Vegetables, Nutrition and Health Benefits

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PREFACE

The subject of this book was selected based on the production and consumption of vegetables which is in continuous grown in the last years. While, vegetables and fruits are an important part of a healthy diet being a source of vitamins, minerals, fibers which contribute to the improvement of the quality of life. Many vegetables and fruits crops production will continue to be extended to satisfy the enhanced necessities of the consumers.

This book follows to enrich the information in the field of vegetables and herbs. It includes a brief presentation of some of the most important vegetables and fruits (roots, cucurbits, legumes, potatoes, edible mushrooms, cruciferous and special herbs) regarding the general and morphological description, nutritional properties and health benefits and some possibilities of processing. Vegetables, fruits and herbs are valuable and nutritive foods, which are rich in therapeutic compounds with direct involvement in consumers health.

This book includes 10 chapters contributed by 10 authors from Romania, which review and discuss important developments in vegetables description, processing and humans' health involvement.

This book is intended to be a contemporary source of information on vegetable which could be useful to industry, students, academia, libraries, research institutes, laboratories or other interested professionals.

INTRODUCTION

Vegetables and fruits are important constituents of a healthy and equilibrate daily meal. Used to feed or as medicine fruits and vegetables are recognized for their benefits. Up to 5 portions of fruits and vegetables per day are needed to sustain the proper functioning of the human body. The population growth, the diversification of tastes and the concern for health are the main vectors in the increase of fruits and vegetables consumption. Raw or processed, fruits and vegetables are involved in many diets. Due to their important properties, many people are vegetarian or vegan, which consists of partially or completely substituting of animal origin food with fruits and vegetables. Vegetal matrixes are rich in valuable nutritional components that vary with the plant species, the climatic conditions and other specific factors, even like this no single species contains all the required nutrients. Vitamins, minerals, antioxidants, fibers, proteins, unsaturated fats, carbohydrates and so on are the main compounds from fruits and vegetables which sustain the human body good functioning and enhance the immunity. Carrot and parsley are a rich source of carotenes, dietary fiber, vitamin E (alpha-tocopherol), vitamin K, iron, calcium and magnesium. Red beetroot is well-known as a source of red natural pigments (betalains and betacyanines), inorganic nitrates, polyphenols, folates. Potatoes are maybe one of the most consumed crops all over the world. They could enrich the diet with potassium, phosphorus, iron, calcium vitamins (C, niacin, riboflavin, thiamin), starch and fibers. Eggplants as well as aubergines could be considered one of the most versatile plants being full of phenolic compounds (involved in the bitterness), anthocyanins (nasunin - linked to the purple colour), enzymes and having a unique spongious texture. It is an important source of selenium, calcium, chloride, potassium, magnesium and vitamin B complex. Pumpkin and courgette are valuable sources of crude fibers, vitamins, carotenoids, chlorophylls and other beneficial compounds.

Edible mushrooms are a good source of β-glucans, proteins, minerals, polysaccharides and unsaturated fatty acids. Cruciferous are a unique source of vitamin U involved in antiulcer properties, sulphury compounds which significantly reduce the risk of cancer development, tocopherols and flavonoids. Legumes contain lectins, saponins, phytic acids, prebiotic fibers and oligosaccharides. Lactogenic herbs are a group of plants or spices with special properties related to the stimulation of milk secretion to humans.

Bioactive compounds could improve the immune response of the human organism and to support the development of many defense mechanisms.

Globally, fruits and vegetables sustain the reduction of the digestive, respiratory and skin cancers. So, the regular consumption of fruits and vegetables is a necessity and a pleasure at the same time. They are coloring the dishes and promoting the healthy life style.

CHAPTER 1

CARROT AND PARSLEY: NUTRITIONAL PROPERTIES AND HEALTH BENEFITS

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1.1 Introduction

According to the plant part for which they are produced, marketable vegetables may be classified into: fruits, seeds, edible pods, leaves, stems or more often metamorphosed stems, tubers and roots (https://www.eolss.net/sample-chapters/C10/E5-02-03-01.pdf).

The plants whose edible part lies underground are called root and tuber crops. Roots are maybe the most consumed worldwide type of plant.

This chapter aims to present some of the representative root vegetables, such as carrot and parsley.

1.2. Carrot and parsley

Carrots are perhaps one of the most consumed root vegetables all over the world, being the most popular vegetable after potatoes (Hadley and Fordham 2003, 5949).

