

Review: Cenourete® and Catetinho® - Brazilian Minicarrots

Revisão: Cenourete® e Catetinho® - Minicenouras Brasileiras

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SUMMARY

In this article is described in detail the technology developed at Embrapa Vegetables to process carrot roots as a product similar to the American 'baby-carrot'. The results and observations collected in the last 6 years of research and development are summarized. The Brazilian processed mini-carrots are called Cenourete®, when with the shape of a mini carrot root, and Catetinho®, when with the shape of a small sphere. The production of Cenourete® and Catetinho® consists in polishing cylindrical carrot root segments through abrasion against an abrasive surface. After abrasion, the segments take the shape of small carrots or small spheres depending on the size of the raw-material (specifically the relation length:diameter). It is expected that Cenourete® and Catetinho® will be very attractive as a snack food as much as an ingredient for fresh salads and cooked dishes. Their special formats make them an especially attractive food for children.

RESUMO

No presente artigo é descrita em detalhes a tecnologia desenvolvida na Embrapa Hortaliças para o processamento de raízes de cenoura em um produto similar à "baby-carrot" americana. Os resultados e observações obtidos nos últimos 6 anos em trabalhos de pesquisa e desenvolvimento são apresentados de forma sucinta. As mini-cenouras brasileiras são chamadas Cenourete®, quando apresentadas em formato de uma mini-cenoura e Catetinho®, quando em formato esférico. A produção de ambas consiste no torneamento de pedaços cilíndricos de raiz usando-se uma superfície abrasiva. Após abrasão, os segmentos tomam o formato de mini-cenouras ou de pequenas esferas, dependendo do tamanho da matéria-prima (especificamente a relação comprimento-diâmetro). Espera-se que Cenourete® e Catetinho® tornem-se produtivos atrativos tanto como tira-gosto como componentes de saladas e pratos prontos. Seus formatos especiais tornam-nos especialmente atrativos como alimento infantil.

PALAVRAS-CHAVE

KEY WORDS

Daucus carota; Minimal processing; Fresh-cut carrot; Brazilian baby-carrot; Vegetable processing; Industrial yield.

Daucus carota; Processamento mínimo; Mini cenoura; Baby-carrot brasileira; Processamento de hortaliças; Rendimento industrial.

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1. INTRODUCTION

The average Brazilian carrot production reaches 750.000 t/year in a total area of 28.000 ha (BRASIL, 2005). Carrot roots are suitable for processing in different forms namely frozen, fresh-cut, and diced. They are also important components of baby-food, juices and dehydrated soup formulations. In spite of this, almost all the Brazilian carrot production is for the fresh market with only a small percentage for processing.

In recent years there was an increased interest for fresh-cut ready to eat vegetables. Fresh carrot roots can be sliced and shredded in different shapes and packaged as a single vegetable or added to mixed salads. Long and thin carrot roots can alternatively be cut into small pieces, peeled and shaped into smaller carrot like products and sold refrigerated in small packages. This product known as 'peeled baby-carrot' is primarily consumed as snacks or added to fresh salads. It is quite popular in the USA and in lower scale in Europe.

In the year 2000, Brazil imported around 200 t of 'peeled baby-carrot' from the USA (BRASIL, 2005; Figure 1). The retail price of this product reached R\$ 18,00/kg (R\$ 4,50 per package of 250 g), a very high price when compared with the price of R\$ 0,80/kg of fresh carrot.

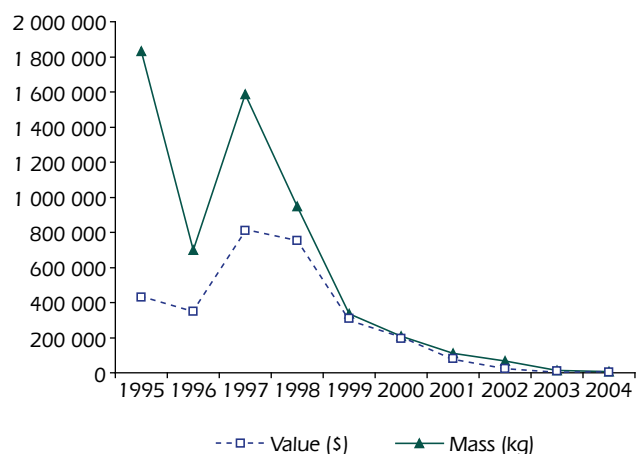


FIGURE 1. Brazilian importation of Baby-Carrot from the USA in monetary value (US\$) and in mass (kg). Source: Brasil, 2005.

