RWANDA STANDARD

RS ARS 942(IDT)

1st edition

2018

Adopted by RSB 2025-06-06

Fresh carrots — Specification

ICS 67.080.20

Reference number

RS ARS 942: 2018

AFRICAN STANDARD

ARS 942(E)

First Edition 2018

Fresh carrots — Specification

Reference No. ARS 942:2018(E)
ICS 67.080.20

Table of contents

Foreword

The African Organization for Standardization (ARSO) is an African intergovernmental organization established by the United Nations Economic Commission for Africa (UNECA) and the Organization of African Unity (AU) in 1977. One of the fundamental mandates of ARSO is to develop and harmonize African Standards (ARS) for the purpose of enhancing Africa's internal trading capacity, increase Africa's product and service competitiveness globally and uplift the welfare of African communities. The work of preparing African Standards is normally carried out through ARSO technical committees. Each Member State interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, Regional Economic Communities (RECs), governmental and non-governmental organizations, in liaison with ARSO, also take part in the work.

ARSO Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare ARSO Standards. Draft ARSO Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an ARSO Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ARSO shall not be held responsible for identifying any or all such patent rights.

This African Standard was prepared by the ARSO Technical Harmonization Committee on *Agriculture and Food Products* (ARSO/THC 02).

ARSO Central Secretariat
International House 3rd Floor
P. O. Box 57363 — 00200 City Square
NAIROBI, KENYA

Tel. +254-20-2224561, +254-20-3311641, +254-20-3311608

E-mail: arso@arso-oran.org
Web: www.arso-oran.org

Copyright notice

ARSO Central Secretariat
International House 3rd Floor
P.O. Box 57363 — 00200 City Square
NAIROBI, KENYA

Tel: +254-20-2224561, +254-20-3311641, +254-20-3311608

E-mail: arso@arso-oran.org
Web: www.arso-oran.org

Introduction

Carrot (*Daucus carota* L., var. *sativus* Hoffm.) is a major horticultural root vegetable umbellifer cultivated and eaten worldwide [1,2]. Carrots are one of the 10 most economically important vegetable crops in the world with a total production of more than 42.7 million tonnes of carrots and turnips distributed as follows: Asia 65 %; Europe 22 %; Americas 8 %; and Africa 4.5 % [1,3]. Cultivated carrots can be separated into two types: eastern/Asiatic and western [2]. Eastern/Asiatic carrots have reddish purple (anthocyanin-containing) or yellow roots, pubescent leaves which give a grey-green appearance, and a tendency for early flowering. Western carrots have orange, yellow, red or white roots, less pubescent green leaves, and less tendency to bolt without extended exposure to low temperatures. Most of the taproot consists of a pulpy outer cortex (phloem) and an inner core (xylem). High-quality carrots have a large proportion of cortex compared to core.

Carrots are constituted of approximately 88% water, 1% protein, 7% carbohydrate, 0.2% fat, and 3% fibre [4]. The carbohydrate fraction is almost exclusively simple sugars, predominantly sucrose, glucose, and fructose, with a small amount of starch [5]. Carrots are a good source of fibre; the insoluble fibres cellulose and hemicellulose constitute the greatest portion (50 % to 92 %) of the total dietary fibre, with a very small amount of lignin (4%). The soluble fibres consist of fermentable hemicellulose and pectin and constitute 8% to 50% of total fibre [6]. Moreover, carrots are a source of macro- and micro-minerals such as magnesium, calcium, potassium, phosphorus, organic sodium, and many other trace minerals, which are essential for the normal functioning of cells, tissues, and bones, as well as protecting against deficiencies which are increasing in industrialized and non-industrialized countries, particularly at an early age [7]. Orange coloured carrot is the predominant in the world today and is used mostly in fresh-cut salads or cooked in many different ways: fried, steamed, boiled, or cooked in stews, soups, and cakes. Moreover, baby carrots or mini carrots (peeled carrots cut into cylinders) are sold as snacks. The use of carrot as a basic ingredient in the formulation of juice, mixed juices, and baby foods is currently increasing worldwide because consumers are becoming increasingly aware of the nutrient quality of this vegetable and the health benefits of the regular intake of these products as part of the diet [5,8].

