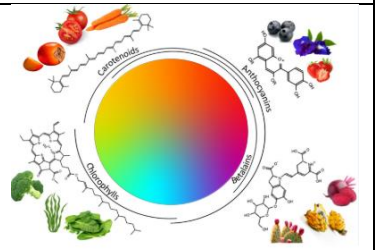
BEVERAGES

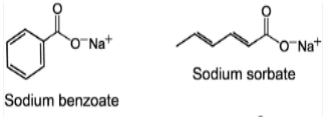
I. Classification

1. **Alcoholic beverages**
   - Fermented: beer, wine, cider, pulque, traditional fermented drinks.
   - Distilled: spirits such as whisky, vodka, rum, gin, brandy.
   - Fortified and special types: fortified wines (port, sherry), liqueurs, aromatized wines.

2. **Non-alcoholic beverages**
   - Fruit and vegetable beverages: juices, nectars, drinks, concentrates.
   - Soft drinks: carbonated and still, cola-type, flavored drinks, energy and sports drinks.
   - Dairy-based beverages: milk drinks, fermented milk beverages..
   - Functional and nutraceutical drinks

II. The main raw materials in industrial beverage production

Sugars & sweeteners	○ **Sucrose (Table Sugar):** Disaccharide (glucose + fructose), highly water-soluble. Sweetness standard (relative value = 1). It interacts strongly with water via hydrogen bonds, affecting the structure and diffusion properties of the beverage matrix. ○ **High Fructose Corn Syrup (HFCS)**: HFCS-42, HFCS-55 (42% or 55% fructose), common in soft drinks. It provides sweetness similar to or higher than sucrose, easy to handle in liquid form, increases shelf-life due to fructose's hygroscopic nature (less crystallization), modifies mouthfeel and sometimes color. ○ **Intense Sweeteners** : Provide significant sweetness at extremely low concentrations, no caloric value, allow development of sugar-free products. They bind to sweet taste receptors with high affinity, creating a temporal and intensity profile different from sucrose. Examples: Aspartame (E951), acesulfame-K (E950), sucralose (E955), stevia glycosides.	
Acidulants & pH regulators	○ **Citric Acid (E330):** Provides sour taste typical of fruit juices and lemon sodas, chelates metal ions (delaying oxidation of flavors and colorants), acidifies beverages to inhibit microbes. ○ **Phosphoric Acid (E338):** Used especially in cola-type soft drinks. it creates the sharp, metallic acidity of colas, stabilizes pH in the 2.5–3.0 region,	
Natural colorants	• Curcumin (E100): Yellow color from turmeric, stabilized by emulsifiers or solubilized with polysaccharides in beverages. Sensitive to light and oxidation. • Beta-carotene (E160a), Paprika Extract (E160c), Lycopene (E160d): Lipophilic pigments responsible for yellow, orange, red hues. Delivered in oil-in-water emulsions; chains of conjugated double bonds create vivid color but are prone to oxidative degradation. • Anthocyanins (E163): Water-soluble pigments from berries, grapes, and some vegetables; color is highly pH dependent (red in acidic conditions), but sensitive to temperature, oxygen, and light.	
Flavorings & solvents	Complex mixtures of esters, aldehydes, terpenes, and other volatiles. Volatiles are sometimes dissolved in ethanol (E1510), triacetin (E1518), or propylene glycol (E1520) for enhanced solubility and uniform release.	

Stabilizers emulsifiers, & texturants	• Modified Starches (E14xx, e.g., E1442, E1450): Increase pulp suspension and viscosity, stabilize emulsions. Substituted with phosphate or octenyl-succinate groups for improved solubility. • Pectins and Gums: Form hydrated networks that increase viscosity and prevent sedimentation and phase separation, contributing to body and mouthfeel.	
Preservatives & antioxidants	• Sorbates (E200–E203) and Benzoates (E210–E213): Extend shelf-life by inhibiting yeasts, molds, and some bacteria, especially in acidic beverages. • Ascorbic Acid (E300): Acts as an antioxidant, stabilizes color and flavor, but can also promote iron/copper-catalyzed oxidation if poorly controlled.	

III. Technology of non-alcoholic beverages

1. Fruit and vegetable juices and drinks

1. **Reception and preliminary operations:** Sorting, washing, grading of raw material. Peeling, destoning, trimming when necessary.
2. **Extraction of juice:** Mechanical pressing (for citrus, apples, grapes, berries). Crushing and enzymatic maceration to increase yield and clarify juice when appropriate.
3. **Clarification or retention of pulp:**
    - Clarified juices: enzymatic treatment and filtration/centrifugation to remove pectins, suspended solids, and turbidity.
    - Cloudy juices/nectars: controlled retention of pulp and cell fragments to give body and opacity.
4. **Standardization and formulation:** Adjustment of soluble solids (°Brix) by concentration or dilution. Correction of acidity and sugar/acid balance and addition of permitted ingredients (sugar, flavors, vitamins) according to product category (juice, nectar, drink).
5. **Preservation:** Thermal treatments (pasteurization or hot-fill; in some cases UHT), refrigeration, high pressure processing (HPP) in certain premium segments. The aseptic packaging ensures shelf stability.