In 2001, Embrapa Vegetables introduced a new technology to process carrot roots as a product similar to the American 'baby-carrot'. The Brazilian processed mini-carrots are called Cenourete® (shape of a mini carrot root) and Catetinho® (shape of a small sphere). The production of Cenourete® and Catetinho® consists in polishing cylindrical carrot root segments through abrasion against an abrasive surface. After abrasion, the segments take the shape of small carrots or small spheres depending on the size of the raw-material (specifically the relation length:diameter). They are then polished using a finer grade in order to obtain a smooth surface, sanitized, packaged and stored at low temperature (1-5 °C) until consumption, as detailed in the coming sections. Both are fresh, additive-free and nutritious products and can be consumed raw as snacks or in salads, cooked or canned.

The production of Cenourete® and Catetinho® was made possible through the combination of two technologies developed at Embrapa Vegetables:

- The introduction of two new carrot cultivars, namely Alvorada and Esplanada; and
- The construction of a series of small and low cost equipments for all the stages in the processing line especially developed for small agro industries.

The technology for Cenourete® and Catetinho® was first developed to add value to thin roots that are left in the field or sold by much smaller prices. In general, this class of roots represents 10% of the total production. However, depending on the time of the year, region and production system used, it can reach 20% of total production what would represent around 150.000 t of carrot roots per year. It was showed previously that this category of root can be processed into Cenourete® and Catetinho® using a very simple equipment adapted from a potato peeler (LANA et al., 2001; SILVA et al., 2001). These studies were realized with carrot cultivar named Alvorada. This cultivar, that belongs to the group of cultivars named Brasília, has uniform orange colour what makes it suitable for processing operations where the roots are peeled and the internal root tissues are exposed.

Later on, the introduction of cultivar Esplanada (VIEIRA et al., 2005), characterized by longer and thinner roots than Alvorada, changed this panorama allowing the cultivation of carrot especially for processing while the development of new equipment made it possible to increase the capacity of the agro industries as it will be detailed in the next sections.

With the technology developed at Embrapa it is possible to produce mini-carrots very similar in appearance to the imported product (Cenourete®), besides a new product without similar (Catetinho®), using a technology that is 100% Brazilian. The Brazilians Cenourete® and Catetinho® have the advantage of lower price and higher freshness since the time between production and marketing is much shorter compared with the imported product. Besides that, the equipments were especially constructed to make possible the operation of small scale Brazilian agro industries.

It is expected that Cenourete® and Catetinho® will be very attractive as a snack food as much as an ingredient for fresh salads and cooked dishes. Their special formats make them an especially attractive food for children. This can lead to an increase in the consumption of carrot in Brazil with many advantages to the whole carrot productive chain together with a higher supply of pro-vitamin A and an alternative of healthy, low fat, low sugar and low salt snack.

2. CULTIVARS SUITABLE FOR PROCESSING

The productivity of Cenourete® and Catetinho® mini-carrots is directly related to the shape and size of the roots. Cylindrical, long and thin roots result in higher productivity because more segments are obtained per root and less time of abrasion is necessary to shape the segments. Besides that, the roots must present uniform internal orange colour without greening. The yield of Cenourete® is much more dependent on root length than the yield of Catetinho®. For Catetinho® production, the length of the segments is adjusted according to the diameter of the root, as far as the diameter is equal to or lower than 30 mm, and consequently a higher proportion of the root can be used regardless of its size. On the other hand, the production of Cenourete® demands segments 55-60 mm long with a diameter equal to or lower than 25 mm and the length of the root is as important as the diameter to define the final productivity. Roots

with diameter higher than 30 mm are not recommended because the time necessary to round them to the adequate size is too long what results in high consumption of energy, high losses of external tissue during abrasion and low productivity.

