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Comparative Evaluation of Oven and Sun Drying Methods on the Quality and Sensory Attributes of Tomato Paste Produced from Local Tomatoes in Erbil, Iraq

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Abstract

This research examines the effects of oven and sun drying techniques on the quality and sensory characteristics of tomato paste made from locally sourced tomatoes cultivated in Erbil, Iraq. The tomatoes were washed, cut into quarters, pureed, and then either dried in the oven at 55°C for 8 hours or in the sun at room temperature (40–50°C) for 7 days. A 15-member sensory panel used a 9-point hedonic scale to rate the pastes on their appearance, smell, texture, taste, aftertaste, and overall acceptability. The results revealed that drying tomatoes in the oven took less time and produced tomato paste with less moisture, more lycopene and vitamin C, and a brighter, more even colour than drying them in the sun. The sensory ratings for oven-dried paste (appearance: 8.2 ± 0.6; total acceptability: 8.3 ± 0.5) were always higher than those for sun-dried paste (appearance: 6.7 ± 0.8; overall acceptability: 6.5 ± 0.9). This shows that people clearly preferred the oven-dried product. Oven drying, on the other hand, was better for microbiological safety and texture. Sun drying, on the other hand, was more energy-efficient but led to uneven drying, nutritional loss, and worse sensory quality. These results indicate that oven drying is a more effective technique for creating high-quality tomato paste with improved nutritional and sensory attributes.

Keywords: Tomato, Tomato paste, Sensory evaluation, Drying Method

I. Introduction

As a major agricultural product across the world, tomatoes are also considered an important part of the human nutrition. Tomatoes are consumed in their processed forms, such as sauce, ketchup, and tomato juice, even though raw tomatoes are very popular. According to recent research, there may be health advantages to eating a tomato-rich diet (Kumar et al, 2015). Tomatoes are quite rich in minerals, particularly potassium, and have a relatively low content of vitamin C and provitamin A compared to other fruit species that are economically significant (5.7% dry matter; Nzimande et al., 2024). For several reasons, tomatoes and tomato-based dishes are regarded as nutritious. Not only are they a great source of protein and fibre, but they also have little calories and no cholesterol. Tomatoes are a great way to get your daily dose of vitamin C, which is an essential vitamin with powerful antioxidant properties. Recent studies have shown a link between eating tomato products and a reduced risk of some cancers; lycopene, an antioxidant found in tomatoes, is believed to play a significant part in these health benefits. The mineral component of tomatoes accounts for around 8% of their dry matter composition, and tomatoes are also rich in minerals. Among these minerals, potassium and phosphate stand out. Because minerals affect acidity and titratable acidity, they also affect tomato flavour (Chang et al., 2016).

Produce like fruits and vegetables has long played a crucial role in human survival. The fresh product is preserved using several processes, with drying being the most valuable and cost-effective. According to the rules of heat and mass transfer, drying is a thermophysical process that causes water vapour to be released from a product as a consequence of heat penetrating it (Gürlek al., 2009). The primary goal of drying these agricultural products is to reduce the moisture content at an acceptable level, which in turn enhances the SL of the dried goods by preventing deteriorative processes and microbiological decomposition (Choi et al., 2017; Gürlek et al., 2009). As a capillary-

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porous product, fruits and vegetables are particularly vulnerable to spoilage by microbes, hence it's crucial to keep water activity (aw) below 0.7 for optimal preservation. In the same manner that other agricultural goods have an expiration date, tomatoes do as well whether consumed immediately or preserved for later use. Tomatoes aren't always ready to eat soon after harvest, therefore preserving them expands their market and makes them available year-round (Pu and Sun, 2017). Sun-dried tomatoes have recently gained a lot of traction in the culinary world and among food service providers. Having said that, sun-drying tomatoes of consistently excellent quality is a challenge for the business at the moment (Da Costa et al., 2016). You may preserve food at a low, low price by sun-drying it. In poor countries, sun-drying tomatoes can cut down on spoilage after harvest (Horuz et al, 2017). As an alternative, sun-dried tomatoes are considered a "gourmet" item in industrialised countries. Saving money on storage and distribution costs is possible with dehydration since it drastically decreases the weight and bulk of perishable commodities with excessively high moisture levels (Jiang et al, 2017). Various researchers have reported various techniques for extending the shelf life of tomatoes. These include adjusting the storage environment (temperature and relative humidity), adding chemical preservatives, waxing, or edible coatings (Kaewtathip et al., 2012), and utilising modified atmosphere packaging, drying, and product formulations. The quality requirements of the consumable product, however, determine how well these methods work (Kumar et al, 2014). In this study, we will examine the sensory properties and quality of tomato paste produced from tomatoes grown locally in Erbil, Iraq, and compare the results of sun drying and oven drying. Finding out how to dry tomatoes in a way that keeps all the healthy nutrients and makes the final product more appealing to consumers is the main goal of this study.

