weight at a given time.

The air temperature ranged between 20–32 °C (Graph 1). During the day, the relative humidity was 40–45%.

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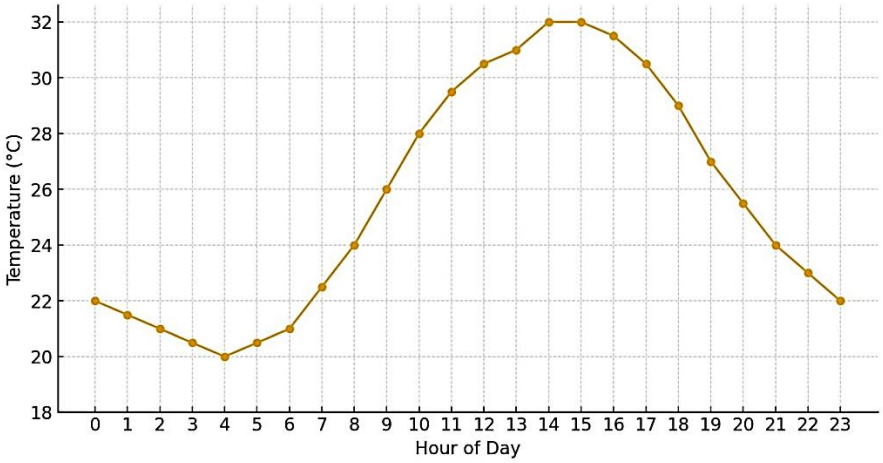
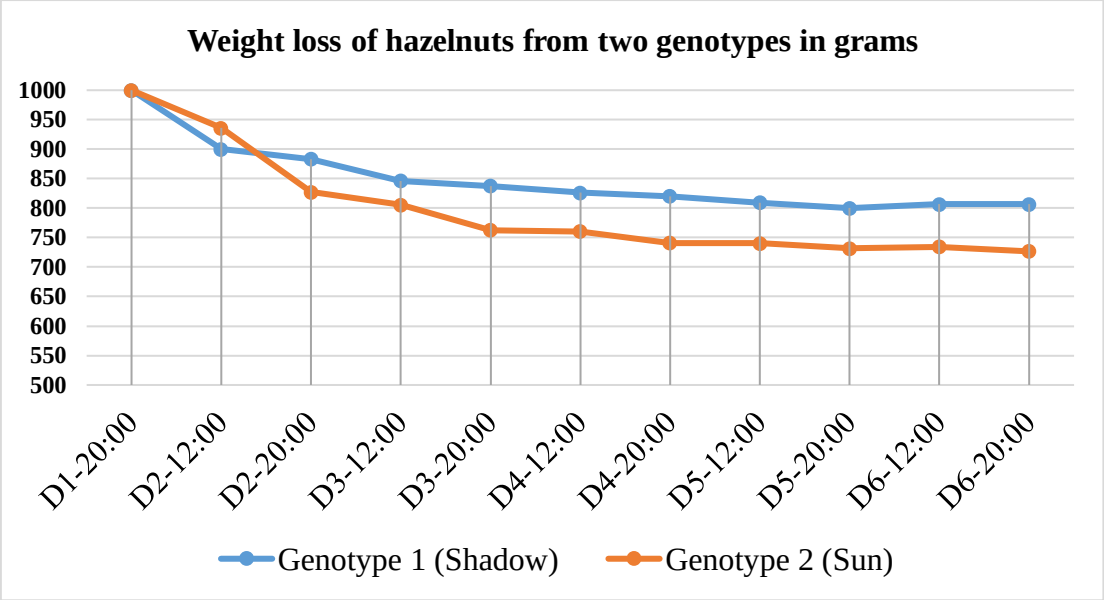
Graph 1. Temperature conditions during drying



Results and discussion. The study revealed that moisture loss varied both by drying environment and by genotype. For example, genotype 2, which was dried exclusively under sunlight, initially lost 6% moisture while in shade prior to treatment, but subsequently exhibited a further 12% reduction in moisture after 8 hours of direct sun exposure. In contrast, the 'Ata-baba' cultivar, dried directly under sunlight from the outset, lost only 7% moisture over the same 8-hour period.

