Hot Air Roasting Methods for the Preparation of Almonds

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Mini-Review

Received: 05-May-2022, Manuscript No. JFPDT-22-62947; **Editor assigned:** 10-May-2022, Pre QC No. JFPDT-22-62947 (PQ); **Reviewed:** 24-May-2022, QC No. JFPDT-22-62947; **Revised:** 30-May-2022, Manuscript No. JFPDT-22-62947 (A); **Published:** 08-Jun-2022, DOI: 10.4172/2321-6204.10.3.001

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Keywords: Almond; Hot air roasting; Dry roasting; Post-harvest technology; Food technology

ABSTRACT

A thermal procedure suitable for almonds and other tree nuts is hot air (dry) roasting. Roasting the almonds changes their flavour profile and gives them a brown colour and a crispy texture. Specific temperature-time roasting techniques are used to achieve light, medium, or dark roasted items. The roasting conditions influence the flavour composition and intensity. Hot air roasting temperatures for almonds typically vary from 130 to 154°C (265 to 310°F). Almonds are high in unsaturated fatty acids, and because of this, almond oil is prone to oxidation during manufacturing and storage. Roasted almonds lose their quality and shelf life due to oxidative reactions. Lower hot air roasting temperatures retain the microstructure of the almond and extend its shelf life. A two-step roasting procedure can be used to improve hot air roasting for almonds. The nut microstructure is stabilised in the first process with an intermediate temperature, and the flavour and colour are generated in the second step with a higher temperature. This review summarises the hot air roasting technology and the best methods for processing and managing almonds.

INTRODUCTION

Sweet almonds (*Prunus dulcis*) are an important agricultural commodity since they are the most widely produced and consumed tree nut on the planet. Almonds provide a lot of nutritional and dietary benefits, including a high content of monounsaturated fatty acids, vitamin E, fibre, and protein, as well as a long shelf life. Almond demand continues to rise. As almond products are increasingly sent over greater distances and stored under varying conditions, it is becoming more vital for producers and processors to monitor the flavour of almonds to guarantee that the quality and value of exports and products are retained.

Almond taste must first be established and understood from a chemical and sensory basis in order to sustain the quality of almond goods. Flavor is experienced as a combination of orthonasal and retronasal detection of volatile molecules, as well as stimulation of taste receptors in the mouth during mastication. The raw almond and the various conditions, to which the almonds are subjected, either directly or indirectly, produce almond volatiles. Almond nutmeats may be exposed to sunshine, heat, humidity, metal ions, and air oxygen during harvesting and shelling, all of which can cause alterations in almond volatiles by encouraging oxidative degradation of almond lipids. Heat can be used in further processing (e.g., roasting) to affect the flavour or texture of almonds. The temperature of the food can rise beyond 100°C during roasting, stimulating maillard reactions that produce volatile heterocycles such as pyrazines, furans, pyrans, pyrroles, and pyridines, as well as tiny strecker aldehydes, ketones, and sulfides/thiols. Almonds contain roughly half of their weight in lipids (oil), which are vulnerable to oxidation processes in the presence of oxygen and light [1]. Lipid oxidation results in undesirable off-flavors and aromas, shortening the shelf life of the product. After roasting, the rate of oxidation increases. Pre-and post-process storage and handling will help to maximise quality.

RAW ALMOND HANDLING

The ideal storage conditions for almonds are cool (10°C or 50°F) and dry (65% relative humidity). Respiration will be minimised and the rate of deteriorative reactions will be slowed if the storage temperature is kept below 10°C. The almonds will stay moist at 5%-6% moisture content if the relative humidity in the storage environment is between 55% and 60%.

Hot air roasting

Changes in almond texture, color, and flavor: The moisture in the almonds evaporates while roasting, giving them a crispy texture. Non-enzymatic browning, often known as the maillard process, is a complicated reaction that occurs between sugars and amino acids or proteins. The synthesis of brown or coloured chemicals during non-enzymatic browning of almonds changes the skin colour and produces a golden or dark brown colour within the kernel. Many different volatile or non-volatile reactive chemicals are generated during non-enzymatic browning. For almonds and other tree nuts, more than 300 taste compounds are produced during non-enzymatic browning and contribute to the distinctive roast flavor [2,3]. Temperature, nut moisture level, and time all play a role in roast flavour development.

Heat transfer during roasting: Convective heat transmission is used in hot air roasting. The temperature of the nuts rises continually as a function of heat transfer during hot air roasting, and the temperature of the almonds climbs to well above 100°C (212°F). As the nut temperature approaches 130°C (266°F), the rate of temperature growth slows and moisture evaporation accelerates. During roasting, the moisture content of almonds drops to 2% or less.

The effects of roasting temperature on almond weight loss, moisture content, and color: The rate of weight loss, moisture content, and colour change are all influenced by the temperature during hot air roasting (lightness). Because moisture evaporation is a major source of weight loss, there is a close link between weight loss and changes in moisture content after roasting.

