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# Persimmon (*Diospyros kaki*): Nutritional value and processed products — A review

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**Abstract**
Persimmon (primarily *Diospyros kaki*) is a seasonal fruit valued for its pleasant flavor, striking orange color and diverse bioactive composition. It provides carbohydrates, dietary fiber, vitamins (notably provitamin A/carotenoids and vitamin C), minerals (K, Ca), and phenolic compounds (tannins, proanthocyanidins, flavonoids). These constituents underlie a range of proposed health benefits (antioxidant, cardioprotective, anti-inflammatory, anti-diabetic). The fruit is processed into many products — dried persimmon, puree/pulp, concentrates, powders (spray- or freeze-dried), jams/spreads, beverages (juices, milk drinks), fermented products and value-added ingredients from peel/by-products. This review summarizes its nutritional composition, bioactive profile, key processing approaches (including deastringency methods), typical value-added products, and research/industry trends and challenges.

**Keywords:** Nutritional, value added products, astringency, bioactive

## Introduction
Persimmons (family Ebenaceae) have been cultivated in East Asia for millennia and are now produced worldwide (notably China, Korea, Japan, Spain, USA). Two common consumer categories are astringent (e.g., Hachiya) and non-astringent (e.g., Fuyu) types; astringency arises from soluble tannins and must be removed or naturally lost at full ripeness for palatability. Beyond fresh consumption, persimmons are processed into a wide variety of products — historically dried persimmons are a traditional food, while modern processing includes powders, concentrates and formulated beverages. Recent research has focused on valorization of by-products (peel, seeds) for fiber and phenolics.

## Botanical background and varieties
*Diospyros kaki* L. is the main cultivated species for edible persimmons. Varietal differences (shape, astringency, sugar, tannin content) affect processing suitability: non-astringent cultivars can be eaten firm; astringent cultivars are often processed or fully ripened prior to consumption. Variety selection guides product choice (e.g., puree for powders, astringent cultivars for traditional drying).

## Nutritional Composition
### 1. Macronutrients and Energy
Per 100 g edible portion, persimmons provide predominantly carbohydrates (simple sugars and some complex carbs), low fat, low protein, and modest calories (~70–120 kcal depending on variety and ripeness). They are a good source of dietary fiber (soluble + insoluble), which contributes to satiety and gut health.

### 2. Vitamins and Minerals
Persimmons are rich in provitamin A carotenoids (β-carotene and other carotenoids), giving the fruit its orange hue, and supply vitamin C (ascorbic acid). They also contribute minerals such as potassium and calcium in appreciable amounts. These micronutrients support vision, antioxidant defenses and electrolyte balance.

### 3. Dietary fiber
High dietary fiber is a characteristic: values vary by cultivar and maturity, but persimmons frequently contribute substantially to the daily fiber requirement per typical serving, supporting digestive function and glycemic control.

### 4. Bioactive phytochemicals (polyphenols, tannins, carotenoids)
Persimmons are notable for proanthocyanidins, condensed tannins, flavonoids and other phenolics as well as carotenoids and vitamin E. Astringent cultivars typically contain higher soluble tannins (responsible for astringency) which are also powerful antioxidants; many studies attribute antioxidant, anti-inflammatory and cardioprotective effects to these compounds. Peel and calyx often contain concentrated phenolics and fiber, which are being explored for ingredient extraction.

## Health Implications
Preclinical and human observational studies suggest potential benefits of persimmon consumption: antioxidant activity, improved lipid profiles, antihypertensive effects, glycemic moderation, and possible anti-inflammatory/cancer-modulating actions. However, while many *in vitro* and animal studies are promising, large randomized controlled trials in humans are limited — so claims should be presented with caution. Clinical relevance depends on intake, matrix (fresh vs processed), and bioavailability of bioactives.

## Processing of Persimmon
Processing aims to: extend shelf-life, concentrate flavors/nutrients, produce convenient formats, reduce astringency, and valorize by-products. Major challenges include handling astringency (especially for Hachiya-type), texture control (soft/fibrous pulp), enzyme activity (browning), microbial stability and retention of bioactives during thermal or dehydration steps. Preservation of carotenoids/phenolics during processing is an active research area.

## Common processed products and production methods

### 1. Dried Persimmons (Traditional & Modern methods)

- Traditional air-dried or sun-dried whole persimmons (e.g., "hoshigaki" in Japan) are produced by peeling and air-drying, producing a chewy-sweet product.
- Hot-air drying, freeze-drying, and osmotic dehydration are used industrially. Freeze-drying/puffing can produce crunchy fruit snacks and better retain structure and nutrients. Recent studies highlight freeze-dried persimmon powder/snack as a year-round product.