Graph 2. Dynamics of moisture loss in genotypes under sun and shade drying



Graph 3. Moisture reduction in Ata-baba cultivar across drying methods

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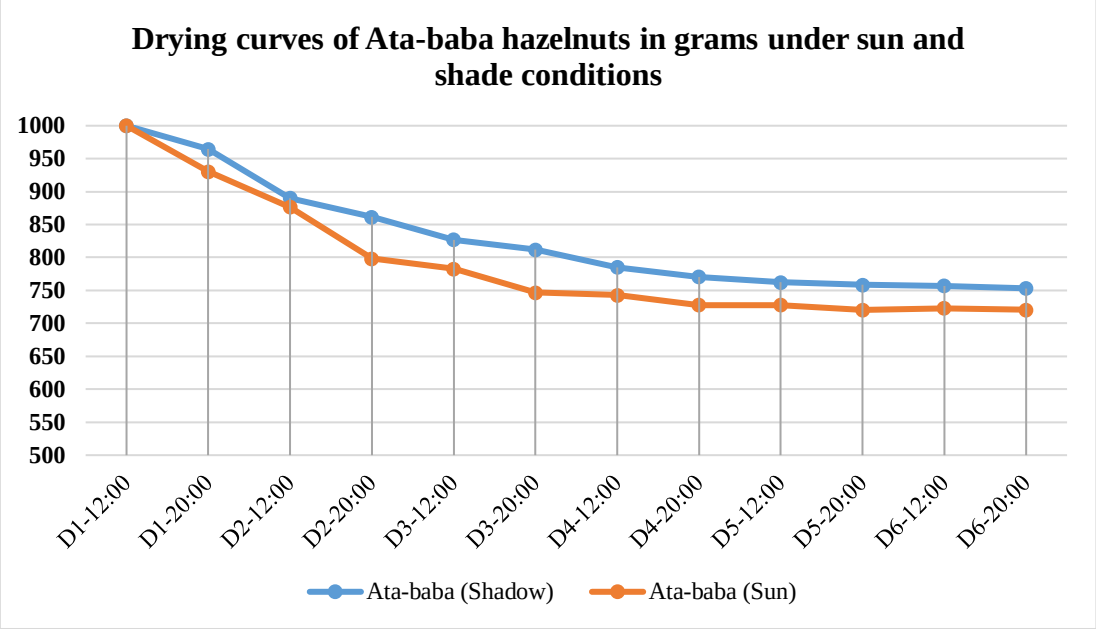

Genotype 1, which was dried solely in shaded indoor conditions, exhibited its greatest moisture loss during the first day, particularly at night. This effect may be explained by the accumulation of daytime heat indoors. Thereafter, the rate of moisture loss gradually decreased, stabilizing from the fifth day onward. A similar stabilization trend was observed in the sun-dried treatments (genotype 2 and 'Ata-baba'), which reached constant weight on the 5th–6th days.

The rate of moisture loss was highest during the initial stages of drying and varied with treatment conditions. On the first day, the rate of moisture reduction was 0.62%/hour for genotype 1 (shade), 0.24%/hour for 'Ata-baba' (shade), 1.45%/hour for genotype 2 (sunlight), and 1.39%/hour for 'Ata-baba' (sunlight).

Overall, by the end of the 5th–6th days, the total moisture loss amounted to 19.33% for genotype 1 (shade), 24.68% for 'Ata-baba' (shade), 27.34% for genotype 2 (sunlight), and 27.94% for 'Ata-baba' (sunlight).