Even though at first it was not so appreciated as it was a tiny, bitter root with little appeal as food, after years of human cultivation and domestication, with a helping hand from nature, it was transformed into an extremely versatile vegetable, appearing in several colors, shapes and sizes (Stolarczyk and Janick, 2011, 13).

Parsley is an edible plant, which has two cultivated forms: the root parsley and the leaf parsley (Gorzelany et al., 2013, 54).

It is an underestimated root vegetable, even if it contains an important number of bioactive compounds, such as vitamins, fibers, phenolics and flavonoids.

Moreover, phenols are specific compounds for parsley, being the ones that give it the popular spice taste.

1.2.1. The carrot and parsley as memebers of the botanical family

Carrots belong to the *Apiaceae* family, and occur in two cultivated varieties: *Daucus carota ssp. sativus convar. sativus* (long type carrots), and *Daucus carota ssp. sativus convar. curtus* (short type carrots). Pasley (*Petroselinum crispum*) also belongs to the *Apiaceae* (*Umbelliferae*) family, which contains over 280 genera and nearly 3,000 species (Basu et al., 2014, 1).

1.2.2. Carrot and parsley- origin and domestication

Their origin is quite disputed; some findings state that the carrots (either purple or yellow) probably originate from 3000 B.C. Afghanistan or Iran, and purple carrots originate from 2000 B.C. Egypt.

Moreover, there are some studies mentioning the presence of fossil pollen traces of the Apiaceae from the Eocene period (55 to 34 million years ago) (http://www.vegetablefacts.net/vegetable-history/history-of-carrots/).

Another discovery says that the domesticated carrot *Daucus carota* is native to Ethiopia about 5 000 years ago. The original cultivars were purple or yellow in colour, and a large variety of other colours have since been developed, most notably red carrots in China.

Being cultivated for over 2 000 years, it was very quickly assimilated by Asia, Russia and the USA.

Parsley seems to be of South European (probably East Mediterranean-Sardinia) origin and became popular at more Northern latitudes in the Middle Ages (http://gernot-katzers-spice-pages.com/engl/Petr_cri.html). Additional research considered it a native of the Eastern Mediterranean regions, De Candolle of Turkey, Algeria and the Lebanon (https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/petroselinum-crispum).

1.2.3. Carrot and parsley variety groups

The Daucus genus includes approximately 20 species spread out around the Mediterranean region, in contrast with its origins which are in Central Asia (Simon et al., 2008, 336).

Discussing about the varietal groups, there is a vast amount of them, depending on the region to which they belong.

Numerous varieties were distinguished, starting from purple and yellow carrots, to orange carrots. Different varieties were named according to the colour intensity, core colour and size, root type or crop maturity. The varietal groups include the European (Nantes, Chantenay, Danvers, Paris Market, Flakkee, Berlicum and Amsterdam Forcing), Asian (Kuroda), North American (Imperator) and South American (Brasília) varieties (Simon et al., 2008, 329). Table 1.1. shows several varieties of carrots.

According to (https://living.thebump.com/varieties-parsley-5523.html), there are 4-11 varieties of parsley, the most widespread being common parsley, Italian parsley, Hamburg parsley, Japanese parsley. While there are 30 varieties of parsley, according to (http://www.newworldencyclopedia.org/entry/Parsley), two forms are particularly popular: curly-leaf parsley and Italian or flat-leaf parsley (*Petroselinum crispum var. neapolitanum*). Other types of parsley are *P. crispum var. Crispum,* known as double curled parsley (https://data.nal.usda.gov/dataset/germplasm-resources-information-network-grin), *P. crispum var. tuberosum*, or *P. crispum Tuberosum Group*.

Table 1.1. Several varieties of carrots according to https://www.grow-it-organically.com/carrot-varieties.html

 *Scarlet Nantes Carrots*	 *Touchon Carrots*	 *Kaleidoscope Mix Carrot Blend*
 *Red-Cored Chantenay' Carrots*	 *Bolero Carrots*	 *Nelson Carrots*
 *White Satin Carrot*	 *Merida Carrot*	 *Purple Dragon Carrot*

Cosmic Purple Carrot

Baby Carrot

Romeo Carrot

Babbete Carrot

Atomic Red Carrot

Yellow Submarine Carrot

1.2.4. Carrot and parsley - phytochemical composition

Phytochemicals from vegetables could reduce platelet aggregation, modulate synthesis and cholesterol absorption, and reduce blood pressure. Moreover, there are various studies which support the fact that a high intake of fruits and vegetables provide protection against some dangerous diseases like cancers of the lungs, colon, breasts, cervix, esophagus, oral cavity, stomach, bladder, pancreas, prostate, and ovaries (Shahidi et al., 2011, 125).