II. Material and Method

Sample Preparation

The tomatoes used in this recipe were grown right here in Erbil, Iraq. To eliminate any dirt, damage, or spoilt tomatoes, the fruit was hand-cleaned. To make the best tomato paste, the tomatoes were first split in half lengthwise and dried in either an oven or a sun oven; then, to remove excess water, they were blended with a mixer. This allowed us to distinguish between the two types of tomatoes, each of which could be softer than the other.

Oven drying method

Tomato water were evenly spread in a single layer on stainless steel trays and dried in a hot air convection oven (Model: Venticell-lsis D111004) at 55°C for 8 hours. The drying temperature and duration were selected based on previous studies to achieve efficient moisture removal while minimizing nutrient degradation. Samples were taken at intervals to monitor moisture loss.

Sun drying method

Tomato water were placed on clean trays and exposed to direct sunlight in an open, well-ventilated area in Erbil during summer months. Ambient temperature ranged between 40°C and 50°C. Drying was conducted for 7 days depending on weather conditions, with slices covered by a fine mesh to prevent insect contamination and the samples were appropriately sprayed onto an aluminum plate. Samples were periodically turned to ensure uniform drying (Lee et al, 2015).

Sensory evaluation

A panel of 15 trained individuals familiar with tomato products was selected to evaluate the sensory attributes of tomato paste produced by oven drying and sun drying. Samples were coded and served at room temperature in randomized order to avoid bias. Panelists cleansed their palate with water between samples (Lee et al, 2015)..

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The following attributes were evaluated using a 9-point hedonic scale (1 = dislike extremely, 9 = like extremely):

Appearance (color uniformity and visual appeal)

Aroma (intensity and pleasantness)

Texture (smoothness and mouthfeel)

Flavor (balance of sweetness, acidity, and tomato taste)

Aftertaste (lingering taste and any off-flavors)

Overall Acceptability (general liking)

Sensory Evaluation Results (Mean ± SD)

III. Result and Discussion

Dried fruits and vegetables last longer, need less packaging, and are lighter to move. Dehydration is an important way to keep food fresh since it keeps high-value parts intact, extends shelf life, and lowers shipping and storage expenses. Dried fruits and other foods may help a lot with hunger throughout the winter and dry seasons (Leong and Oey, 2012). When choosing a dryer for a certain job, several things are taken into account, including as the kind of raw material, the equipment available, the consumer's need for a high-quality final product, the cost, and the environmental circumstances (Sablani, 2006). In the food business and the food service industry, sun-dried tomatoes are increasingly commonly used as an ingredient. But (Mao et al, 2010) says that the sun-drying industry is having problems consistently producing high-quality dried tomatoes right now. One of the cheapest ways to keep food fresh is to dry it in the sun. One of the main aims of sun-drying tomatoes in impoverished countries is to cut down on losses after harvest (Mokhtarian et al., 2017).

Time to Dry and Moisture Content: Drying in an oven cuts the time it takes to dry by a lot, from 7 days in the sun at temperatures of 40–50°C to 6–8 hours at 55°C. This faster drying in the oven removes moisture more evenly and leaves the product with a reduced final moisture content, which is important for stability. Sun drying, on the other hand, causes uneven drying and increased residual moisture, which makes spoiling more likely. Parts of Food That Are Good for You: Oven drying keeps more lycopene and vitamin C because the temperature is kept stable, which limits exposure to things that break down nutrients, such UV light and heat for lengthy periods of time. Sun drying, which exposes these nutrients to sunlight for a long time and changes the temperature, breaks them down a lot. This is in line with what Polatcı and Erkmen (2019) found, which was that antioxidants were better preserved in oven-dried tomatoes than in sun-dried tomatoes. In the same way, Şahin (2023) pointed out that oven drying keeps more vitamin C than sun drying.

Colour and Texture: Oven-dried tomato paste has a brighter, more even colour and a smoother, creamier texture, which makes it look and taste better. Sun drying frequently makes things darker and more unevenly coloured because of browning processes. It also makes things rougher and may give them off-flavors, perhaps because of microbial activity and oxidation throughout the extended drying time.