Carrots are the single major source of β-carotene and good sources of various other lipophilic antioxidants such as lutein and lycopene [5]. The colour of the carrots, in general, is a good indication of the type of carotenoids and the quantity they have. For instance, α- and β-carotenes (orange) are the predominant carotenoids in orange carrot, whereas lycopene (red) and lutein (yellow) are the predominant carotenoid species in red and yellow carrot cultivars, respectively [8]. Carrot is also rich in hydrophilic phenolic antioxidants which are known for a wide range of health promoting properties such as anticancer, anti-atherogenic, anti-inflammatory, and antimicrobial [9,10]. Carrots are highly nutritious and rich in a diversity of phytochemicals including carotenoids (some of them with provitamin A activity), phenolic compounds, ascorbic acid, α-tocopherol, vitamins D, K, B1, B6, and biotin, and polyacetylenes, many of which have antioxidant and other health promoting effects [11]. The content of carotenoids and minerals in carrots is dependent on the cultivar, season, management production, environmental conditions, and postharvest handling and storage conditions [12,13]. Similarly, the cooking process can affect the nutritional contents as well as the bioavailability of carotenes and minerals [14].

Among all the phytochemicals present in carrots, β-carotene is the main one responsible for the protective effects on health due to its quantity and bioactive quality. In the human system, the physiological activity of α-and β-carotene is 50 % and 100 % of the provitamin A activity, respectively, because one molecule of β-carotene yields two molecules of retinol. Vitamin A (retinol) is required for a variety of biological processes including vision, cell development, immune system functioning, and reproductive health [15]. It has been demonstrated that it is required for visual dark adaptation in dim light and for recovery from night-blindness [16]. A second very important function of vitamin A involves the control of cellular development and body processes. Retinol is metabolized to an active hormone-like molecule, retinoic acid (RA), a potent regulator of cell differentiation with effects in all organ systems. Retinoic acid first binds to RA receptors, which in turn interact with specific nucleotide sequences of DNA. The interaction directly affects gene expression and transcription, which control cellular development. For instance, epithelial cells depend on retinoic acid for structural and functional maintenance. RA specifically regulates immune responses, especially the differentiation of T-lymphocytes and the processes they regulate, which are necessary for intestinal mucosal immunity and for the innate immune responses necessary for virus clearance after viral infection [17].

The natural antioxidants carotenoids, phenolics, vitamin C, and tocopherol protect against the free radicals generated endogenously through normal diet and metabolic activity as well as from environmental sources. The reactive oxygen species (ROS) react with critical cellular biomolecules such as lipids, proteins, or DNA to initiate events that lead to increased risk of chronic disease such as cancer, cardiovascular disease, neuronal degeneration, and ophthalmological diseases. Both phenolic compounds and carotenoids are strong *in vitro* antioxidants. Phenolic fractions are potent free radical scavengers and β-carotene is considered a strong quencher of singlet oxygen [18]. The hydrophilic antioxidant activity has been reported to be proportional to the phenolic content of carrot cultivar; thus a hydrophilic extract of black (or purple) carrot shows the highest antioxidant activity compared to red and orange cultivars [12,19]. The hydrophilic phenolic antioxidants are known for a wide range of health promoting properties such as anticancer, anti-atherogenic, anti-inflammatory, and antimicrobial.

Carotenoids have been implicated in the inhibition of cancer cells in animal models and in humans, as important dietary phytonutrients having cancer preventive activity for lung, colon, breast, and prostate cancers. They also play a role in the protection against photooxidative processes preventing age related macular degeneration by acting as singlet oxygen and peroxyl radical quencher and can interact synergistically with other antioxidants [20]. The efficacy of carotenoids for suppressing the reactive species is related to the number of conjugated double bonds present in the molecule. β-carotene, zeaxanthin, cryptoxanthin, and α-carotene, which are detected in human serum and tissues, belong to the group of highly active scavengers. Since carotenoids are highly hydrophobic, their interaction with ROS is expected to occur in a lipophilic environment, such as in cell membranes and lipoproteins. The consumption of lutein is associated with prevention of age related macular degeneration and reduced risk of atherosclerosis [21]. By contrast, lycopene consumption is associated with reduced risk of certain type of cancer and cardiovascular diseases [22].

