Processing of organic vegetables

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Outline

EU Organic farming, rules on production

Definition of fruit and vegetables processing:

- Minimally processed
- Moderately processed
- Highly processed

Description processing methods:

- Fresh-cut vegetables
- Vegetables canning
- Refrigeration and freezing preservations
- Drying vegetables
- Processing of vegetable juice and blends
- Vegetables fermentation and pickling
- Vegetable spices and herbs

Learning Outcomes

- Improved the basic and applied concepts and knowledge of food quality and processing applied to raw materials produced according to organic practices
- Enhance technical knowledge required to optimize process and technologies to organic raw materials of organic production and the factors that need to be taken into account
- Develop knowledge and skills on food quality and safety and main criteria applied to organic produce

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European Union – Organic farming, rules on production

Organic agriculture is a way of making food that respects the natural cycles of life. It minimizes human impact on the environment and works as naturally as possible in compliance with the following objectives and principles (Council Regulation, EC 889/2008):

1. Crop rotation, so that resources on the ground are used efficiently
2. Strict restrictions on the use of chemical pesticides, synthetic fertilizers, antibiotics and other substances
3. Banned the use of genetically modified organisms (GMOs)
4. Resources on site are used optimally, such as manure to fertilize fields for the production of organic feed
5. It uses plant and animal species resistant to diseases that are adapted to the local environment

Organic farming is part of an extensive supply chain, which also includes food processing, distribution and retailing.

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European Union – Organic farming, rules on production

"Organic processed products should be produced by the use of processing methods which guarantee that the organic integrity and vital qualities of the product are maintained through all stages of the production chain. The preparation of processed organic food must be kept separate in time or space from non-organic food." (EU processed products, 2018)

In general, organic foods must be processed on the basis of the following conditions:

1. Product must be mainly obtained by using ingredients of agricultural origin
2. Ingredients authorized in accordance with Article 21 of Council Regulation (EC) 834/2008 may be used (e.g. additives, processing aids, flavorings, water, salt, enzymes, minerals, vitamins, etc.)
3. Non-organic ingredients are allowed if authorized by the Article 21 or a Member State
4. An organic ingredient cannot be mixed with the same ingredient in non-organic form or as ingredient in conversion (i.e. transition from non-organic to organic farming)
5. Food obtained from in-conversion crops can only contain one ingredient of agricultural origin

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Fruit and vegetables processing is the set of methods and techniques used to transform raw ingredients into food for consumption

Levels of fruit and vegetables processing

Minimally Processed: Foods that are washed, peeled, sliced, juiced, frozen, dried, or pasteurized

Moderately Processed: In addition to being washed, peeled, sliced, etc. these foods may also be cooked, ingredients mixed, and some preservatives added

Highly Processed: Many ingredients are added to enhance flavor, add vitamins and minerals, and extend shelf life, These foods are mostly or fully prepared for eating

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Fruit and vegetables processing includes:

I. Fresh-cut vegetables
II. Vegetables canning
III. Refrigeration and freezing preservations
IV. Drying vegetables
V. Processing of vegetable juices and blends
VI. Vegetables fermentation and pickling
VII. Processing of spices and herbs

Raw Product
Straight from the farm

→ → →

End Product
Ready to be purchased by consumer

Food processing is what happens between the farm and the consumer

Processing of organic vegetables

I - Fresh-cut vegetables

The term fresh-cut vegetables refers to fresh vegetables that are peeled and cut into small portions and, thus, are ready-to-eat or to cook

To obtain fresh-cut vegetables, the basic premise is minimal processing to retain fresh-like texture, color, and flavor, and safe-to-use quality

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I - Fresh-cut vegetables

Minimal processing operations generally include (1) fruit or vegetables selection, (2) washing and/or (3) peeling, cutting and/or slicing or wedging, (4) dipping, spaying or coating, (5) draining, (6) packaging and (7) refrigeration.