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FINDIĞIN GÜNƏŞ VƏ KÖLGƏ ŞƏRAİTİNDƏ NƏMLİK İTKİSİNİN DİNAMİKASI

XÜLASƏ

Tədqiqatın məqsədi - Tədqiqatın məqsədi fındığın müxtəlif qurudulma şəraitində nəmlik itkisinin dinamikasını öyrənməkdir. Burada günəş və kölgədə qurudulma üsullarının effektivliyi müqayisə olunmuş və yerli "Ata-baba" sortu ilə yanaşı müxtəlif genotiplərin nəmlik itkisi dinamikası araşdırılmışdır.
Tədqiqatın metodologiyası - Nümunələr Qax rayonunun Ləkit kəndində yerləşən bağlardan götürülmüşdür. Genotip 1 yalnız kölgədə, genotip 2 yalnız günəşdə, "Ata-baba" isə hər iki şəraitdə qurudulmuşdur. Fındıqlar gün ərzində iki dəfə ayrıca çəkilmiş, sabit çəki əldə olunana qədər proses davam etdirilmiş və nəmlik itkisi faizlə hesablanmışdır.
Tədqiqatın tədbiqi əhəmiyyəti - Tədqiqatın nəticələri istehsalçılara fındığın keyfiyyətini qorumaq, biokimyəvi dəyişikliklərin qarşısını almaq və itkiləri minimuma endirmək üçün düzgün qurudulma üsulunun seçilməsində praktik tövsiyələr verir.
Tədqiqatın nəticələri - Günəşdə qurudulan nümunələr 5–6 gün ərzində sabit çəkiyə çatmış, kölgədə isə proses daha uzun çəkmişdir. Nəmlik itkisi 19,33% (genotip 1, kölgə) ilə 27,94% ("Ata-baba", günəş) arasında dəyişmişdir. İlkin quruma sürəti günəşdə daha yüksək olmuşdur ki, bu da mühit və genotip amillərinin təsirini göstərir.
Tədqiqatın elmi yeniliyi - Azərbaycanda ilk dəfə olaraq fındıqların qurudulma şəraiti və genotip amilinin nəmlik itkisinə təsiri sistemli şəkildə müqayisə edilmişdir.
Açar sözlər: Fındıq, Nəmlik itkisi, Qurudulma üsulları, Ata-Baba sortu, Genotiplər

ДИНАМИКА ПОТЕРИ ВЛАГИ У ФУНДУКА ПРИ УСЛОВИЯХ СУШКИ НА СОЛНЦЕ И В ТЕНИ

РЕЗЮМЕ

Цель исследования - Целью исследования было изучение динамики потери влаги у фундука при разных условиях сушки. Работа направлена на сравнение эффективности сушки на солнце и в тени, а также на выявление реакций различных генотипов, включая местный сорт «Ата-баба».
Методология исследования - Образцы сорта «Ата-баба» и двух генотипов были собраны в селе Лекит (Гахский район, Азербайджан). Генотип 1 сушился только в тени, генотип 2 — только на солнце, а сорт «Ата-баба» — в обоих вариантах. Орехи взвешивались дважды в день до достижения постоянного веса, и рассчитывалась потеря влаги в процентах.

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Важность исследовательского приложения - Полученные результаты дают практические рекомендации производителям по выбору оптимального метода сушки для сохранения качества ядра, предотвращения биохимических изменений и сокращения потерь.
Результаты исследования - При сушке на солнце орехи достигали постоянного веса за 5–6 дней, тогда как в тени процесс занимал больше времени. Общая потеря влаги составила от 19,33% (генотип 1, тень) до 27,94% («Ата-баба», солнце). Скорость начальной сушки была выше на солнце, что указывает на влияние как условий среды, так и генотипа.
Научная новизна исследования - Впервые в Азербайджане проведено системное сравнение влияния условий сушки и генотипа на потерю влаги у фундука.
Ключевые слова: Фундук, Потеря влаги, Методы сушки, Сорт Ата-Баба, Генотипы

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