Due to the fact that ascorbic acid is easily oxidized, many of its functions and activities are known to be based primarily on its properties as a reversible biological reductant. Aside from its antiscorbutic activity it is likely to have a protective role against several human diseases such as cardiovascular diseases and cancer. It also is involved in many other biological processes, such as the inhibition of enzymatic browning and the formation of nitrosamines, the reduction of metallic ions, and the improvement of the stability and utilization of folic acid and vitamin E [23]. It enhances the absorption of iron to prevent anaemia [24]. The severity of traditional heating treatments is detrimental to the sensory and nutritional quality of fruit and vegetable products, causing the reduction of ascorbic acid content and the free radical scavenging activity of carrot juice by heat treatment at 80 °C for 1 minute [25]. Similarly, the cooking process changes the nutritional contents as well as the bioavailability of carotenes and minerals [26]. Cooking of carrots reduces thermolabile vitamin C but increases the content of carotenoids (α-and β-carotene, lutein + zeaxanthin), vitamin E, and vitamin K. This may be explained by the changes in bioaccessibility and bioavailability of carotenoids during heating.

Carrots are rich in a diversity of phytochemicals including carotenoids with provitamin A activity, phenolic compounds, ascorbic acid, α-tocopherol, vitamins D, K, B1, and B6, and polyacetylenes, many of which have antioxidant and other health promoting effects. Crop improvement programs to breed antioxidant-rich cultivars such as black and mixed colour carrots have improved the diversity of available carrots, which could potentially increase the intake of health promoting compounds through diet and aid in the prevention of chronic human diseases. It is noteworthy that the cooking processor industrial thermal processing can affect the contents of these phytochemicals as well as their bioaccessibility and bioavailability, depending on the severity of the treatment. In this context, mild thermal processing has been shown to increase carotenoids as a result of broken physical barriers such as chromoplast membranes and cellulose-thickened cell walls, releasing the nutrients and making them accessible for absorption.

Polyacetylenes in carrots are responsible for the bitter off-flavour of carrots; they are potent skin sensitizers and irritants and are neurotoxic at high concentrations, and they have traditionally been viewed as toxicants [5]. More recently, polyacetylenes have been considered bioactive compounds with potential effects on human physiology and disease [27]. *In vitro* studies suggest that carrot polyacetylenes have anti-inflammatory activity in macrophages, biphasic stimulatory and cytotoxic effects on primary mammary epithelial cells, and cytotoxic activity against a number of cell-lines [5,28,29], antifungal, antibacterial, antiviral and antiplatelet.

Fresh carrots — Specification

1 Scope

This standard applies to carrots of varieties (cultivars) grown from *Daucus carota L*. to be supplied fresh to the consumer, carrots for industrial processing being excluded.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ARS 53, *General principles of food hygiene — Code of practice*

ARS 56, *Prepackaged foods — Labelling*

CAC/GL 21, *Principles for the establishment and application of microbiological criteria for foods*

CAC/RCP 44, *Recommended international code of practice for the packaging and transport of tropical fresh fruit and vegetables*

3 Terms and definitions

For the purposes of this standard, the following terms and definitions apply.

3.1
similar varietal characteristics
the carrots in any lot are of the same general type. For example, carrots with a short, but blunt growth, like the Oxheart variety, shall not be mixed with long or half-long carrots, like the Imperator or Danvers varieties.

3.2
firm
the carrot is not soft, flabby, or shrivelled

3.3
fairly clean
the individual carrot is reasonably free from dirt, stain or other foreign matter and that the general appearance of the carrots in the lot is not more than slightly affected

3.4
fairly well coloured
the carrot has an orange, orange red, or orange scarlet colour, but not a pale orange or distinct yellow colour

3.5
fairly smooth
the carrot is not rough, ridged, or covered with secondary rootlets to the extent that the appearance is materially affected

3.6
well formed
the carrot is not forked, or misshapen to the extent that the appearance is more than slightly affected

3.7
damage
any defect which materially affects the appearance, or the edible or shipping quality of the individual carrot root, or the general appearance of the carrot roots in the container, or causes a loss of more than 3 percent, by weight, in the ordinary preparation for use, or which materially affects the appearance or shipping quality of the tops. Any one of the following defects, or any combination of defects, the seriousness of which exceeds the maximum allowed for any one defect, shall be considered as damage:

(a) Growth cracks which are not shallow or not smooth, or which materially affect the appearance of the carrot;

(b) Sunburn which causes a loss of more than 3 percent, by weight, in the ordinary preparation for use, except that superficial light green colour at the stem end which does not materially affect the appearance of the root shall be permitted; and,

(c) Yellowing or other discoloration or injury to the tops when the appearance of the bunch is arterially affected. The appearance of the individual bunch shall be considered materially affected when the tops are trimmed to the extent that only a relatively few leaves remain. The appearance of bunches with tops having slight discoloration such as yellowing, browning or other abnormal colour affecting a few leaflets shall not be considered materially affected if the tops as a whole show a predominantly normal green colour.