The effects of roasting temperature on microstructure: Almonds are seeds that store the energy required for germination (mainly in the form of lipids). Almonds have a microstructure that is highly compartmentalised, which protects lipids from oxygen and oxidation in the environment. The lipids in almonds are stored as intracellular oil droplets in small globular structures called oleosomes, which have a diameter of around 1 to 2 m and are covered by a monolayer membrane [4,5]. The oleosomes are isolated from one another by a honeycomb-like membrane network. Because raw almonds' subcellular arrangement protects the oil from oxygen, there is less substrate available for oxidation. The oleosomes burst, the membrane network is disrupted, and the volume of extracellular pores expands during roasting. The loss of compartmentation, as well as the increase in porosity that comes with it, speeds up oxygen transfer and oxidation. The temperature of the product during roasting and, to a lesser extent, the roasting duration influence these changes in almond microstructure. Hot air temperatures should be kept as low as possible when dry roasting almonds to retain the natural microstructure and extend shelf life [6].

Industrial roasting systems

A roasting process must meet the following requirements to produce high-quality roasted almonds:

1. The heat treatment must be consistent.
2. Color, flavour, and texture must all be consistent after heat treatment.
3. To maintain the nuts' integrity and beauty, roasting equipment must only transfer a small amount of mechanical energy to them.

Technical innovation has largely driven the development of roasting equipment and procedures. Continuous roasters (single belt convection roasters, vertical continuous roasters, continuous drum roasters, and so on) and batch roasters are among the hot air roasting systems available (semi-fluidizing batch roasters, drum roasters, ball roasters, etc.). Continuous roasters have a restricted range of roasting temperatures and periods, although they may be desirable if product and roasting degree fluctuations are low. Batch roasters are extremely adaptable, allowing for a wide range of roasting temperatures and product characteristics. Batch operations can be run in a quasi-continuous mode with current control systems, eliminating the operational differences between batch and continuous systems.

Heat transfer that is uniform

Roasting necessitates a high rate of energy transfer. It is critical to either mix the nuts, as in rotating drum or ball roasters, or transfer the energy uniformly across the nuts to eliminate temperature variances that lead to colour differences among the nuts. Mechanical activity in rotary roasters, on the other hand, may damage the surface structure of almonds, resulting in oil release.

Cooling

Cooling is an important step in the roasting process. A quick air-cooling process is required to terminate the roasting reactions after the roasting process is completed. To prevent oxidation during storage, the roasted product must be chilled to below 25°C -30°C (77°F -86°F). If the product temperature is above 30°C (86 °F), moisture may condense on the inner surface of the packaging, so it should not be packed and sealed.

Two-step hot air roasting process

A two-step roasting procedure can be used to improve hot air roasting for almonds and other tree nuts. The nut microstructure is stabilised in the first process with an intermediate temperature, and the flavour and colour are generated in the second step with a higher temperature. Microstructure deterioration during roasting is minimised in the two-step roasting method, resulting in better oxidative stability. A semi-fluidizing hot air batch roaster is used to achieve the two-step roasting process, which has been successfully marketed and deployed around the world. This two-step roasting equipment can treat more than 100,000 tonnes of nuts per year. Many industrial-scale trials comparing different nut types and varieties, roasting processes, and roasting degrees have clearly demonstrated improved oxidative stability by the two-step roasting process compared to traditional industrial hot air roasting processes for almonds, hazelnuts, and peanuts. When compared to nuts roasted using a typical hot air procedure, nuts roasted with the two-step process had better shelf stability in all of the testing [7].

DISCUSSION

Downstream processing and packaging

When processing roasted nut goods, it's important to think about how long they'll last. Roasted nuts are unstable items because oxidation begins immediately after roasting, so any further processing should be done as soon as feasible. Roasted nuts face additional challenges in terms of mechanical treatment and transportation methods. Roasted almonds are subject to mechanical damage due to their low moisture content, resulting in broken surface structures and oil leakage. As a result, just the tiniest amount of downstream processing that impacts the appearance and integrity of the surface should be used. The roasted nuts must first reach the proper temperature for chocolate making and dicing. The oxidative stability of the oil is the primary concern for applications involving ground roasted nuts. Because the cellular structure is entirely destroyed, the oil is in the continuous phase, and the surface exposed to air is decreased, microstructure degradation is not an issue. Proper packaging is required to extend the shelf life of roasted nut products. Non-transparent packaging materials are required, and modified environmental or vacuum packaging may be utilised to reduce the risk of oxidation reactions during storage. Furthermore, while storing lipids and tastes at lower temperatures is ideal, items must be protected from condensation when taken from cold warehouses.

CONCLUSION

The almonds are roasted to change their flavour profile and give them a brown colour and crisp texture. The flavour composition and intensity are influenced by the roasting circumstances. Almonds are traditionally roasted at temperatures ranging from 130°C to 154°C (265°F to 310°F) using hot air. Non-enzymatic browning occurs during hot air roasting, resulting in brown colour creation as well as the formation of volatile and non-volatile chemicals that contribute to aroma and flavour. Increased warmth also causes more weight loss and moisture loss. For nuts, two-step hot air roasting is common. The microstructure of the nut is stabilised in the first step at an intermediate temperature, and the flavour and colour are produced in the second step at a higher temperature. The two-step roasting process reduces microstructure damage during roasting, resulting in improved oxidative stability. Proper packaging is essential to improve the shelf life of roasted nut goods. To limit the risk of oxidation reactions during storage, non-transparent packaging materials are required, and a customised atmosphere or vacuum packaging may be used.

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