1. Fruit/vegetables selection
2. Washing
3. Peeling, cutting and/or slicing or wedging
4. Dipping, spaying or coating
5. Draining
6. Packaging
7. Refrigeration

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I - Fresh-cut vegetables

"Fresh-cut fruits are more perishable than whole fruits, because the tissue integrity of fruits is more easily altered during processing. Post-cut quality of fresh-cut fruits suffers from wound induced biochemical and physiological changes such as water loss, accelerated respiration and cut-surface browning as well as microbiological spoilage" (Vasantha Rupasinghe and Yu, 2013)

Cutting effects over shelf-life

- Reduction of **food safety** (microbiological attack)
- Increased **respiration** rates
- Increased **ethylene** production

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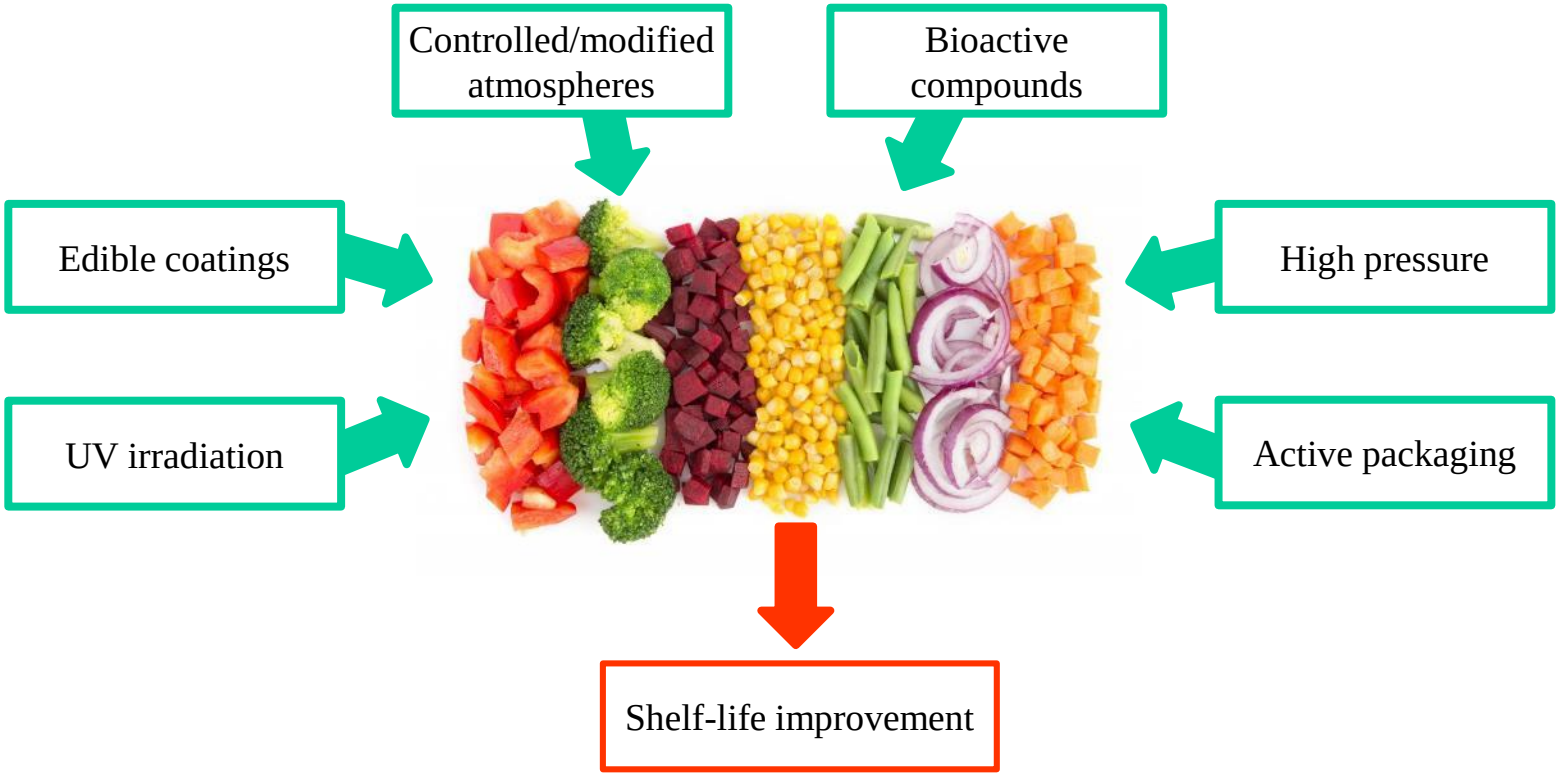
I - Fresh-cut vegetables

Preservation of fresh-cut fruits needs combinative efforts of antimicrobial and/or anti-browning treatments as well as packaging methods



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II - Vegetables canning

Canning is an important, safe way to conserve food if practiced properly. The canning process consists in placing the food in jars and heat it to a temperature able to destroy the microorganisms that are responsible for deteriorative processes. During this heating process, the air is expelled from the vessel, while a vacuum seal is formed during the cooling process. The vacuum seal prevents food contamination from the external environment.