3.8
fresh
the tops are not badly wilted

3.9
full tops
the leafstems have not been cut back, but dried or damaged leaves or leafstems may have been removed

3.10
diameter
the greatest dimension of the root measured at right angles to the longitudinal axis

3.11
serious damage
any defect which seriously affects the appearance, or the edible or shipping quality of the individual carrot or the general appearance of the carrots in the container, or causes a loss of more than 20 percent, by weight, in the ordinary preparation for use

4 Provisions concerning quality

4.1 General

The purpose of the standard is to define the quality requirements of carrots at the export control stage, after preparation and packaging.

4.2 Minimum requirements

4.2.1 In all classes, subject to the special provisions for each class and the tolerances allowed, the carrots shall be:

(a) intact: not having any mutilation or injury spoiling the integrity of the produce.

(b) sound; produce affected by rotting or deterioration such as to make it unfit for consumption is excluded: Carrots shall be free from disease or serious deterioration which appreciably affects its appearance, edibility or market value. In particular, this excludes produce affected by rotting,

even if the signs are very slight but liable to make the produce unfit for consumption upon arrival at its destination.

(c) clean, that is to say:

(i) practically free of any visible foreign matter, if they are washed. Washed carrots shall be practically free of visible soil, dust, chemical residue or other visible foreign matter.

(ii) practically free of excess dirt and impurities if they are not washed. Unwashed carrots shall be practically free of excessive soil, dust, chemical residue or other visible foreign matter. However, 2% by weight of adhering soil may be regarded as normal.

(d) practically free from pests. The produce shall be practically free of insects or other pests. The presence of pests can detract from the commercial presentation and acceptance of the produce.

(e) practically free from damage caused by pests: pest damage can detract from the general appearance, keeping quality and edibility of the produce.

(f) firm: carrots which are no longer firm and have become shrivelled or dehydrated are excluded.

(g) not forked, free of secondary roots: carrots grown in stony or poorly prepared ground can develop forked growth. Carrots shall be single roots.

Moreover, carrots with secondary root growths are excluded.

(h) not woody: carrots which have become fibrous or woody are excluded.

(i) not running to seed: carrots which have started to produce seed heads or stems are excluded.

(j) free of abnormal external moisture i.e. sufficiently dried after washing: this provision applies to excessive moisture, for example, free water lying inside the package, but does not include condensation on produce following release from cool storage or refrigerated vehicle. In order that the carrots remain in good condition during transport and handling, they shall be sufficiently dried before packaging.

(k) free of foreign smell and/or taste: this refers particularly to produce which has been stored in badly kept premises or has travelled in a badly maintained vehicle, especially produce which has acquired a strong smell from other produce stored on the same premises or travelling in the same vehicle. For example, care shall be taken to use only non-smelling materials as protection in packaging.

4.2.2 The development and condition of the carrots shall be such as to enable them:

(a) to withstand transport and handling, and

(b) to arrive in satisfactory condition at the place of destination.

4.3 Classification

Carrots are classified in three classes defined below:

4.3.1 "Extra" Class

The carrots in this class shall be of superior quality and washed. They shall be characteristic of the variety or the varietal type. They shall be carefully presented.

They shall be free from defects with the exception of very slight superficial defects, provided these do not affect the general appearance of the produce, the quality, the keeping quality and presentation in the package. Such alterations may appear during cultivation, harvest, storage, packaging or transport.

The roots shall be:

— smooth: with due regard to the varietal type, the surface of the carrot shall be smooth and free from wrinkles, indentations or undulations.

— fresh in appearance: roots shall be bright showing no signs of dehydration or ageing.

— regular in shape: roots shall display a shape fully characteristic of the variety and they shall not show any malformation.

— free of fissures

— free of bruises and cracks

— free of damage due to frost.

Green or violet/purple tops are not allowed.

4.3.2 Class I

Carrots in this class shall be of good quality. They shall be characteristic of the variety or the varietal type. Although the Class I quality requirements are less strict than for "Extra" Class, Class I carrots shall, nevertheless, be characteristic of the variety or varietal type, carefully selected and presented.

The roots shall be:

— fresh in appearance: roots shall be bright showing no signs of dehydration or ageing. Slight silvering of the skin is permissible.