Because of the incidence and the popularity of the orange carrots to the detriment of the black or purple ones (*Daucus carota L. ssp. sativus var. atrorubens Alef.*), the former will be presented in more detail in this part of the chapter, without neglecting the latter.

It is well known that vitamin A is a vital constituent in the human body, being involved in the maintenance of healthy teeth, skeletal and soft tissue, mucous membranes, and skin. It is also known as retinal because it generates the pigments that are necessary for the functioning of the retina (Gordon, 2003, 263).

Vitamin A is present in colourful fruit and vegetables (e.g.: peas, tomatoes, and carrots).

Carrots have a high content of pro-vitamin A (β carotene) and are also high in B complex vitamins and many minerals including calcium, copper, magnesium, potassium, phosphorus, iron and folic acid.

Related to colour, some important antioxidants such as carotenoids, polyphenols and vitamins are present in carrots.

Carotenoids are the most abundant in orange carrots with a potential antioxidant role, which can neutralize the effect of free radicals. In carrots, overall carotenoid levels have increased in the past four decades through traditional breeding, reaching levels of 1000 ppm carotenoids (Dias, 2012, 1359).

Carrots are also an excellent source of calcium pectate, which is an extraordinary pectin fiber with cholesterol lowering properties. It is involved in reducing the risk of high blood pressure, stroke, heart disease and some types of cancer (Bakhru, 1993, 182).

In the following table (Table 1.2.) one can see some specific phytochemicals found in carrots.

Table 1.2. Nutritional and phytochemical composition of raw carrot per 100 g of product (USDA, 2021)

Phytochemicals	Value/100 g (unit)
Minerals	
Calcium, Ca	33 mg
Iron, Fe	0.3 mg
Magnesium, Mg	12 mg
Phosphorus, P	35 mg
Potassium, K	320mg
Sodium, Na	69 mg
Zinc, Zn	0.24 mg
Vitamins	
Vitamin C, total ascorbic acid	5.9 mg
Thiamin	0.066 mg
Riboflavin	0.058 mg
Niacin	0.983 mg
Vitamin B-6	0.138 mg
Folate, DFE	19 µg
Vitamin B-12	0 µg
Vitamin A, RAE	835 µg
Vitamin A, IU	16706 IU
Vitamin E (alpha-tocopherol)	0.66 mg
Vitamin D (D2 + D3)	0 µg
Vitamin D	0 IU
Vitamin K (phylloquinone)	13.2 µg

Quite similar to peppers, dill and horseradish, parsley is a great source of vitamin C (Butnariu and Butu, 2015, 660). Parsley has an important antioxidant potential due to the content of vitamins A, C, complex B, and E, and the minerals Fe and Mg. It is a rich source of essential oils and component substances, like myristicin allyltetramethoxybenzene, a-felandren, a-terpinene, caryophyllene, terpinolene, and p-cineole, and other components in small quantities such as apiol (Butnariu and Butu, 2015, 662).

Table 1.3. shows the main phytochemical compounds of parsley.

Table 1.3. Phytochemical composition of raw parsley per 100 g (USDA, 2022)

Phytochemicals	**Value/100 g (unit)**
Vitamins/Minerals	
Vitamin A equiv.	421 mg
Calcium	138 mg
b-Carotene	5,054 mg
Iron	6.2 mg
Lutein/zeaxanthin	5,561 mg
Magnesium	50 mg
Thiamine	0.086 mg
Manganese	0.16 mg
Riboflavin	0.09 mg
Phosphorus	58 mg
Niacin	1.313 mg
Potassium	554 mg
Pantothenic acid	0.4 mg
Sodium	56 mg
Vitamin B6	0.09 mg
Zinc	1.07 mg
Vitamin K	1,640 mg
Folate	152 mg
Vitamin C	133 mg
Vitamin E	0.75 mg

1.2.5. Carrot and parsley- consumption forms

From white to black, carrot roots are consumed as raw or processed by different methods, such as boiled, canned, frozen or powdered forms.

Carrots (*Daucus carota*) are a root vegetable with a crisp texture when fresh.

Carrot roots are also used as an important source of vitamin A and beta-carotene. The leaves could also be consumed in salads and the seeds are good for making tea.

Parsley could be consumed raw in salads and juices, as well as processed in soups, different stews, next to meats and as a garnish, when in leaf form. Moreover, it can be consumed as infusions or decoctions.