The canned foods are heated under steam pressure at temperatures of 116-121°C. The amount of time needed for processing is different for each food, depending on the food's acidity, density and ability to transfer heat

II - Vegetables canning

Vegetables canning is performed using two different safe ways:

- Boiling water bath method. Jars of food are completely covered with boiling water at 100°C (sea level) and cooked for a specified amount of time. The method is safe for berries, fruits, jams, jellies, pickles, etc.
- Pressure canner method. Jars of food are dipped in 5-8 cm of water at 115°C using a pressure cooker. The method is safe for preserving vegetables, meats, poultry and seafood.

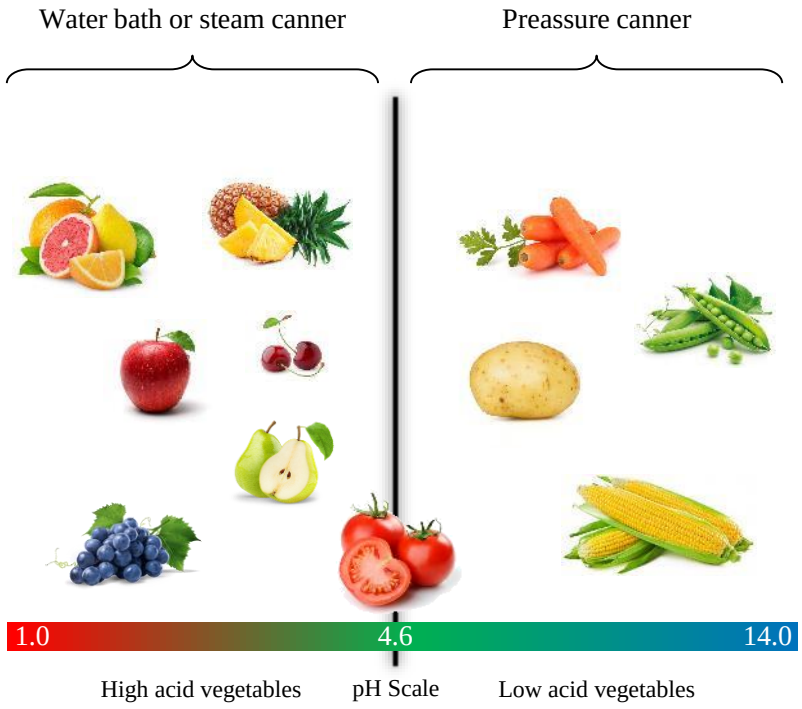
A food contamination by the *Clostridium botulinum* is the main reason why canning (in particular pressure canning) is necessary as preservative method. Although bacterial cells are denaturized at water boiling temperature, they can produce spores able to withstand these high temperatures. The spores grow in canned low acidic foods like meats and vegetables. Spores are responsible for the production of deadly botulinum toxins (poisons)

Processing of organic vegetables

II - Vegetables canning

The flow sheet for vegetable canning operation covers the following food process unit operations, which are performed in sequence:

1. Washing
2. Size grading
3. Peeling/cutting
4. Blanching
5. Filling/weighing
6. Exhausting and vacuum closing
7. Retort process
8. Retort/sterilizers
9. Sealing/closing
10. Cooling
11. Labelling and packing



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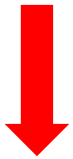
II - Vegetables canning

Besides safety, the quality of canned vegetables in terms of color, texture, and flavor is important to consumers. The quality of canned vegetables starts with proper selection of raw material (variety, maturity, composition, etc.) to be processed



The canned vegetables are evaluated for color, uniformity of size and shape, absence of defects, texture and, for some canned vegetables like snap beans, clarity of the liquid. While evaluating a canned vegetable, record is kept for container size, code, net weight, vacuum, headspace, drained weight, and drained weight/put-in weight ratio

III - Refrigeration and freezing preservation of vegetables

Low-temperature postharvest storage is used widely to extend the shelf life of horticultural produces

Refrigeration. It consists in the use of temperatures between -1 to 8 °C. Refrigeration allows the preservation of vegetables quality after harvest by decreasing the speed of cell metabolism and, thus, delaying plant senescence in general (Mc-Glasson et al. 1979; Sevillano et al. 2009).

