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Significance of Agronomic and Quality Attributes in Processing Tomato Varieties

Chafik Hdider*

Laboratory of Biotechnology and Plant Physiology, National Agricultural Research Institute of Tunisia. Hedi Karray street, 2049 Ariana, Tunis, Tunisia

Correspondence: * **hdider.chafik@iresa.agrinet.tn**

ABSTRACT

The tomato is one of the most extensively genetically studied food crops. For many years, breeding efforts have permitted the development of improved varieties for growers, processors and consumers. These improvements concerned adaptation to diverse climatic conditions and methods of production, resistance to disease, presentation, conservation and food uses. In addition, extensive efforts are currently under way to improve other valuable quality attributes of tomato and particularly antioxidants. The choice of appropriate varieties is one of the most important factors for the success of cultivation of tomatoes in general, and particularly processing tomatoes. For processing, suitability of the tomato variety to the final product is also of major importance for the industry. In the present review, we review the current knowledge and recent findings on tomato varieties in order to gain better insight and understanding on important agronomic and fruit quality criteria that affect the choice of tomato variety, particularly for processing.

Keywords: genotypic effect, *Lycopersicon esculentum* Mill, physicochemical characteristics, tomato products, variety evaluation

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INTRODUCTION

Tomato is the second largest vegetable crop in the world, with a global annual production of 133 million tons (FAO 2007). More than 30 million tons of this world tomato production is being processed each year. Tomato is then the world's leading vegetable for processing. In Africa, approximately 16 million tons are produced, with Egypt, Morocco, Nigeria and Tunisia as top producers (FAO 2007). In Tunisia, tomato is the main 'vegetable' grown and consumed and is therefore of strategic importance. In 2007, the tomato crop amounted to 780,000 t, including 558,000 t for processing. Moreover, Tunisia is the main tomato-processing country in Africa and among the world's leaders in terms of per capita annual consumption, with up to 54 kg on a fresh weight basis (Hdider *et al*. 2007).

The tomato is one of the most extensively genetically studied food crops. For many years, breeding efforts have permitted the development of improved varieties for growers, processors and/or consumers. These improvements concerned adaptation to diverse climatic conditions and methods of production, resistance to disease, presentation, conservation and food uses. In addition, other extensive efforts are currently under way to improve quality characteristics of the fruits. This is reflected by the large volume of research on virtually all aspects of the crop. Between 2000 and 2007, over a thousand scientific papers per year relating to tomato research have been published, not including those in the less widely read literature, conference and workshop proceedings (Atanassova *et al*. 2003; Ho 2003; Passam *et al*. 2007).

The choice of appropriate varieties is one of the most important factors for the success of cultivation of tomatoes in general, and particularly processing tomatoes. In fact, genetic factors linked to tomato cultivars can have a considerable influence on various important parameters such as yield potential, resistance to disease and fruit quality (Gould 1983; Tigchelaar 1986; Laterrot 1994; Dumas *et al*. 2003). The choice of suitable varieties depends on many factors such as the region or area of culture, the method of production and the harvesting method. In addition, processing tomatoes must have the quality attributes required by the relevant food processing industry.

Considering the continuous interest in tomato varieties,

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Invited Mini-Review

it is important to review the current knowledge of tomato varieties in order to gain better insight and understanding on important agronomic and fruit quality criteria that affect the choice of tomato variety. The present review will therefore focus on the pertinent information on tomato varieties in general, and particularly varieties for processing. Both cultivar (cultivated variety) and variety terms are used interchangeably mostly to avoid repetition.

CLASSIFICATION

Tomato varieties are numerous and various and can be classified into different categories according to their genetic type, growth habit, earliness, market need or end use and harvesting method. These are considered as the most important categories used by breeders and growers for the description of tomato varieties.

Genetic types

Tomato varieties are divided into different genetic types according to the breeding procedure or the method of introducing the new desired characteristics. In general, tomato cultivars are open pollinated, hybrid F_1 or transgenic.

Open pollinated varieties are a result of either natural or human selection for specific traits, which are then reselected in every crop. Their traits are relatively fixed, within a range of variability. Open pollinated varieties reproduce true from seed, retaining the same characteristics from one generation to the next. Heirlooms are generally old open pollinated varieties (at least 40-50 years old), that have been preserved and kept true in a particular region for some real virtue, particularly flavour. Rodríguez *et al*. (2005) reported that many heirlooms studied represent great interest for tomato breeding for the improvement of fruit quality. Although these varieties lack holding ability, disease resistance or early maturity, etc. that would make them commercially viable, some producing companies have started to make them available to home garden seed sellers once again. Until now, open pollinated processing tomato cultivars still has a market value in certain countries like Tunisia and Turkey (Hdider 1999; Duman *et al*. 2005).