1.3. Morphological description and classification of carrot and parsley

The carrot (*Daucus carota*) is a member of the umbel family, otherwise known as the Apiaceae, or Umbelliferae, family. The name "umbel" comes from the flower heads, known as pedicels, which originate from a common point and spread out like an umbrella. The name appears to derive from the Latin umbrella, or a parasol, which itself comes from umbra or umbraticus, meaning shade or shadow (https://www.grit.com/farm-and-garden/vegetables/heirloom-seeds-for-cultivated-carrots-zm0z13sozgou/).

Daucus carota is a complex species comprising wild and cultivated carrots, resulting in a confused taxonomy. It contains 13 subspecies, 12 for wild taxa and one for the cultivated taxon (subsp. sativus (Hoffm.) Arc.) (https://www.cabi.org/isc/datasheet/18018).

Regarding the distinctive characteristics of vegetables, these could be described by four different attributes: 1) colour and appearance, 2) flavour (taste and aroma), 3) texture and 4) nutritional value. The consumers' acceptance depends on these four attributes. So, the consumer needs first to evaluate the visual appearance, followed by taste, aroma and texture (Birthare, 2022).

Carrot plant morphology includes: leaves, which are compound from pinnate double two or three; the young plant has lancet-shaped leaves. Each plant has a size 5-7 petiole which is rather long. The petiole is thick with a smooth surface.

The carrot plant's dark green stems are so short that they are barely visible, i.e. round rods with a small diameter of 1-1.5 cm. The plant has a fibrous root system and riding. The shape and function of the storage of food reserves is dependent on the taproot growth. Depending on the varieties, the root form will grow between 6-30 cm. The flowers of the carrot plant are double umbrella -shaped, and white to pale pink in colour (http://bloganda23.blogspot.com/2013/12/morphology-and-classification-plant.html).

Figure 1.1 summarizes the carrot plant morphology.

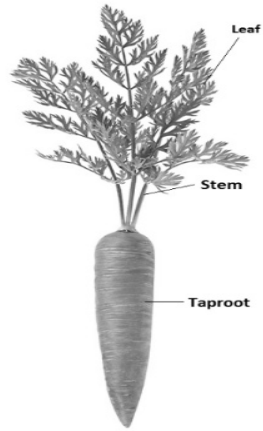


Figure 1.1. Carrot morphology

The classification of the vegetables is a general term, which can be further discussed according to different aspects, such as: botanical aspects, growing conditions and various development stages of the plant parts.

Botanical classification is based on the physiological characteristics of plant development, organization and structure. This classification is structured on 11 levels: kingdom, division, class, subclass, order, family, genus, species, variety, cultivar and strain (Yamaguchi, 1983, 4, 5).

Table 1.4. shows the carrot's botanical classification.

Table 1.4. Carrot botanical classification according to (https://www.cabi.org/isc/datasheet/18018)

Domain	Eukaryota
Kingdom	Plantae
Phylum	Spermatophyta
Subphylum	Angiospermae
Class	Dicotyledonae
Order	Apiales
Family	Apiaceae
Genus	Daucus
Species	Daucus carota

The alternative scientific names of parsley are: *P. hortense Hoffm.*, *P. sativum Hoff.*, *Carum petroselinum (L.).*

Morphologically, *Petroselinum crispum* belongs to the *Apiaceae* or *Umbelliferae* family and the *Petroselinum* genus.

Kingdom	Plantae
Phylum	Magnoliophyta
Class	Magnoliopsida
Order	Apiales
Family	Apiaceae
Genus	Petroselinum

The taxonomic classification of *Petroselinum* is shown in Table 1.5.

Table 1.5. The taxonomic classification of *Petroselinum* according to (Lohwasser et al., 2010, 176)

Species	Convariety	Variety	Form
Petroselinum crispum (Mill.) Nyman	crispum	silvestre (Alef.) Danert vulgare (Nois.) Danert	vulgare angustifolium (Hayne) Danert variegatum (Nois.) Danert
		crispum	hispanicum (Alef.) Danert crispum tenuisectum (Thell.) Danert
	radicosum (Alef.) Danert	neapolitanicum Danert radicosum	radicosum breve (Alef.) Danert
		erfurtense Danert	

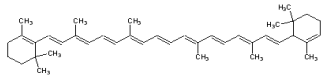
1.4. Nutritional properties and health benefits of carrots and parsley

Carotenoids are pigments found in almost all coloured fruits and vegetables, but they are especially correlated with carrots. The consumption of carrots has always been associated with various health benefits, including a reduced risk of age-related macular degeneration and

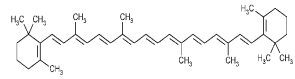
cataract, some cancers and coronary heart disease (Milani et al., 2017, 1295).