The production of Brazilian's mini-carrots Cenourete® and Catetinho® was first made possible with the introduction of the cultivar Alvorada (VIEIRA et al., 2000). This cultivar presents uniform internal colour, very low incidence of greening and high content of pro-vitamin A. It can be cultivated in the main producing regions of Brazil all over the year using the same productive system used for fresh carrot roots. The raw material for the agroindustry consists of thinner roots of low price that are either left in the field or discarded after selection and grading. The advantages of this system are the low cost of raw material and the reduction of post harvest losses adding value to a product that otherwise would become waste or animal feeding. However, the supply of raw material is irregular along the year because the proportion of thin roots varies with cultivar and edaphoclimatic conditions. Besides that, the amount of waste depends on the price of carrot in the fresh market. When the prices are high, even thin roots are sent to the market and the supply of roots to the industry can be impaired. This results in irregular supply in what concerns amount and appropriate root size, making it impossible to plan the production along the year and standardize the processing operations. In a scenario of small scale agro industries this is not a limiting situation but it is not competitive when more efficient industries are in the market.

The cultivar Esplanada introduced in 2005 (VIEIRA et al., 2005) was especially developed for processing. It has longer (>200 mm length) and thinner (<30 mm diameter) cylindrical roots what results in a higher productivity in the industry, compared with cultivar Alvorada. Besides that, it presents uniform dark orange colour and very small incidence of greening. Esplanada is adapted to the same regions and planting time as Brasília and Alvorada cultivars, what assures the continued production of roots along the year in the main production regions in Brazil. Due to its resistance to high temperature and foliar diseases, it can be cultivated without the application of pesticides. Because it has long and thin roots all the roots can be destined to processing as far as the planting density is adequate as described in the section 'Production of Raw Material'.

Cultivar Brasília is not recommended due to its internal colour gradient with the xylem presenting a lighter orange colour than the phloem.

Esplanada, as much as Alvorada, can flower in the spring season in the South and Southeast regions of Brazil, what restricts its use in this time of the year in these regions.

During the winter season, in regions too cold for the cultivation of Esplanada and Alvorada, other cultivars from Nantes group that present uniform internal colour can be used. In this case, the same recommendations for Alvorada concerning root size should be taken. Imported cultivars from the Imperator group can also be cultivated in this period. These cultivars present roots with very good characteristics for processing but it should be stressed that they are not well adapted to the Brazilian conditions and are very susceptible to foliar diseases what requires intensive use of pesticides even during the winter.

Studies relating internal quality and chemical composition of Brazilian cultivars with suitability for processing are object of present investigation but no concluding results are available. Information

from the literature indicates that the rate of accumulation of chlorogenic acid after processing is the best indicator of suitability for minimal processing of carrot cultivars (AUBERT et al., 1993; BABIC et al., 1993).

3. PRODUCTION OF RAW MATERIAL

The main objective in a production system of carrot for mini-carrot production is to increase the proportion of roots with diameter lower than 30 mm. Potential root size varies among cultivars but within a certain range it can be adjusted through improvements in the growing system especially population density and harvest date. Root length is also important as already discussed; however this attribute is less influenced by growing conditions than root diameter and more dependent on genotype.

The importance of adjusting cultivation system and harvest date is depicted in Figure 2. The production of Cenourete® from Cultivar Esplanada varied from $2.3 \pm 0.4 \text{ t}\cdot\text{ha}^{-1}$ to $10.7 \pm 1.1 \text{ t}\cdot\text{ha}^{-1}$ depending on population density and harvest date. Reducing line spacing from 20 to 12.5 cm increased the recovery of Cenourete® significantly for all harvest dates (SILVA et al., 2004, data not published). For both population densities the roots should be harvested at 80-90 days after sowing. Extension of the crop cycle results in reduction in the amount of thin roots and corresponding increase in the amount of large roots that are not suitable for processing.