The following slight defects, however, may be allowed provided these do not affect the general appearance of the produce, the quality, the keeping quality and presentation in the package:

— slight defects in shape: roots shall remain characteristic of the varietal type; however, they may show slight distortions.

— slight defects in colouring: carrots shall be characteristic of the varietal type; however, a slight colour defect is allowed.

— slight healed cracks: small healed cracks caused during growth are acceptable provided they are shallow, clean and dry.

— slight cracks or fissures due to handling or washing provided they are fresh, shallow and cover only a small area.

  Fine cracks due to frost especially around the crown and shallers are allowed provided the flesh remains firm.

Green or violet/purple tops up to 1 cm long for roots not exceeding 10 cm in length, and up to 2 cm for other roots, are allowed. This discoloration refers to the carrot where the root has protruded from the ground during growth.

4.3.3 Class II

This class includes carrots which do not qualify for inclusion in the higher classes but satisfy the minimum requirements specified above. The carrots in this class shall be of marketable quality, suitable for human consumption and suitably presented.

The following defects may be allowed provided the carrots retain their essential characteristics as regards the quality, the keeping quality and presentation:

— defects in shape and in colouring: carrots can be distorted provided they retain the essential characteristics of the varietal type.

  Defects in colouring are allowed provided the carrots retain the essential characteristics of the varietal type.

— healed cracks not reaching the heart: healed cracks caused during growth are acceptable provided they do not expose the core of the carrot and are clean and dry.

— cracks or fissures due to handling or washing provided they are fresh and do not expose the core.

  Cracks due to frost especially around the crown and shallers are allowed provided the flesh remains reasonably firm and substantially intact.

Green or violet/purple tops up to 2 cm long for roots not exceeding 10 cm in length, and up to 3 cm for other roots, are allowed. This discoloration refers to the carrot where the root has protruded from the ground during growth.

5 Provisions concerning sizing

Size is determined by the maximum diameter or the weight of the root when without foliage.

(i) Early carrots[1] and small root varieties

  Roots shall not be less than 10 mm when sizing is by diameter and not less than 8 g when sizing is by weight.

  Roots shall not be more than 40 mm when sizing is by diameter and not more than 150 g when sizing is by weight.

  Early carrots are those harvested before they are fully mature and have completed their growth.

(ii) Main-crop carrots and large root varieties

  Roots shall not be less than 20 mm when sizing is by diameter and not less than 50 g when sizing is by weight.

Roots classified in the "Extra" Class shall not be more than 45 mm when sizing is by diameter and not more than 200 g when sizing is by weight and the difference in diameter or in weight between the smallest and the largest root in any one package shall not be more than 20 mm or 150 g.

For roots classified in Class I, the difference in diameter or weight between the smallest and the largest root in any one package shall not be more than 30 mm or 200 g.

For roots classified in Class II, the roots need only satisfy the minimum sizing requirements.

6 Provisions concerning tolerances

Tolerances in respect of quality and size shall be allowed in each package, or in each lot for produce presented in bulk, for produce not satisfying the requirements of the class indicated.

Tolerances are provided to allow for human error during the grading and packing process. During grading and sizing it is not permitted to deliberately include out of grade produce, i.e. to exploit the tolerances deliberately.

[1] Roots in which growth has not been arrested.

The tolerances are determined after examining each sample package and taking the average of all samples examined. The tolerances are stated in terms of percentage, by weight of produce in the total sample not conforming to the class or to the size indicated on the package.

6.1 Quality tolerances

Under no circumstances shall these tolerances apply to produce affected by rotting, or any other deterioration rendering it unfit for consumption.

6.1.1 "Extra" Class

5 per cent by weight of carrots not satisfying the requirements of the class, but meeting those of Class I or, exceptionally, coming within the tolerances of that class.

5 per cent by weight of carrots having a slight trace of green or violet/purple colouring at the top.

6.1.2 Class I

10 per cent by weight of carrots not satisfying the requirements of the class, but meeting those of Class II or, exceptionally, coming within the tolerances of that class. However, broken carrots and/or carrots which have lost their tips are excluded from that tolerance.

10 per cent by weight of broken carrots and/or carrots which have lost their tips.

6.1.3 Class II

10 per cent by weight of carrots satisfying neither the requirements of the class nor the minimum requirements, with the exception of produce affected by rotting or any other deterioration rendering it unfit for consumption.

In addition, not more than 25 per cent by weight of broken carrots may be allowed.