Carrots are rich in fibers, carotenoids, vitamins C and E, and phenolics such as coumaric, chlorogenic and caffeic acids (Alasalvar et al., 2001, 1412). Water-soluble anthocyanin obtained from carrots also possesses antioxidant properties. The cardiovascular system may be protected by drinking carrot juice, which increases its total antioxidant status, and decreases lipid peroxidation (Potter et al, 2011, 1).

Carrots are a very good source of α and β- carotene, which has raised interest in them as a food source, bioavailability and mode of action, and due to their use in functional food and nutraceutical products (Rodriguez-Concepciona et al., 2018, 19).



α-carotene



β- carotene

Figure 1.2. Chemical formula of α and β- carotene

Carotenoids are promoters of cognitive functions. Health-related benefits associated with a high carotenoid intake include enhanced immune system functions and lower risk of developing degenerative chronic diseases. They are also useful as skin photo protectants and providers of cosmetic benefits (Meléndez-Martínez et al., 2018, 99).

Carotenoids and antioxidant polyphenols, and dietary fibers from carrots fight against bladder cancer and other carcinomas.

All the carotenoids are linked with a significant decrease in post-menopausal breast cancer (Ülger et al., 2018, 16); also, smokers who eat carrots have a lower risk of lung cancer, while a β-carotene rich diet may also protect against prostate cancer (Wu et al., 2004, 264).

Vitamin E present in carrots consists of tocopherols and tocotrienols such as α-tocopherol, β-tocopherol, α-T3 and β-T3 tocopherol, and has many important implications in skin and hair care, also being widely known for its antioxidant capacity.

The study of (da Silva, 2014, 2151) presents carrot consumption from the perspective of its four important nutrition and health benefits, such as: wound healing, hepatoprotective, renoprotective and anti-diabetic function, cholesterol lowering and cardiovascular disease decrease, and anti-hypertensive, antioxidant, anticarcinogen, and immunoenhancing benefits.

Several sterols, like sitosterol, sitostanol, campesterol, brassicasterol, and stigmasterol are found in carrots, and they are involved in anti-inflammatory and antiatherosclerosis processes, as well as anticancer fighting. The sterols are generally precursors of plant hormones, which manage embryonic development, cell division, plant growth, and fertility. For humans, sterols support the absorption of calcium and bone growth, the synthesis of prostaglandins and leukotrienes, which are important components of the immune system (Hounsome and Hounsome, 2011, 36).

Moreover, carrots are unique vegetables, which contain a special combination of three flavonoids: kaempferol, quercetin and luteolin. They are also rich in other phenols, including chlorogenic, caffeic and p-hydroxybenzoic acids, along with numerous cinnamic acid derivates.

Lutein and zeaxanthin are important carotenoids with potential in visual and cognitive development in infants. Zeaxanthin is the major carotenoid present in human milk, as well as in carrots. Recent studies have found that lutein/zeaxanthin are present in the brain regions, which are specialized in visual processing, memory, learning and language (Vishwanathan et al., 2014, 661).

Black carrots have relatively higher flavonoid contents (quercetin, luteolin, kaempferol, and myricetin) as compared to red and orange cultivars. So, several studies have reported the presence of various levels of anthocyanins in different cultivars of black carrots, ranging from 55% to 99% (Kammerer et al., 2004, 480).

Many recent studies have concluded that the enhanced glucose absorbance capacity and reduction of amylase activity of dietary fiber in carrots might help control post-prandial serum glucose level, which involves the strong relationship between dietary fiber intake and a lower risk of type 2 diabetes (da Silva, 2012, 1363). So, carrot consumption improves insulin sensitivity and/or decreases insulin requirement.

Recently, researchers as (Poudyal et al., 2010, 1323) have discovered that purple carrots have participated in reducing impaired glucose tolerance, endothelial function and abdominal fat deposits or fighting against

metabolic syndrome. Also, purple carrot juice may contribute to the restoration of liver function by reducing the liver wet weight, portal inflammation, fat deposits and portal fibrosis in the liver.