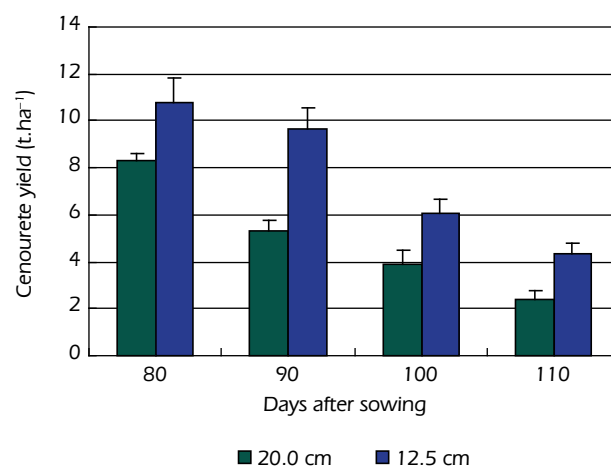


FIGURE 2. Production of Cenourete® from carrot cultivar Esplanada, sowed with 20 cm between lines (5 lines/m) or 12.5 cm between lines (8 lines/m) and harvested 80, 90, 100 or 110 days after sowing. Values are the average of 4 replicates \pm standard deviation. (SILVA et al., 2004, data not published).

The production of carrot from cultivar Alvorada and Nantes only for processing as mini-carrot is not recommended. At higher density the roots will be thinner but the productivity will be smaller than that obtained with cultivar Esplanada because the proportion of roots with a diameter lower than 30 mm is considerably low and the roots are shorter than Esplanada. Studies conducted at *Embrapa Hortaliças*, Brasília-DF showed that the yield of Cenourete® from cultivar Alvorada harvested 110 days after sowing varied from 1.3 ± 0.3 to $3.1 \pm 0.4 \text{ t}\cdot\text{ha}^{-1}$ depending on the plant spatial distribution (single or triple rows) and planting density (14, 16, 18 or 20 plants/m). The yield of Cenourete® obtained from

cultivar Nantes under the same conditions was significantly higher than that obtained with Alvorada and varied from 2.7 ± 0.7 to 4.9 ± 0.6 t.ha⁻¹ (Figure 3, top) but was still lower than that obtained with Esplanada (SILVA et al., 2004, data not published).