6.2 Size tolerances

For all classes: 10 per cent by weight of carrots not satisfying the requirements as regards sizing. The roots may fall below the minimum size or exceed the maximum permissible difference for the class.

7 Provisions concerning presentation

7.1 Uniformity

The contents of each package, or lot for produce presented in bulk, shall be uniform and contain only carrots of the same origin, variety or varietal type, quality and size (if sized).

The visible part of the contents of the package, or lot for produce presented in bulk, shall be representative of the entire contents.

A special effort shall be made to suppress camouflage, i.e. concealing in the lower layers of the package produce inferior in quality and size to that displayed and marked.

Similarly prohibited is any packaging method or practice intended to give a deceptively superior appearance to the top layer of the consignment.

7.2 Packaging

Carrots shall be packed in such a way so as to protect the produce properly.

Packages shall be of a quality, strength and characteristics to protect the produce during transport and handling.

The materials used inside the package shall be new, clean and of a quality such as to avoid causing any external or internal damage to the produce. The use of materials, particularly of paper or stamps, bearing trade specifications is allowed provided the printing or labelling has been done with non-toxic ink or glue.

Packages, or lots for produce presented in bulk, shall be free of all foreign matter. This provision is designed to ensure suitable protection of the produce by means of materials inside the package which are new and clean and also to prevent foreign bodies such as leaves, sand or soil from spoiling its good presentation. A visible lack of cleanliness in several packages could result in the goods being rejected.

7.3 Presentation

Carrots may be presented:

a) bunched carrots

The roots shall be presented with their foliage, which shall be fresh, green and sound. Roots in the same bunch shall be practically uniform in size. The bunches in each package shall be practically uniform in weight and arranged evenly in one or more layers.

b) topped carrots

The foliage shall be evened off or cut off at the top of the carrot without damaging it. The foliage shall be trimmed neatly just above the crown without damage to the root.

The carrots may be presented:

— in small packages.

— arranged in several layers or jumble packed.

— in bulk (direct loading into a transport vehicle or vehicle compartment) for Class II.

8 Marking or labelling

8.1 Consumer packages

In addition to the requirements of ARS 56, the following specific provisions apply:

8.1.1 Nature of produce

If the produce is not visible from the outside, each package shall be labelled as to the name of the produce and may be labelled as to the name of the variety and/or commercial type.

8.2 Non-retail containers

Each package[2] shall bear the following particulars, in letters grouped on the same side, legibly and indelibly marked, and visible from the outside.

Marking can be done either on a label attached to or printed on the package with water-insoluble ink.

For carrots transported in bulk (direct loading into a transport vehicle or vehicle compartment), these particulars shall appear on a document accompanying the goods, and be attached in a visible position inside the transport vehicle.

[2] Package units of produce prepacked for direct sale to the consumer shall not be subject to these marking provisions but shall conform to the national requirements. However, the markings referred to shall in any event be shown on the transport packaging containing such package units.

In the case of reused packages, all previous labels shall be carefully removed and previous indications deleted.

8.2.1 Identification

Name and address of exporter, packer and/or dispatcher. Identification code (optional). [3]

8.2.2 Nature of produce

— "Bunched carrots" or "carrots" if the contents are not visible from the outside

— "Early carrots" or "main-crop carrots" if the contents are not visible from the outside

— Name of the variety or the varietal type for "Extra" Class.

8.2.3 Origin of produce

Country of origin and, optionally, district where grown, or national, regional or local place name.

8.2.4 Commercial specifications

— Class

— Size expressed in minimum and maximum diameter or weight (optional)

— Number of bunches in the case of bunched carrots.

8.2.5 Official control mark (optional)

9 Contaminants

9.1 Heavy metals

Carrots shall comply with those maximum levels for heavy metals established by the Codex Alimentarius Commission for this commodity.

9.2 Pesticide residues

Carrots shall comply with those maximum pesticide residue limits established by the Codex Alimentarius Commission for this commodity.

10 Hygiene

10.1 It is recommended that the produce covered by the provisions of this Standard be prepared and handled in accordance with the appropriate sections of ARS 53 and CAC/RCP 53.

10.2 The produce shall comply with any microbiological criteria established in accordance with CAC/GL 21.

[3] The national legislation of a number of countries requires the explicit declaration of the name and address. However, in the case where a code mark is used, the reference "packer and/or dispatcher (or equivalent abbreviations)" has to be indicated in close connection with the code mark.

Bibliography

[1] FAOSTAT. (2018) Food and Agriculture Data: Carrots and Turnips [Internet]. Food Agric. Organ. U. N.