### 2. Puree / Pulp and Concentrates

Persimmon pulp is produced by washing, destemming, pulping and sieving. Concentrated persimmon (syrup/concentrate) can be produced by evaporation or membrane concentration. Enzymatic treatments or deastringency steps are often applied prior to concentration to remove soluble tannins and improve flavor stability. Such concentrates serve as ingredients for jams, bakery fillings, beverages and sauces. Patents and industrial methods emphasize enzymatic or other deastringency to preserve nutrients.

### 3. Powders (Spray-Dried and Freeze-Dried)

Spray-drying of persimmon pulp with carriers (maltodextrin) yields shelf-stable powders for instant beverages, bakery mixes and nutraceutical ingredients; process parameters strongly influence powder stability and retention of carotenoids/phenolics. Recent 2024–2025 research has explored optimized spray-drying formulations for stable persimmon pulp powder.

### 4. Beverages (Juices, Milk Drinks, Fermented Drinks)

Persimmon juice is produced by pressing pulp; clarification and deastringency may be required. Formulated products include persimmon-flavored milk drinks (stable formulations have been developed), fermented beverages and wine-like products. Persimmon-enriched dairy beverages have been shown feasible with acceptable sensory properties.

### 5. Jams, Marmalades, Spreads and Bakery Fillings

Persimmon puree is used for jams, spreads and as filling for confectionery and baked goods. Texture control (pectin content) and sugar: acid balance determines final product properties; persimmon's natural pectin and sugars make it suitable for such products with minimal gelling aids when properly formulated.

### 6. Chips, Slices and Value-Added Snacks

Dehydrated slices, sugar-coated chips and freeze-dried fruit crisps target the snack market. Process selection (low-temperature drying, freeze-drying) influences texture and nutrient retention.

### 7. By-Product Valorization (Peel, Seeds, Calyx)

Peels contain high fiber, pectins and phenolics; they are being explored for fiber-enriched ingredients, antioxidant extracts and functional food additives. Seed oil and extracts may have niche applications. Valorization reduces waste and adds revenue streams.

## Deastringency Methods (Removal of Soluble Tannins)

Astringency removal is critical for many processed products, especially those using astringent cultivars. Methods include:

- Natural ripening (soluble tannins polymerize and precipitate as fruit softens).
- Ethanol or $CO_2$ treatments induce polymerization/precipitation of soluble tannins (industrial post-harvest).
- Enzymatic treatments and calcium/protein additions are explored.
- Physical methods (storage at controlled temperature/humidity) also alter tannin solubility. Industrial patents describe enzymatic routes to reduce astringency while maintaining nutritional value.

## Effects of Processing on Nutrients and Bioactives

Thermal processing (pasteurization, concentration) can degrade vitamin C and some heat-sensitive carotenoids, while dehydration concentrates sugars and fiber. Drying and powdering can preserve many phenolics if conditions prevent excessive oxidation; freeze-drying best preserves carotenoids/phenolics but is costlier. Optimization must balance cost, shelf-life, and bioactive retention.

## Safety considerations and antinutritional factors

- **Bezoar Risk:** Unripe persimmons, particularly astringent types, can cause gastric bezoars in susceptible individuals due to tannin–protein complexes. Consumers should avoid unripe astringent fruit and processing should address astringency.

- **Allergenicity and Interactions:** Persimmon is generally safe; however, high sugar content warrants caution for diabetic individuals. Processing that concentrates sugars (confectionery, concentrates) changes glycemic impact.

## Market Trends and Research Directions

Recent research emphasizes: (1) development of spray-dried and freeze-dried powders for year-round use, (2) functional beverages and dairy products enriched with persimmon, (3) extraction and use of peel and seed fractions for fibers and antioxidants, and (4) process optimization to retain carotenoids and phenolics. Climate, cultivar selection and post-harvest handling continue to shape industry development.

## Conclusions and Recommendations

Persimmon is nutritionally valuable and rich in bioactive compounds, making it a promising raw material for diverse processed products. To maximize nutritional benefits and commercial viability, processors should: choose cultivar-product matches (e.g., astringent for drying with proper deastringency), use gentle drying (freeze- or low-temperature technologies) to retain bioactives where economically feasible, valorize peels and by-products, and validate health claims with clinical studies. Future work should prioritize human trials on functional outcomes, industrial-scale methods to preserve carotenoids/phenolics, and economically viable valorization pathways for by-products.

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