Because purple carrots are rich in anthocyanin, but low in carotenoids, these findings have been attributed to the anthocyanins. Out of the multitude of anthocyanins, it was found that the black carrot contains cyanidin-3-galactoside, cyanidin-3-glucoside, and cyanidin-3-arabinoside. These compounds are involved in inhibiting the growth of colorectal carcinoma cells (Ekinci et al., 2016, 1365). Similar results were reported by (Pala et al., 2017, 529) who examined the extracts' cytotoxicity effect against breast adenocarcinoma, bone osteosarcoma, alveolar adenocarcinoma, and neuroblastoma.

These types of anthocyanins are acylated, which means they have the ability to cross the gastrointestinal tract and remain intact. These polyphenols, flavonoids, and carotenoids in black carrots are considered to contribute as a possible defense against many types of cancer, diabetes mellitus, cardiovascular and oxidative stress.

An important type of component, commonly found in Apiaceae vegetables such as carrot, celery, celeriac, parsnip, and parsley are the polyacetylene of the falcarinol type. This type of polyacetylene is responsible for the bitter taste and it has antiinflammatory, antiplatelet-aggregatory and immune-stimulating effects (Zidorn et al., 2005, 2518).

The most bioactive polyacetylene known as falcarinol has shown a significant cytotoxic activity against human tumour cells, as demonstrated by (Brandt et al., 2004, 388) and (Hansen et al., 2003, 1011).

Parsley is well known for its medicinal and healing benefits due to the rich composition of its bioactive compounds. The antiinflammatory, antiallergenic, antimicrobial, diuretic, hypoglycemic, anti-arthritis and anti-chest pain properties are some of the properties for which it is so popular.

Myristicin and apiol, two major phenols found in parsley, are involved in antioxidant activities, which protect cells by slowing down the ageing process.

Myristicin activates the production of glutathione, which fights the oxidation of components in the body and maintains visual acuity.

Other compounds such as flavonoids including apiin, other apigenin glycosides and luteolin, tocopherol, ascorbic acid and essential oils in parsley could also aid in the antioxidant activity (Daradkeh and Mohamed Essa, 2018, 193). The limonene in parsley is involved in reducing cancer symptoms and preventing its growth, along with helping weight loss by the removal of excess fluid from tissues (diuretic action).

Some studies on the reduction of uric acid level and the prevention of ion oxidative stress revealed that parsley (*Petroselinum crispum*) is capable to adjust the biological metabolite of animals due to its major flavanols constituents (Fatemeh et al., 2011, 818).

It is common knowledge that kidney stones are a very common disease generated by the high dietary calcium intake or by the consumption of leafy vegetables like kale and spinach, as well as by low fluid consumption.

So, to prevent or to heal this disfunction, parsley decoct or extract can be used as a diuretic that helps in controlling kidney stones, urinary tract infections, and gallbladder stones (https://www.healthbenefitstimes.com/health-benefits-of-parsley/).

The myricetin present in parsley was used in the treatment and prevention of diabetes. Laboratory and animal studies have demonstrated that myricetin can lower blood sugar levels and decrease insulin resistance. It also appears to provide anti-inflammatory effects and remove excess fat from the blood (https://www.medicalnewstoday.com/articles/284490.php).

Some flavonoids like fisetin, apigenin, naringenin, luteolin, quercetin and kaempferol have the aim to inhibit the potently 20alpha-HSD activity in non-reproductive tissues, so they are responsible for the increase in plasma progesterone.

Parsley can fight gastrointestinal disorders such as constipation, flatulent dyspepsia, urinary disorders such as cystitis, painful urination; bronchitic cough; dysmenorrhea, functional amenorrhea; muscle pain; sexual dysfunction in men, diabetes, hypertension; oxidative stress (www.herbal extracts.com.au).

Coumarins are substances present in all the *Umbelliferae* family, possessing a variety of biological properties, including antimicrobial, antiviral, anti-inflammatory, antidiabetic, antioxidant, and enzyme inhibitory activity (Poumale Poumalea et al., 2013, 279).

1.5. Processing technology of vegetables (from raw material to processed products)

To meet consumers' needs, to offer a big variety of foods and to have a balanced diet require a large variety of processing technologies.

One of the advantages of processed foods is their microbiological safety and prolonged shelf life.

Even though processed foods are highly incriminated, the need for processing cannot be overlooked.

There are many possibilities to process carrots, such as puree, concentrated juice, baby foods and natural fresh juice, to name just a few of the traditional ones, to more elaborated carrot chips, or carrot cake.

1.5.1. Raw carrots and parsley

Raw vegetable consumption has become indispensable for a healthy diet. Because of the excessive modernization of the consumers' needs, raw carrot storage has turned into a particular technology, with clearcut stages, including harvesting, handling and storage.