[2] Quiros, C.F., Rubatzky, V.E. and Simon, P.W. (1999) Carrots and Related Vegetable Umbelliferae [Internet]. 1st Ed. CABI Publishing, Wallington, UK; New York, NY, USA.

[3] Char, C.D. (2018) Carrots (Daucus carota L.). In: Yahia EM, editor. *Fruit and Vegetable Phytochemicals: Chemistry and Human Health*, 2nd Ed. John Wiley & Sons Ltd, Hoboken, NJ, USA. p. 969–78.

[4] USDA ARS. (2018) National Nutrient Database for Standard Reference Release 1, Basic Report: 11124, Carrots, Raw [Internet]. USDA Natl. Nutr. Database Stand. Ref.

[5] Arscott, S.A. and Tanumihardjo, S.A. (2010) Carrots of Many Colors Provide Basic Nutrition and Bioavailable Phytochemicals Acting as a Functional Food. *Comprehensive Reviews in Food Science and Food Safety*, **9**, 223–39. https://doi.org/10.1111/j.1541-4337.2009.00103.x

[6] Marlett, J.A. (1992) Content and Composition of Dietary Fiber in 117 Frequently Consumed Foods. *Journal of the American Dietetic Association*, **92**, 175–86.

[7] FAO/WHO. (2001) Human Vitamin and Mineral Requirements: Report of a Joint FAO/WHO Expert Consultation, Bangkok, Thailand [Internet]. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy. p. 1–290.

[8] Singh, D.P., Beloy, J., McInerney, J.K. and Day, L. (2012) Impact of Boron, Calcium and Genetic Factors on Vitamin C, Carotenoids, Phenolic Acids, Anthocyanins and Antioxidant Capacity of Carrots (Daucus carota). *Food Chemistry*, **132**, 1161–70. https://doi.org/10.1016/j.foodchem.2011.11.045

[9] Grassmann, J., Schnitzler, W.H. and Habegger, R. (2007) Evaluation of Different Coloured Carrot Cultivars on Antioxidative Capacity Based on their Carotenoid and Phenolic Contents. *International Journal of Food Sciences and Nutrition*, **58**, 603–11. https://doi.org/10.1080/09637480701359149

[10] Sun, T., Simon, P.W. and Tanumihardjo, S.A. (2009) Antioxidant Phytochemicals and Antioxidant Capacity of Biofortified Carrots (Daucus carota L.) of Various Colors. *Journal of Agricultural and Food Chemistry*, **57**, 4142–7. https://doi.org/10.1021/jf9001044

[11] Southon, S. and Faulks, R. (2003) Carotenoids in Food: Bioavailability and Functional Benefits. In: Johnson IT, and Williamson G, editors. *Phytochemical Functional Foods*, 1st Ed. Woodhead Publishing Limited, Cambridge, England, United Kingdom; Boca Raton, FL, USA. p. 107–27.

[12] Nicolle, C., Simon, G., Rock, E., Amouroux, P. and Rémésy, C. (2004) Genetic Variability Influences Carotenoid, Vitamin, Phenolic, and Mineral Content in White, Yellow, Purple, Orange, and Dark-Orange Carrot Cultivars. *Journal of the American Society for Horticultural Science*, **129**, 523–9.

[13] Goldman, I.L., Kader, A.A. and Heintz, C. (1999) Influence of Production, Handling, and Storage on Phytonutrient Content of Foods. *Nutrition Reviews*, **57**, 46–52. https://doi.org/10.1111/j.1753-4887.1999.tb01807.x

[14] Sharma, K.D., Karki, S., Thakur, N.S. and Attri, S. (2012) Chemical Composition, Functional Properties and Processing of Carrot: A Review. *Journal of Food Science and Technology*, **49**, 22–32. https://doi.org/10.1007/s13197-011-0310-7

[15] Ross, A.C. (2016) Retinol: Properties and Determination. In: Caballero B, Finglas PM, and Toldrá F, editors. *Encyclopedia of Food and Health: Reference Module in Food Science (5-Volume Set)*, 1st Ed. Academic Press/Elsevier, Oxford, UK; Waltham, MA, USA. p. 604–9.