2. Soft drinks (carbonated and still)

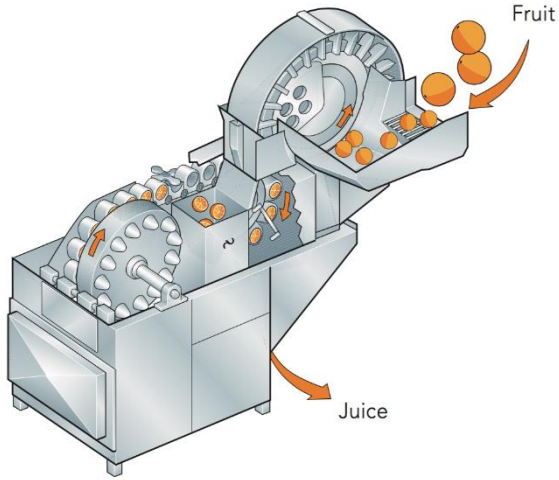
1. **Syrup preparation:** Dissolution of sugars or sweeteners, acids, flavors, and other additives in water, then, filtration and, if required, deaeration of water.
2. **Carbonation:** Dissolution of CO_2 under pressure at low temperature.
3. Filling and packaging : Filling lines adapted to PET bottles, glass bottles, cans, or bag-in-box. Use of hygienic design and, when required, tunnel pasteurization or cold-chain distribution.

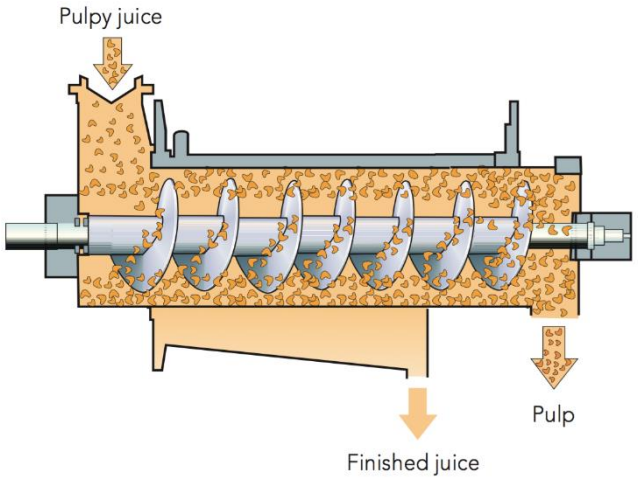
3. Dairy-based and functional beverages

- **Formulation of milk-based drinks:** adjustment of fat content, addition of cocoa, fruit, flavors, or sweeteners.
- **Fermented dairy beverages:** use of specific cultures (e.g. lactic acid bacteria) and control of fermentation temperature and time.
- **Functional drinks:** incorporation of probiotics, fibers, plant extracts, vitamins…

IV. Industrial fruit juice manufacturing

1. **Reception and preparation of raw material**: Fruits are received, sorted, and washed to remove defective fruits, foreign matter, and surface microorganisms, mainly reducing microbial load and slowing enzymatic and fermentative reactions without major chemical changes. Crushing, cutting, and destoning increase surface area for extraction; cell walls and membranes are broken, releasing vacuolar contents (water, sugars, organic acids, pigments, aroma compounds) and exposing oxidative enzymes to phenolic substrates, which can cause enzymatic browning if not controlled.
2. **Juice extraction:** Mechanical pressing separates liquid juice from the solid pomace while solutes (sugars, acids, salts, aromas) diffuse into the juice and colloids (pectins, proteins, cell-wall fragments) are released, affecting turbidity and viscosity. Optional enzymatic assistance with pectinases, cellulases, and amylases hydrolyzes polysaccharides into soluble oligomers and monomers, decreasing must viscosity and increasing juice and solute yield.
3. **Clarification or pulp management:** For clear juices, deaeration, enzyme treatment, flotation/centrifugation, filtration, and fining promote flocculation and aggregation of proteins, polyphenols, and colloids and remove high–molecular-weight pectins, reducing gel formation and haze. For cloudy juices and nectars, stabilizers such as pectin, CMC, and gums form a hydrated polysaccharide network that increases viscosity and keeps pulp particles suspended.
4. **Standardization, formulation, and possible concentration:** Standardization adjusts °Brix, pH, titratable acidity, and the levels of sugars, acids, flavors, and vitamins; changes in ionic strength and pH modify the ionization state of organic acids and aroma–colloid interactions, affecting perceived acidity and aroma release. Concentration by vacuum evaporation or reverse osmosis reduces water activity and increases solute concentrations, improving microbial stability but potentially inducing non-enzymatic browning and new aroma formation at higher thermal loads.
5. **Preservation treatments:** Pasteurization or other heat treatments inactivate spoilage and pathogenic microorganisms and key enzymes through protein denaturation, while partially degrading heat-sensitive vitamins such as vitamin C by oxidation or hydrolysis. Nonthermal alternatives like high-pressure processing, sterile filtration, or refrigeration mainly reduce microbial and enzymatic activity via membrane damage or physical removal, with limited changes to small molecules.
6. **Filling and storage:** Hot-fill or aseptic filling into glass, PET, or cartons may lead to migration or adsorption of aroma compounds at the packaging interface, and during storage polyphenols and vitamin C gradually oxidize, causing slow browning, while colloids can aggregate to form haze or sediment.





https://orangebook.tetrapak.com/chapter/fruit-processing