Freezing. It consists in the use of temperatures between -18 to -25 °C. Freezing changes the state of water from liquid to solid. Frozen water is unavailable for microorganism and chemical reactions, but it does not fully stop these reactions (Bahceci et al. 2005). In fact, this immobilization of water to ice decreases the water activity (a_w) of the food.

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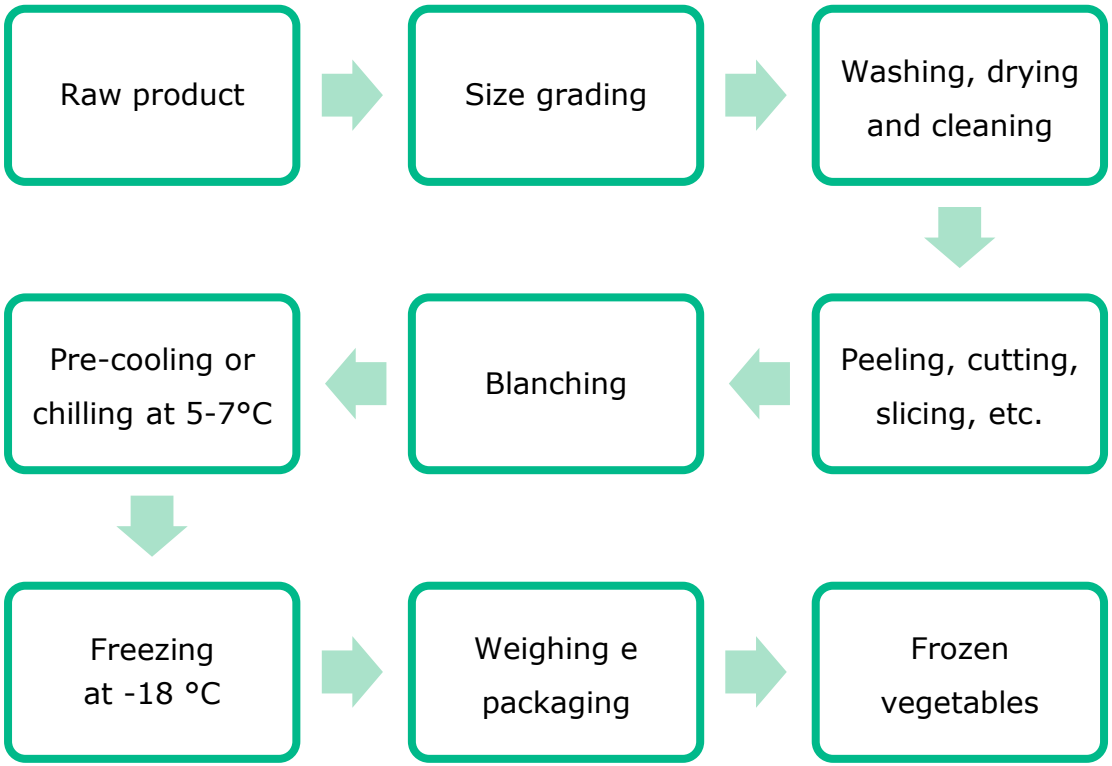
III - Refrigeration and freezing preservation of vegetables

Frozen vegetables represent a significant section of the market of frozen foods. Since freezing does not improve the final product quality, the quality of frozen product depends on the initial quality of fresh vegetables (Galindo et al. 2007)



III - Refrigeration and freezing preservation of vegetables

Different types of freezing equipment are available. The type of equipment depends on several factors such as (1) type, size and shape of raw material, (2) finished product quality, (3) production rate, (4) space availability, (5) and cooling medium. Freezing equipment can be grouped as follow:

- Direct contact with cold surface. During the freezing process, packed or unpacked product is in direct contact with a cold metal surface. Devices are plate freezer and scraped surface freezer
- Air as cooling medium. Food product is frozen using air at very low temperature. Devices are air blast tunnel, air freezer, belt freezer, spray freezer, fluidize bed freezer and impingement freezer
- Liquids as coolants. Product is frozen using liquid at very low temperature. The liquids may be sprayed on the product or the products may be dipped in the liquids. This group includes immersion-type and cryogenic freezers

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IV - Drying of vegetables

Drying is one of the oldest, typical, effective and viable preservation processes throughout the world; it consists of three main interlinked steps that can be summarized as (Aghbashlo et al., 2015):

1. product formulation or treatment selection,
2. dehydration process
3. quality and properties assessment

Drying prevents both food spoilage and decay through moisture removal due to simultaneous heat and mass transfer, allowing foods to be stored for long periods with minimal deterioration occurring (Nadian et al., 2015). Moreover, drying is particularly effective in enabling storability of food at room temperature and in simplifying the handling of the products through their reduction of weight and packaging volume (Liu et al., 2016)

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IV - Drying of vegetables

Drying technology:

- Sun drying. It is based on the use of sunlight as heating source. Direct sunlight and heat can affect thermally-sensitive vitamins and pigments significantly
- Mechanical drying. In this case water is removed from food through heat by suppling latent heat of vaporization.

Drying is a complex process involving simultaneous heat and mass transfer requiring precise process control. Drying behavior of food materials depends on the composition and moisture content of the food material to be dried, it's thickness and geometry, airflow rate, and relative humidity

IV - Drying of vegetables

Although the process is mainly physical in nature, it can result in desirable and undesirable physical and biochemical changes

Reduction in moisture during drying of high-moisture materials, like vegetables, induces changes in shape, density and porosity. Initial product quality plays a major role in food drying operation. Upon rehydration, dried vegetables should exhibit desirable sensory and nutritional quality.

V - Processing of vegetable juice and blends

Vegetable juice and blends are among the major processed vegetable products. They are liquid foods prepared from vegetables as the major raw material.

On the basis of the appearance of juice, which depends on its content and size of insoluble solids, the product can be classified into three types of juice:

- clear juice
- cloudy juice
- pulpy juice

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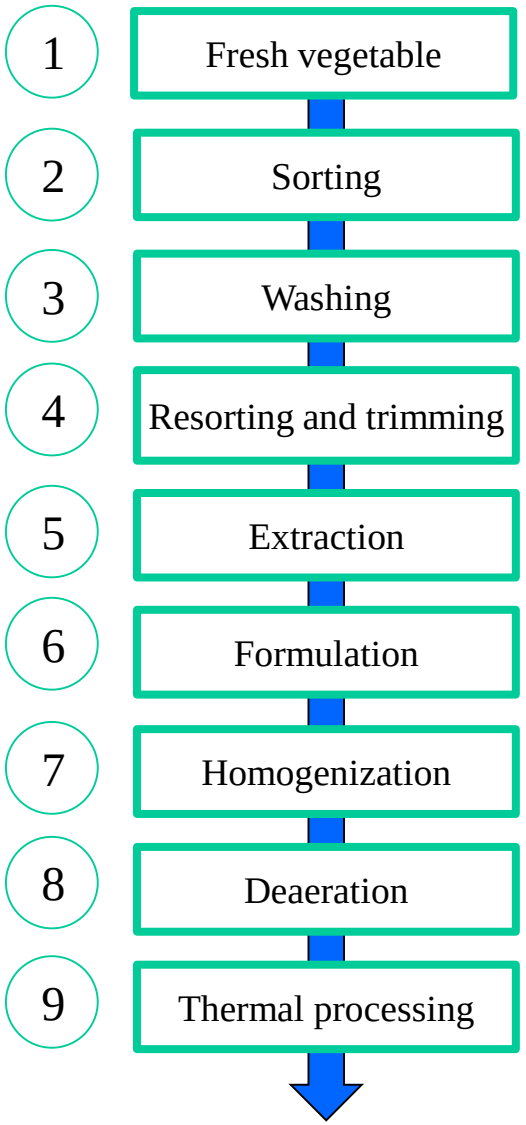
V - Processing of vegetable juice and blends