Hybrid F_1 varieties are the first filial generation made by crossing two different varieties. The result is a new uniform seed variety with specific characteristics from both parents. The unique characteristics of a hybrid are very uniform only in the first generation of seed, so seed saved from F_1 plants will not come true if replanted and may exhibit many distinct types in the second generation. To produce consistent F_1 hybrids, the original cross must be repeated each season. The hybrid technique has afforded breeders greater efficiency in creating new gene combinations, and private breeding programs the proprietary nature of hybrid cultivars (Boleda 1992). Hybrids are now on the market, which have several interesting characters. Hybrid F_1 cultivars, which were initially developed for greenhouses or adapted to stacked culture, have almost completely replaced open pollinated cultivars. At present, hybrids F_1 are widely used in processing tomato crops of many countries. However, in some of them their use is still hotly debated and reserved for high yielding growers, largely because of their considerably higher cost in comparison with open pollinated varieties (Hdider 1999). In general, major factors contributing to the increased acceptance of hybrid cultivars by growers, processors and the industry are disease resistance, reliable field production, vigorous growth, uniformity, earliness and good processing characteristics (Boleda 1992; Hdider 1997, 2000).

Although there is no universally accepted definition of a genetically modified organism (GMO), The European Directives 2001/18/EC (EC 2001) provide a general definition of a Genetically Modified Organism (GMO). A (GMO) means an organism, with the exception of human beings, in which the genetic material has been altered in a way that does not occur naturally by mating and/or natural recombination. Organism means any biological entity capable of replication or of transferring genetic material. In addition, these Directives include annexes that give information concerning the techniques that result in genetic modification, that are not considered to result in genetic modification, or that result in genetic modification but yield organisms that are excluded from the scope of the Directives. Transgenic techniques are powerful in speeding introgression of desired traits in tomato and several genetically engineered varieties of tomatoes have been developed in many countries, and some of them were approved for commercialization and were available in a limited number of markets for a few years. The cultivar Flavr Savr™ was the first transgenic tomato in the world and the first genetically-engineering food to be sold commercially in USA (Kramer and Redenbaugh 1994). By regulation of polygalacturonase (PG) using antisence technology, the cultivar Flavr Savr™ developed possessed improved textural qualities. Virus-resistant tomato was the second transgenic crop to be commercialized (James 1997). Although molecular marker techniques are frequently applied in plant breeding, the application of genetic engineering has been resisted in Europe. GMO are tightly controlled by national and international legislation and their use must be in accordance with the directives, which are set up and controlled by specialized organisms. In Tunisia, use of GMO is in the course of legislation.

Growth habit

Growth habit is a very important criterion of classification of tomato varieties. It affects mode of culture, staking methods, pruning, length and harvest method, and other aspects of management. It is possible to grow determinate, indeterminate and semi-determinate varieties.

Determinate varieties (bush or dwarf tomatoes) grow to a certain height and then stop growth when terminal bud of the shoots is transformed into clusters. These varieties are compact and produce for a relatively short period of time. These characteristics permit the use of high plant populations without staking and a once machine harvest or a maximum of two to three handpicks (Tigchelaar 1986). The majority of varieties used in field commercial production and especially in processing tomato are determinate in growth habit.

Indeterminate varieties (vine or cordon tomatoes) keep growing and producing new blossoms even after fruit set and their inter-nodes are spaced. These varieties are generally grown in greenhouses and sometimes in field production. Staking and pruning are necessary and the production of fruit is over a long period of time.

Semi-determinate varieties grow larger than determinate varieties and have more clusters, but smaller than true indeterminate. These tomato varieties are used in greenhouses and in the open field for early production (Marković *et al*. 2000). They require staking and only a minimum of leaf removal.

Earliness

Tomato varieties require different time to mature. Generally, the current tomato varieties being grown are early, main-season and late varieties. The earliest varieties will, under optimal conditions, produce mature fruit in the minimum number of days after seeding or transplanting. In processing tomato, early varieties produce mature fruit less than 90 days after transplanting (Tigchelaar 1986). In a trial with different early period varieties grown in different locations, the earliest cultivars have 86 and 91 days between transplanting and ripening (Dadomo *et al*. 2001). Main-season and late varieties take more than five months after sowing to produce fruit.