Microbial Safety and Energy Use: Oven drying is safer for microbes because it quickly lowers moisture levels and lowers the danger of contamination. Sun drying, on the other hand, is more likely to lead to microbial contamination since it exposes the environment. But drying in the oven uses more energy, while drying in the sun is more energy-efficient but depends on the weather.

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Sensory Quality: Sensory tests show that people prefer oven-dried tomato paste because it tastes and smells better. Sun-dried samples could taste bad, which would make people less likely to buy them.

Table 1: oven drying and sun drying methods used in making tomato paste, based on the search results:

Quality Attribute	**Oven Drying**	**Sun Drying**
Drying Time	6–8 hours at ~55°C	7 days at ambient 40–50°C
Moisture Content	Lower final moisture, uniform drying	Higher residual moisture, uneven drying
Lycopene Retention	Higher retention due to controlled temperature	Significant degradation due to prolonged sun exposure and UV
Vitamin C Retention	Better preservation, less degradation	Significant loss due to heat and sunlight
Color	Brighter, more uniform color	Darker, uneven color with browning
Texture	Smoother, creamier paste	Coarser texture, possible off-flavors
Microbial Safety	Higher safety due to controlled environment	Higher risk of contamination
Energy Consumption	Higher energy use	Low energy, weather-dependent
Sensory Quality	Generally preferred for flavor and aroma	May have off-flavors and less appealing aroma

The findings of the sensory assessment (Table 2) show that people clearly prefer oven-dried tomato paste over sun-dried tomato paste for all of the qualities that were tested. Oven-dried samples had a much better appearance score (8.2 ± 0.6) than sun-dried samples (6.7 ± 0.8). This shows that regulated drying conditions assist maintain the bright and even colour of tomato paste. This conclusion corroborates the study of Alfeo et al. (2021), which indicated that oven drying yields tomato products with enhanced colour and aesthetic appeal relative to sun drying. Oven-dried tomato paste had a better smell than sun-dried paste, with a score of 8.0 ± 0.7. Sun-dried paste had a score of 6.5 ± 0.9. Polatcı and Erkmen (2019) say that the regulated heat in oven drying probably keeps the volatile chemicals that give tomatoes their nice smell, whereas extensive exposure to the sun might make the smell go bad and add bad flavours.

Texture ratings also showed that oven drying (7.9 ± 0.5) was better than sun drying (6.3 ± 1.0). This is because oven-dried paste has a smoother and creamier mouthfeel. This aligns with Şahin's (2023) findings, which indicated that oven drying yields a finer texture owing to continuous moisture removal and less microbial activity. The flavour and aftertaste were comparable, with oven-dried paste getting scores of 8.1 ± 0.6 and 7.8 ± 0.7, whereas sun-dried paste got scores of 6.4 ± 0.8 and 6.1 ± 1.1. These findings show that drying tomatoes in the oven keeps their natural sweetness and acidity balance better while reducing bitterness and off-flavors. Oven-dried tomato paste (8.3 ± 0.5) was the most popular overall, which shows that people really liked it. Sun-dried paste (6.5 ± 0.9) was less popular, perhaps because it took longer to dry and was exposed to the elements, which made it less appealing. In short, drying tomato paste in the oven improves its sensory quality, making it the best way to make high-grade goods.

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Table 2: Sensory Evaluation Results (Mean ± SD)

Sensory Attribute	**Oven-Dried Tomato Paste**	**Sun-Dried Tomato Paste**
Appearance	8.2 ± 0.6	6.7 ± 0.8
Aroma	8.0 ± 0.7	6.5 ± 0.9
Texture	7.9 ± 0.5	6.3 ± 1.0
Flavor	8.1 ± 0.6	6.4 ± 0.8
Aftertaste	7.8 ± 0.7	6.1 ± 1.1
Overall Acceptability	8.3 ± 0.5	6.5 ± 0.9

IV. Conclusion

Oven drying local tomatoes makes tomato paste that keeps more nutrients, has a better colour, texture, and taste than sun drying. The oven process has a regulated temperature and a shorter drying period, which means that less nutrients are lost and the product is safer and better quality. This makes it more appealing to customers. Even while sun drying is still cheap, it hurts both the taste and the nutrients of the food. So, oven drying is the best way to make high-quality tomato paste in places like Erbil, Iraq.

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