Vegetable juices are obtained using mechanical devices that separate the juice as a fluid from the solids. The raw juice undergoes processing to make it safe and preserve its quality

Fruit composition, geometry and other physical characteristics affect (1) the method of juice extraction and defect removal, (2) the need for peeling prior to extraction, (3) the inclusion of deaerating process and other secondary operations



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VI - Vegetables fermentation and pickling

Pickling is the preservation of foods by the addition of salt and/or vinegar as a primary means of preservation

Pickling is accomplished by two processes:

- brining
- direct acidification with or without a mild heat process

Fermentation is a biochemical process in which changes are brought about in biological substrates (mostly carbohydrate) resulting in the conversion of degradable food components into more stable forms. Fermentation is usually performed by microorganisms

Preservation of foods by fermentation depends on the principle of oxidation of carbohydrates and related derivatives to generate end products which are generally acids, alcohol, and carbon dioxide. The end products allow to control food spoilage microorganisms (Caplice and Fitzgerald 1999)

Lactic acid bacteria is the most important group of microorganisms used in the fermentation of vegetables

Processing of organic vegetables

VI - Vegetables fermentation and pickling

Vegetables pickling is performed using two different safe ways:

- Salting or brining. It is achieved by mixing the cut or whole vegetable with dry salt or in a salt solution. The brined or salted vegetables may or may not undergo a microbial fermentation involving a mixture of microorganisms (i.e. lactic acid bacteria and yeasts). The type of microorganisms depends on the concentration of salt used.
- Direct acidification. It is accomplished by adding acetic acid as vinegar. Moreover, this preservation method may be characterized by pasteurization, addition of other preservatives allowed by the organic E.U. regulations as well as refrigeration, alone or in combination.

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VI - Vegetables fermentation and pickling

Fermentation processing can be accomplished using one of the following three processes:

- Spontaneous fermentation. It is the process where biochemical changes have taken place without the starter cultures.
- Back-slopping. Based on the use of starter cultures from previous batch of a fermented product, which is used to inoculate the new batch
- Inoculation. Based on the use of selected starter cultures. It is used when it is possible to inactivate the indigenous flor through a heat treatment of the raw material (Josephsen and Jespersen 2006)

Processing of organic vegetables

VII - Vegetable spices and herbs

The terms "herbs" and "spices" are often used interchangeably since both refer to aromatic parts of plants

The word "herb" comes from the Latin word "herb," meaning a medical plant. Herbs are botanically classified as perennials that wither after blooming and their stems are not woody (Hirasa and Takemasa 1998). In a narrow sense, herbs are soft stemmed plants; both fresh and dried forms of leaves and flowers are used for seasoning foods. The herbs are valued for their medicinal and aromatic properties and are often grown and harvested for these applications (Peter and Babu 2004)

The word "spice" comes from the Latin word "species" meaning specific kind. Spices are derived from different parts of the plants such as seeds, leaves, flowers, buds, fruits, bark, or rhizomes and cultivated for their aromatic, fragrant, pungent, or other desirable properties (Hirasa and Takemasa 1998; Uhl 2000). Some edible herbs are categorized as spices but spices do not have any plant classification as they only refer to parts of the plant

VII - Vegetable spices and herbs

These aromatic vegetable materials have long been used:

- as flavourings and colourings, and are responsible for taste, aroma, and appearance of foods and beverages
- for their medicinal and preservative properties. Their beneficial effects are associated with their antimicrobial, antioxidant, and medicinal properties including antidiabetic, anti-inflammatory and anticarcinogenic. These properties have been attributed to their intrinsic active constituents categorized as polyphenols, terpenes, vanilloids, or organosulfur compounds (Kaefer and Milner 2008)

Processing of organic vegetables

VII - Vegetable spices and herbs

Herbs and spices processing:

- Herbs and spices contain about 75–80% moisture; drying is commonly employed to lower the moisture content to less than 15%
- Spice extracts such as essential oils and oleoresins from leaves and flower tops of various herbal spices can be recovered using water and steam distillation, supercritical carbon dioxide extraction, and solvent extraction using low-boiling organic solvents

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