Earliness is of particular importance in spacing tomato production. It advances, extends, and makes more manageable the tomato harvest and more even delivery of tomato to the industry (Gould 1983). For processing tomato, a careful

planning of the crop is generally necessary to ensure the best production and quality during the whole processing period. In this context, the use of the most suitable varieties to be adopted for the different planting is a fundamental element (Dadomo *et al*. 2000). Distinct tomato variety trials are generally made according to earliness to reflect the farmer's actual trend in the use of varieties cultivation planning (Bezert 2001; Dadomo 2001).

Market need or end use

Nowadays, tomato varieties are very specialized. They have been developed for a variety of food uses ranging from a simple fresh use to a more complicated ounce requiring different methods of processing. The importance of individual quality attributes of tomato fruit varies depending on their intended use. A particular tomato variety that may be excellent to eat fresh is not necessarily good for processing. Processing requires frequent handling, high temperature and pressure. In order to better match tomato attributes with the large demand and variety of tomato based products, a quite large number of studies aiming to evaluate and improve the quality of tomato cultivars has been realized (Schuch and Bird 1994).

For each type of production, distinct varieties and systems of crop management are generally used. Processing tomato varieties differ from fresh market varieties, and as we have seen later, varieties developed to greenhouse with many harvests are very different of processing varieties. In some cases, tomato cultivars able to be used for both fresh consumption and processing are used (Plum tomatoes or Roma tomatoes). In Tunisia, growers tend to grow such varieties because consumers like processing type and they can sell part of their production on the local markets if prices are good (Hdider 2000). In processing, round and square fruits are generally preferred in concentrate and diced products, and long-cylindrical fruits in peeled tomato (Leoni 1993). Beef tomatoes are very large and are excellent for sandwiches and sauces. However, cherry tomatoes are very small, high in sugar and low in acid and are eaten whole.

Harvesting methods

Tomato growers use mechanical harvesting or hand picking. Although mechanical harvest is the dominant harvest method in the majority of countries, hand picking is still exclusively used in some countries like Tunisia. Tomato varieties differ in their adaptation to the harvesting methods. For mechanical harvest, varieties must have compact growth, concentrated fruit set, firm fruit resistant to overmaturity and that ripen at the same time, and come off the plant without the attached calyx (Tigchelaar 1986; Gould 1983). For hand pick, varieties must have at least medium sized fruits that come off easily at the joint (jointless). Small sized fruits take more time to pick and hence increase labour cost. In general, varieties are separated according to the harvesting method in field trials (Macua 2001).

AGRICULTURAL AND FRUIT QUALITY CHARACTERISTICS

Tomato variety has to satisfy the various demands both of production and of processing. Suitable tomato variety must combine good horticultural characteristics with good fruit quality attributes. Many of those characteristics are under genetic control, but are also more or less influenced by the environmental conditions. The agronomic aspects, fruit quality, processing yield as well as the final product quality change with genotype.

Agricultural characteristics

From an agricultural view, the yield potential and stable productivity and the resistance to disease, pest and disorders are the most important characteristics of a tomato variety. Other important variety characteristics as fruit covering and vegetative development or vigour could be considered.

1. Adaptation to local conditions and yield potential

Varieties have different range of adaptability related to their ability to grow, flower, and fruit under environmental stresses of low and /or high temperature, drought conditions, and disease (Gould 1983). Great interaction of cultivars with the environment was registered in different countries of the Mediterranean area (Dadomo 1994). The performance of varieties differed also significantly among locations of the same country. In a work carried out on 21 new varieties for processing, only some of them showed a good steadiness, in relation to the yield (Giordano 1994).

Varieties have different yield potential and growers use a management system to achieve yields closer to the potential. The highest yielding varieties are generally in great demand. Significant differences between varieties in yield were recorded (Dadomo *et al*. 2001; Hdider *et al*. 2001; Macua *et al*. 2003). Hybrid varieties do not always show large yield advantage when compared with open pollinated varieties. Hdider (1999) evaluated twenty varieties (16 hybrids and 4 open pollinated) and found that hybrids do not gave always higher yield than open pollinated. However, Vassiliou and Christou (1999) evaluated ten hybrids and open pollinated varieties based on the yields and other agronomical and industrial characteristics and found that hybrids gave higher yields and soluble solids (°Brix) compared with open pollinated varieties. The variations in production potential between varieties can be explained by genetic variability and/or by the differences in adaptability to the various environmental growing conditions.

2. Resistance to disease, pest and disorders

Diseases, pests and disorders cause considerable losses in greenhouse, open field or processing tomato production. In processing tomato crops, the fungi, bacteria, virus and animal parasites cause serious epidemics, which reduce yields and have adverse effects on the quality of the fruit (Laterrot 1994).