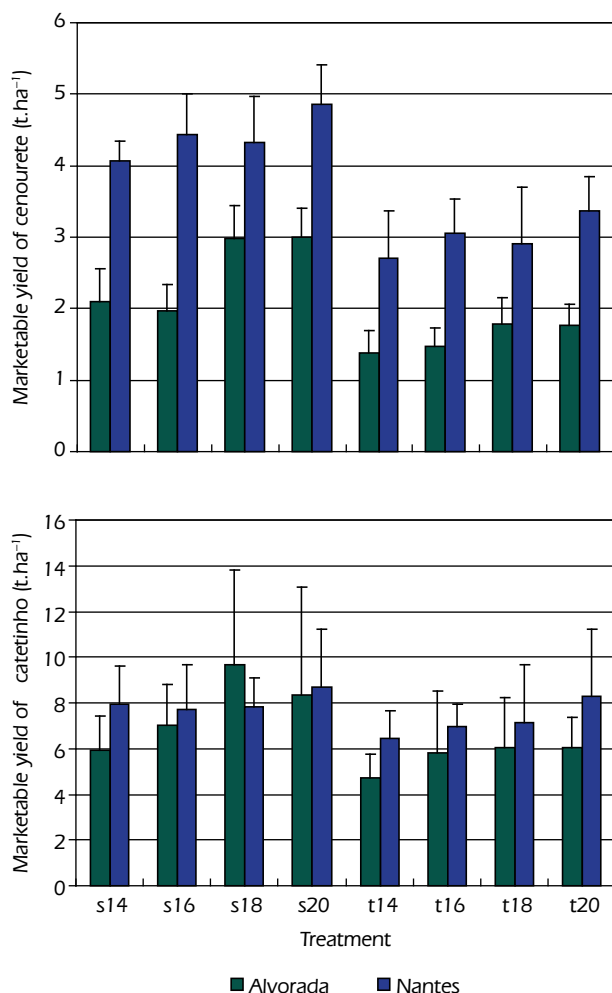


FIGURE 3. Marketable yield of Cenourete® (top graph) and Catetinho® (bottom graph) obtained from carrot cultivars Alvorada and Nantes (according to the legend) grown with single rows 20 cm apart (s) or triple rows (10 cm between single rows and 20 cm between triple rows (t)) at a planting density of 14, 16, 18 or 20 plants/m. Bars represent the average of 4 replicates \pm standard deviation. (SILVA et al., 2004, data not published).

In the same study cited before the root portions shorter than 60 mm that could not be used for Cenourete® production were processed into Catetinho®. Catetinho® yield varied from 5.8 ± 2.7 to 9.7 ± 4.1 t.ha⁻¹ and was higher for single rows than for triple rows. There was no significant difference between cultivars and planting density (Figure 3, bottom) what is expected since Catetinho® is less dependent than Cenourete® on root size.

Since Alvorada and Esplanada have the same requirements in what concerns edaphoclimatic conditions it is much more advantageous to grow Esplanada when its end use is the production

of mini-carrots. However, the small and thin roots from Alvorada and Nantes that would be otherwise discarded or sold at a very low price can be processed into Cenourete® or Catetinho® as far as the right combination time of processing x size of raw material is adequate (see more details in Section Selection, Cutting and Grading of the Roots) and the limitations discussed before are taken into account.

For the best of the authors' knowledge, information about production system of winter hybrids under Brazilian conditions is not available in the scientific and technical literature.

For all cultivars, the recommendations concerning pest, disease and weed control, nutrition and irrigation are the same recommended in the region for the production of carrots destined to the fresh market.

4. HANDLING OF RAW MATERIAL

The roots should be harvested as usual, minimizing mechanical damage and splitting of the roots what reduces productivity and increase microbial deterioration. The leaves should be removed as soon as possible to reduce transpiration and the roots protected from direct sun light. Wilted and flaccid roots are not suitable for processing because they are not well abraded, do not attain the right final shape and part of the peel is not removed. The roots should not remain in the field for more than 1 day, even when protected from the sun. Especial care should be taken when harvesting earlier in the season, because more immature roots loses water more rapidly. Roots of cultivar Esplanada compared with Alvorada and Brasília are more susceptible to water loss due to its lower surface:volume ratio (thinner roots) and because they are harvested relatively immature.

After harvest the roots are washed, trimmed with removal of debris and deteriorated roots and kept refrigerated at 1-5 °C until processing. Alternatively, the roots can be cut into root segments in the appropriate size and stored up to 15 days before processing. Especial care should be taken to avoid excessive water loss and microbial contamination during storage of the roots.

To avoid microbial contamination, the roots and root segments should be stored in clean sanitized boxes and the storage rooms should be kept clean. To reduce water loss during storage the roots and root segments might be packed in plastic bags and protect from excessive ventilation. High relative humidity is essential to prevent desiccation and loss of crispness. Free moisture from the washing process or unevaporated condensation, common with plastic bin-liners (and due to fluctuating temperatures) will promote decay (SUSLOW et al., 2006).

Exposure to ethylene will induce the development of bitter flavor due to isocoumarin formation (LAFUENTE et al., 1996). Exposure to as little as 0.5 ppm exogenous ethylene will result in perceptible bitter flavor, within 2 weeks, at normal storage conditions. Thus, carrots should not be mixed with ethylene-producing commodities.

5. SELECTION, CUTTING AND GRADING OF ROOTS

The carrot roots are first graded according to the diameter and later cut into segments at the appropriate size. This step is particularly important since the final size, appearance and uniformity

of the processed product is determined by the size and uniformity of the raw material.