Not all the carrot varieties are suitable for storage. So, it is important to choose the best type of carrot.

A significant part of fresh carrot production is used for fresh-cut products such as "baby carrots," carrot coins, shreds, and sticks. The carrots for fresh-cut processing are typically harvested at an immature stage for optimal texture and taste (Simon et al., 2008, 351).

If the carrots are consumed after storage, they need to observe some rules, at least to maintain or even to improve their nutrients and flavour quality.

As expected, carrots can be stored for several months, providing the stored roots are mature and in good shape (with minimal damage), and a proper temperature (0–3°C) and humidity (98%) are maintained (Simon et al., 2008, 343).

Similar to carrots, raw parsley is appreciated for its firmness, pale beige colour, tasty roots. The parsley with an intense taste can be used whole, grated in salads, smoothies, or healthy raw meals. Also, parsley root leaves

can be chopped and used for garnishing and flavouring cooked foods (https://healthfully.com/what-is-parsley-root-good-for-7533682.html).

Besides storage, packaging also plays an important role in preventing the decaying process. Packaging aims to evade physical and chemical damage. It is not only a barrier which protects the product from environmental obstacles and harmful germs and insects, but also it works as a trade mark (https://www.johnnyseeds.com/growers-library/vegetables/carrots/carrot-harvest-handling-storage.html).

Fresh-cut carrot and parsley root products, such as sticks, disks, batons, shreds, slices, cubes make up an important part of the fresh-cut vegetable industry (Haque et al., 2017, 81). In general, minimal processing of carrots and parsley include grading, washing, sorting, peeling (even the peel is very flavourful), slicing, chopping, packaging and then storing on an industrial scale.

The carrot and parsley roots may have the outer layer of the root peeled off and then be cut into slices or cubes and kept refrigerated in some form of containers/packaging. There are some disadvantages of this method such as browning, excessive microbial load, and tissue softening that limits its market value and shelf life (Kenny and O'Beirne, 2010, 248).

1.5.2. Carrot and parsley root processing

Carrot and parsley root can be processed in many ways and consumed in a large variety of forms. Maybe the most affected component of carrots during processing remains β-carotene. It is known that the intense processing conditions induce the isomerization and degradation of β-carotene. There may also be thermal processing benefits like the increasing of the bio accessibility of the β-carotene (Lai et al., 2013, 252). Other nonthermal processes, like high-pressure have no effect on the bioactive compounds in carrots. Carrots and parsley can be processed in several ways: juice, puree, snacks, cakes or as soup or stew base.

1.5.3. Carrot juice

Carrot juice seems to be one of the most popular forms of carrot processing, maybe due to the ease of processing and consumption. Simple or in combination with parsley root or other fruits or vegetables, used as fresh or preserved, carrot juice is a rich source of carbohydrates, minerals and phenolic compounds. Moreover, there are several studies highlighting

the importance of the beneficial agents such as polyacetylenes in carrot juice, which has recently been associated with positive effects for the treatment of leukemia (Zaini et al., 2011, 1303).

In many cases, if the carrot or parsley juice is not intended for fast consumption, it must be processed by heat treatments such as blanching and pasteurization to inactivate enzymes and protect against microbial spoilage.

The most representative compound for the leukemia treatment is the polyacetylene, recognized as falcarindiol-3-acetate (FaDOAc) and falcarinol (FaOH). So, the study of (Aguiló-Aguayo et al., 2014, 373) deals with several pH corrections types and thermal treatment processing leading to the preservation of polyacetylenes. The pH value varied from 3.0 to 8.0, while the thermal treatment consisted of blanching (80°C/5 min) and pasteurization (90°C).

The study concluded that the industrial products are especially designed to maintain the falcarindiol-3-acetate (FaDOAc) and falcarinol (FaOH) content. So, the results highlighted that the pasteurization (90°C/1 min) of raw carrot juice and acidified media (pH 3.5) conditions increased significantly the polyacetylene level. Moreover, the storage method by refrigeration at 4°C/8 days could slow the enzymatic degradation of the polyacetylenes, which improved the potential health benefits of carrot juices (Aguiló-Aguayo et al., 2014, 374).

Carrot juice is one of the most diuretic beverages due to the vegetable content. This is due to its fibers, vitamins, minerals and antioxidants. Lutein, lycopene, carotenes, zeaxanthin and xanthophyll are all involved in body detoxification. So diuretic agents aim to remove the excess fluid and electrolytes that have been retained in the body. The study of (Sarfaraz et al., 2016, 1) presents a clinical study on the non-pharmacological use of carrot juice as dietary aid in order to reduce hypertension. The results were good, showing that regular consumption of carrot juice can contribute to reducing hypertension. Table 1.6. shows the carrot juice nutritional composition reported to 100 g of products for three varieties of carrots.