[16] Haskell, M.J., Pandey, P., Graham, J.M., Peerson, J.M., Shrestha, R.K. and Brown, K.H. (2005) Recovery from Impaired Dark Adaptation in Nightblind Pregnant Nepali Women who Receive Small Daily Doses of Vitamin A as Amaranth Leaves, Carrots, Goat Liver, Vitamin A–Fortified Rice, or Retinyl Palmitate. *The American Journal of Clinical Nutrition*, **81**, 461–71. https://doi.org/10.1093/ajcn.81.2.461

[17] Ross, A.C. and Restori, K.H. (2013) Vitamin A and the Immune System. In: Calder PC, and Yaqoob P, editors. *Diet, Immunity and Inflammation*, 1st Ed. Woodhead Publishing, Cambridge, UK; Philadelphia, PA, USA. p. 221–43. https://doi.org/10.1533/9780857095749.2.221

[18] Schafer, F.Q., Wang, H.P., Kelley, E.E., Cueno, K.L., Martin, S.M. and Buettner, G.R. (2002) Comparing β-Carotene, Vitamin E and Nitric Oxide as Membrane Antioxidants. *Biological Chemistry*, **383**, 671–81. https://doi.org/10.1515/BC.2002.069

[19] Koley, T.K., Singh, S., Khemariya, P., Sarkar, A., Kaur, C., Chaurasia, S.N.S. et al. (2014) Evaluation of Bioactive Properties of Indian Carrot (Daucus carota L.): A Chemometric Approach. *Food Research International*, **60**, 76–85. https://doi.org/10.1016/j.foodres.2013.12.006

[20] Tapiero, H., Townsend, D.M. and Tew, K.D. (2004) The Role of Carotenoids in the Prevention of Human Pathologies. *Biomedicine & Pharmacotherapy*, **58**, 100–10. https://doi.org/10.1016/j.biopha.2003.12.006

[21] Alves-Rodrigues, A. and Shao, A. (2004) The Science Behind Lutein. *Toxicology Letters*, **150**, 57–83. https://doi.org/10.1016/j.toxlet.2003.10.031

[22] Rao, A.V. and Rao, L.G. (2007) Carotenoids and Human Health. *Pharmacological Research*, **55**, 207–16. https://doi.org/10.1016/j.phrs.2007.01.012

[23] Meléndez-Martínez, A.J., Vicario, I.M. and Heredia, F.J. (2007) Provitamin A Carotenoids and Ascorbic Acid Contents of the Different Types of Orange Juices Marketed in Spain. *Food Chemistry*, **101**, 177–84. https://doi.org/10.1016/j.foodchem.2006.01.023

[24] Hallberg, L., Brune, M. and Rossander-Hulthén, L. (1987) Is There a Physiological Role of Vitamin C in Iron Absorption? *Annals of the New York Academy of Sciences*, **498**, 324–32. https://doi.org/10.1111/j.1749-6632.1987.tb23771.x

[25] Dede, S., Alpas, H. and Bayındırlı, A. (2007) High Hydrostatic Pressure Treatment and Storage of Carrot and Tomato Juices: Antioxidant Activity and Microbial Safety. *Journal of the Science of Food and Agriculture*, **87**, 773–82. https://doi.org/10.1002/jsfa.2758

[26] Zaripheh, S. and Erdman, J.W. (2002) Factors That Influence the Bioavailablity of Xanthophylls. *The Journal of Nutrition*, **132**, 531S-534S. https://doi.org/10.1093/jn/132.3.531S

[27] Christensen, L.P. and Brandt, K. (2006) Bioactive Polyacetylenes in Food Plants of the Apiaceae Family: Occurrence, Bioactivity and Analysis. *Journal of Pharmaceutical and Biomedical Analysis*, **41**, 683–93. https://doi.org/10.1016/j.jpba.2006.01.057

[28] Metzger, B.T., Barnes, D.M. and Reed, J.D. (2008) Purple Carrot (Daucus carota L.) Polyacetylenes Decrease Lipopolysaccharide-Induced Expression of Inflammatory Proteins in Macrophage and Endothelial Cells. *Journal of Agricultural and Food Chemistry*, **56**, 3554–60. https://doi.org/10.1021/jf073494t

[29] Zidorn, C., Jöhrer, K., Ganzera, M., Schubert, B., Sigmund, E.M., Mader, J. et al. (2005) Polyacetylenes from the Apiaceae Vegetables Carrot, Celery, Fennel, Parsley, and Parsnip and Their Cytotoxic Activities. *Journal of Agricultural and Food Chemistry*, **53**, 2518–23. https://doi.org/10.1021/jf048041s

Price based on 8 pages