Cutting can be performed manually using a sharp stainless steel knife and a template (Figure 4). It is possible to obtain uniform root segments this way; however the operation is time consuming. One trained employee can cut about 120 kg of roots per day. Manual cutting can be improved with the use of the equipment *Corte Fácil* (SILVA et al., 2006). Although the productivity is the same as when using knife and template, the uniformity of the segments is improved and the work is less laborious.

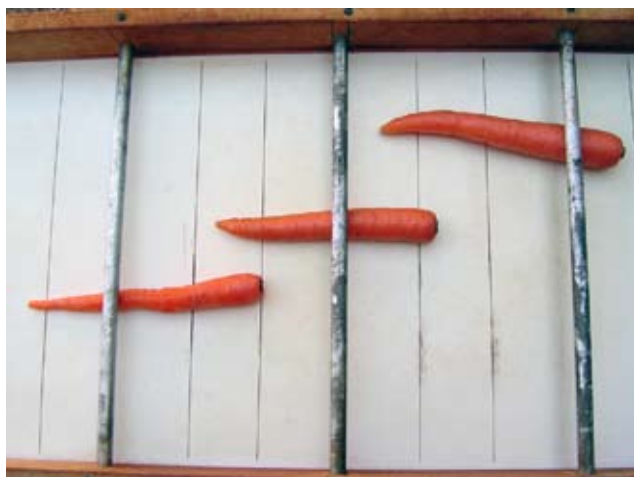


FIGURE 4. Template for manual carrot root cutting (overview and detail). The height of the bars are used to measure the diameter (15, 20, 25 mm) and a line in the bottom to measure the length.

Two equipments are available for semi-mechanized cutting namely *Precisa* and *Cortadora Horizontal*. Details of both equipments are presented in Silva et al. (2006).

For Cenourete® production the roots are cut into 60 mm length segments. For Catetinho® production they should be cut in a length equal to diameter ± 10 mm as far as the diameter does not exceed 30 mm. After cutting, the roots segments should be classified using a *Classificador* (SILVA et al., 2006). Carrot segments with diameter higher than 30 mm are used for other kind of fresh-cut products such as grated, sliced and shredded. Root segments with diameter equal to or lower than 30 mm are taken into the next steps.

A rigorous classification of the segments according to their diameter is essential to obtain a uniform product. This is because the initial diameter will define the time necessary for processing. Bigger segments demand longer time and vice-versa. Young roots, with higher water content, demand shorter processing time, while more fibrous roots demand a longer processing time. Processing time longer than necessary will decrease the productivity, increase energy costs and sometimes result in misshaped Cenourete®. Processing time shorter than necessary will result in partial removal of the peel and misshaped or too large Cenourete® and Catetinho®.

Processing carrot segments with different diameters all together in the same run will result in a non-uniform product in relation to size and shape when producing Cenourete®. For Catetinho® production raw-material of different sizes can be processed together without interference in the final shape of the spheres, but the time of processing will have to be adjusted for the larger raw-material. This can result in higher losses and higher energy consumption than when processing different sizes separately, with a shorter processing time for smaller raw-material.

6. ABRASION

Two equipments are available for abrasion namely *Processador de Cenourete e Catetinho* (SKYMPSEN, 2002) and *Múltipla* (SILVA et al., 2006).

The *Processador de Cenourete e Catetinho* is an adapted potato peeler and using this equipment it is possible to process 1.5 kg of root segments per batch while in the *Múltipla* it is possible to process 8 kg of root segments per batch (corresponding to 2 kg per each of the four compartments).

The operation is performed in two stages. In the first one it is used a rough abrasive surface to remove the peel and round and shape the root segments. A typical processing time varies from 1.5 to 3.0 min depending on the diameter of the root segments and the expected size of the final product. In the second one it is used a smoother abrasive surface to polish the mini-carrots for 45 s to 1 min. The carrot pieces that are initially cylindrical and with sharp edges are abraded mainly in the edges, becoming first elliptical and later rounded. It is recommend to do preliminary tests in order to adjust the size of carrot segments x processing time.