Table 1.6. Carrot juice nutritional composition (amount in 100 g of edible portion) (https://www.medicalnewstoday.com/articles/320297#nutrition)

Carrot juice	Orange carrot juice	Purple carrot juice	Yellow carrot juice
Energy	34 kcal	37 kcal	45 kcal
Proteins	0.47 g	0.65 g	0.7 g
Total lipids	0.14 g	0.28 g	0.1 g
Ash	0.55 g	0.66 g	0.55 g
Carbohydrates	7.36 g	8.03 g	10.20 g
Calcium (Ca)	183 mg	174 mg	16 mg
Iron (Fe)	13.10 mg	1.25 mg	0.8 mg
Magnesium (Mg)	-	-	23 mg
Phosphorus (P)	254 mg	291 mg	40 mg
Potassium (K)	2130 mg	2340 mg	325 mg
Sodium (Na)	644 mg	497 mg	78 mg
β-carotene	100 mg/L	-	-
Total polyphenols	-	325 mg	-
Antocyans	-	50-100 mg	-
Vitamin A	-	-	2 µg
Vitamin C	-	-	4.9 mg

Black carrot juice is rich in anthocyanin pigment acylated with p-coumaric, ferulic, p-hydroxybenzoic and sinapic acids. Black carrot juice is quite difficult to obtain mechanically because of the high pectin content. The mechanically extracted product seems to be more similar to puree than juice. So, the macerate needs to be transformed into juice with the help of some pectolytic enzymes. This kind of enzymes can help to enhance the recovery of the phenols and anthocyanins; the enzyme-catalyzed degradation helps to recover the phenols and anthocyanins which are usually lost as residues by pressing. The antioxidant activity of black carrot juice is similar with the one of black currant juice. Other studies (Khandare et al., 2011, 485) found a higher content in black carrot juice as compared to red grapes, black cherry, prune, pineapple and apple juice, as shown by (Seeram et al., 2008,1419).

Parsley root juice has many health benefits, being an important support in losing weight, detoxification boost, maybe due to the significant quantity of glutathione which helps the body get rid of toxins easily, thus tackling cancer or inflammation (https://www.misskyra.com/lifestyle/heres-why-you-need-to-add-parsley-root-to-your-diet/photostory/69690124.cms).

Parsley root juice or aqueous extract could be consumed as a diuretic that helps keeping in check various diseases such as kidney stones, urinary tract infections, and gallbladder stones (https://www.lybrate.com/topic/benefits-of-parsley-and-its-side-effects).

Regarding the nonconventional processing or combination methods, in the study of (Jabbar et al., 2014, 4) one finds the influence of blanching and sonication treatments on the quality of carrot juice. The study suggested that the combined treatment of blanching and sonication may successfully be used to process carrot juice with optimal results.

This type of combination preserved the antioxidant activity and colour of juice, inactivating enzymes and microbes.

Other methods to use for vegetable juices are the fermented alternative or adding them in lactic products, like yogurt. Fermented vegetable products are very fashionable. The aim of obtaining such a product is to satisfy some consumers' needs, such as eating vegetable products with probiotic potential.

As an auxiliary matter, carrot juice could be added to yogurt to promote the functional and health benefits of the mix. Also, carrots contain a significant quantity of pectin, which will lead to the natural stability of the gel. The carrot juice supplies the yogurt with some other phytonutrients like ascorbic acid, phenolics, tocopherols and fibers. This is undoubtedly a possibility to improve yoghurts with potential to supply antioxidant, pro-vitamin A and dietary fibers, like pointed out by (Kirosa et al., 2016, 19).

An interesting method to harness the benefits of the anthocyanins extracted from black carrots is their addition to some other fruit juices (apple, grape, orange, grapefruit, tangerine and lemon) and nectars (apricot, peach and pineapple). They were used as colorants and health suppliers. Good results were obtained for both heating and storage for all the products.

Carrots are also used in manufacturing puree, jam and cakes. Carrot puree is an alternative for baby food and people with special needs.

1.5.4. Carrot puree

Carrot puree is such an extremely consumed product, especially by consumers with special needs, like: babies, elderly people and persons which are suffering from several forms of swallowing or gastrointestinal