To remove the debris on the cut surface a continuous water jet flows over the rotative disc. The water with the debris runs along the borders of the discs, leaves the interior of the machine through a lateral tube and is collected in an outsider water tank with a filter where the water is separated from the debris.

7. WATER RECYCLING

A water recycling system operates in the abrasion-polishing step in order to save water and avoid the transfer of a large amount of organic waste to the sewing system.

Two *Processadora* used respectively for shaping and polishing can be linked to each other by a pipe and simultaneously to a collecting tank. The water used in the shaping step (1st unit) is collected in a tank after being filtered through a nylon net and pumped back to the first unit. The water used in the polishing step (2nd unit) is directed to the same tank and has the function to renew the water in the tank since it is drinkable water with a lower load of organic matter compared with the water derived from the 1st unit. Before starting the operation, the tank must be filled with

clean water to half of this capacity. The difference in the level of water between the filter and the tank exerts pressure in the filtering surface. When the water reaches a certain volume it is drained through an aperture in the upper part of the tank. After each work shift, the water should be drained and all the equipments washed and cleaned. In the *Múltipla* equipment the water is recycled in a similar manner.

The residues that are suspended or soluble in the water or that are not retained by the filter are discharged in the sewage system. The environmental impact of this load of organic waste is not known, and will certainly depend on the volume of processing.

8. WASHING AND SANITIZING

Since Cenourete® and Catetinho® are likely to be consumed raw, special care should be taken to assure the microbiological safety during processing and marketing. For that two points are essential: the hygiene during processing to avoid contamination and maintenance of the cold chain to inhibit microbial growth.

Drinkable water must be used in all the stages of processing. High quality water is essential to reduce microbial load and prevent cross contamination, but it must be kept in mind that it is not enough to sterilize the product and to avoid contamination by other sources. After polishing, the mini-carrots are rinsed with drinkable water, immersed in a solution of cold chlorinated water (100 ppm of sodium hypochlorite) for 1.5 min and rinsed again with drinkable water. The infiltration of microorganisms below the surface of the product, due to infiltration of contaminated water is a theoretical possibility that has not been investigated.

The use of alternative sanitizing agents such as ozone, dioxide chlorine, peroxide and others are object of study by many researcher groups in view of the problems presented by chlorine. These include: potential adverse health effects of chlorinate by products; corrosion of equipments; sensitivity of chlorine to temperature, light, air, metals and organic materials; resistance presented by some bacterial spores and protozoan oocysts (PARISH et al., 2003).

Control of contamination requires that sanitizing treatments are applied to equipments and facilities as well as to produce. After successive operations there is an accumulation of carrot debris in the equipments and piping system that must be removed daily. Cleaning must involve the application of chlorinated water and scrubbing of the surfaces with brushes or spray washers, followed by rising with drinkable water. It is important to ensure that the water used in this step is clean so that it does not become a vehicle for contamination.

For purposes of inspection the interested reader should address to Technical Regulation about Microbiological Standard for Food – Resolution RDC number 12, 02 January 2001 (*Resolução RDC nº 12, de 02 de janeiro de 2001 - Regulamento Técnico sobre Padrões Microbiológicos para Alimentos*) published by Ministry of Health, National Health Surveillance Agency (SVS/MS – *Ministério da Saúde, Secretaria de Vigilância Sanitária*). This resolution, available at <http://e-legis.anvisa.gov.br/leisref/public/showAct.php?id=144&word> establishes the standards and tolerances for microbial contamination in various groups of foods including fresh-cut vegetables.

The design and building of the facilities must comply with hygiene laws and general guidelines for food industry available in the region. For more information on that, the reader is addressed to

Decree number 326, 30 June 1997 – Ministry of Health (*Portaria nº 326, de 30 de junho de 1997 - Ministério da Saúde*) that approves the technical regulation Hygienic and Sanitary Conditions and Good Production Practices for Food Manufacture Establishments (*Condições Higiénico-Sanitárias e de Boas Práticas de Fabricação para Estabelecimentos Produtores Industrializadores de Alimentos*) available at <http://e-legis.anvisa.gov.br/leisref/public/showAct.php?id=100&word>.

9. PACKING AND STORAGE

After rising, the excess water in the surface of the product should be drained for few seconds and the product packed in plastic bags or plastic boxes with the surface still wet. Centrifuging to remove surface water accelerates whitening of the product surface and for this reason is not recommended. However it should be stressed that the maintenance of free water on the surface of the mini-carrots enhances spoilage when the temperature control and the sanitizing operations are not satisfactory.

Packaging should preferably be under partial vacuum using plastic bags proper for food. The product should be kept under refrigeration (1 to 5 °C). Maintenance of low temperature is essential to keep the organoleptical quality and to inhibit spoilage. The mini-carrots can be frozen but in this case a previous blanching operation is necessary.

Alternative packaging using plastic trays and bowls should be considered in order to make the product more attractive. Other possibilities include the addition of sachets with sauces. Small individual packages, about 100 g of produce, can promote the consumption of Cenourete® and Catetinho® as healthier snacks.

9.1 Shelf-life

When produced according to the guidelines described previously, the shelf-life attained by Cenourete® and Catetinho® (storage at 5 °C) is 15-20 days. End of shelf-life is caused mainly by excessive whitening of the surface and microbial spoilage.

9.2 Industrial yield

Waste in the cutting stage includes crowns, tips, segments wider than 30 mm, segments with defects such as green parts, cracking, discolouration and misshape. For Cenourete® production segments shorter than 55 or 60 mm are also rejected. Typical waste volume at this stage is 30% of the raw material weight. When the small segments are used for Catetinho® production the amount of waste is greatly reduced.

Waste in the shaping and polishing stage refers to peeling and removal of carrot tissue by abrasion. Waste in this stage can reach 50% of the weight of raw material (root segments). Additional waste is represented by mini-carrots that do not attain shape and size specifications for marketing. Lazcano et al. (1998) reported 40% mass loss during the peeling process of baby-carrots, which includes shaping, polishing and grading before packaging. Higher yield compared with the yield obtained in Brazil for Cenourete® and Catetinho® is likely to be due to differences in cultivar. The carrots used in the USA are thinner and longer than Esplanada and consequently baby-carrot recovery is higher than that obtained for Brazilian mini-carrots.

10. UTILIZATION OF INDUSTRIAL WASTE

Root pieces that can not be processed as Cenourete® or Catetinho® can potentially be shredded, sliced or cut into different shapes following the same recommendations regarding sanitization and temperature control.

The solid residues retained in the filter can be dehydrated in order to produce carrot flour (MACHADO et al., 2006). Potential use of this residue for animal feeding remains to be evaluated.

11. RECOMENDATIONS FOR THE RETAIL MARKET

To maintain the organoleptical quality and the microbiological safety of the mini-carrots for enough time for marketing and consumption it is essential to keep the product at low temperature (1-5 °C) along the whole productive chain. Special care should be taken during transport, unloading, and retail display to avoid temperature abuse.

It must be kept in mind that Cenourete® and Catetinho® are products of low consumption and must be displayed with detachment. To enhance sales the mini-carrots can be displayed next to a popular item to gain visibility. When this kind of product is not well known by the clients it is advisable to top it off with a sign describing its characteristics.

Periodical inspection is necessary to remove from display packages with deteriorated product and those which sell date are expired.

12. CONCLUSIONS

The technology to process carrot roots into minicarrots is a relatively simple and low cost technology made available for small and medium scale agroindustries. Two products can be produced, using the same raw-material and equipments namely Cenourete® and Catetinho®, the first one with the shape of a small carrot and the second one with the shape of a sphere. These products are healthy and nutritious options for salads, cooked dishes, snacks and dish ornamentation. All the equipments can be produced in Brazil. A carrot cultivar specially developed for processing and adapted to tropical growing conditions is also available, although thin roots of other cultivars can also be processed.

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