Genetic resistance or tolerance can be used to combat an ever-increasing number of pathogens in tomato crops (Laterrot 1994). In fact, many diseases have been controlled by use of resistant varieties. These varieties are an important component of integrated pest management for tomato production that helps minimize chemical controls. On the other hand, losses of fungicides due to recent and proposed legislation, as well as current pathogen resistance to some fungicides increase the need for resistant varieties.

Open pollinated or hybrid F_1 processing tomato cultivars carrying resistance or tolerance up to 7 pathogen agents are already on the market and used for trials (Macua 2001). Although varieties with multiple resistances are generally F_1 hybrids, open pollinated cultivars carrying a set of 5 resistances are also available.

At present, growers can use varieties resistant or tolerant to *Verticillium dahliae*, *Fusarium oxysporum f. sp. Lycopersici* (race 1, race 2 and race 3), *Stemphylium* spp., *Phytophtora infestens*, *Pseudomonas tomato*, *Meloidogyne* spp., *Alternaria alternata*, *Clavibacter michiganensis*, *Tomato spotted wilt virus* (TSWV) and *Tomato Yellow leaf curl virus* (TYLCV). Varieties with tolerance but not immunity to certain important diseases and used in combination with the other management practices, produced significantly greater yields compared to the common commercial cultivars when grown in the presence of these diseases. Breeding programs currently underway allow us to hope that other varieties with increased resistance to disease, pest and disorders will be available in the next few years.

Concerning disorders, differences in cultivars resistance or susceptibility to blossom end rot (Avdeyev 1994) and fruit cracking (Pascual *et al*. 1999) were observed. In ad-

dition, varieties with good fruit coverage are less susceptible to sunburn (Hdider 1999).

Fruit quality characteristics

Fruit quality characteristics of tomato varieties are actually the biggest challenge facing the management of tomatoes for fresh market and processing. According to Dadomo (1994), quality must be considered in its wider meaning which involves fruit integrity, firmness, right stage of maturity, chemical and physical characteristics, nutrient content, taste, absence of pesticide residue and so on. Physicochemical characteristics, flavour, and healthy compounds content are the major quality attributes of tomato fruit. These attributes are highly variable and strongly influenced by varietal differences in addition to agronomic, geographic, and environmental factors (Dumas *et al*. 2003). Although quality received a little attention in the precedent breeding efforts, it is now a main goal of several researches especially in developing varieties with high nutritional and healthy characteristics (Dorais *et al.* 2008).

1. Physicochemical characteristics

Large variations in the main physicochemical fruit quality attributes among different tomato cultivars were reported. Significant variations in soluble solids content (°Brix) between cultivars were found in different studies. Value between 5.3 and 6.9% (Helyes *et al*. 2003), between 4.38 and 5.42% (Yoltas *et al*. 2003) and between 4.8 and 6.0% (Hdider *et al*. 2002) were reported. Significant variations in pH and acid content between cultivars were also noted in these studies.

Great variation between cultivars in term of consistency was also mentioned. Leoni *et al*. (1994) comparatively evaluated nineteen cultivars for consistency and found a significant variation between them. Bostwick value varied between 10.7 and 15.4 cm in early cultivars and 9.13 and 13.88 cm in medium and late cultivars. Similarly, Macua *et al*. (2003) tested thirty cultivars at two harvesting dates depending on earliness. Value reported ranged from 4 to 13.5 cm Bostwick and from 3.5 to 13 cm in the first and second harvesting date, respectively.

Other quality attributes related to fruit appearance, which include particularly shape, size and colour varied considerably among varieties. Tomato varieties have various fruit shapes and sizes. This variation is affected by genetic (Grandillo *et al*. 1999). Fruit size is a quantitative trait and is also affected by environmental factors. Tomato cultivars produce fruit in a wide variety of shapes. There are long, round, square and egg shaped (plum) tomatoes. There are many other shapes, most of which are not of a great commercial importance, e.g. pear shaped, heart-shaped and very ribbed tomatoes. Tomatoes come in various sizes, from the small cherry tomatoes to the largest fruit sizes that we refer to as beef tomatoes. In processing, tomato fruits with medium size (50 to 100 g) are generally preferred (Leoni 1993). Varieties with large fruits are very liable to cracking and transport damage (Hdider 1999).

Colour is one of the most important individual quality attributes of tomato fruit for the fresh market and processing industry. Although the red fruit is considered to have the normal colour for tomatoes in many parts of the world, tomato varieties with orange, yellow, pink and striped (yellow and red) fruits are also available. Varieties used in processing tomatoes are generally with red fruit. Orange, yellow and striped fruits are used to add colour or variation to the tomato salad. Many studies have demonstrated differences between varieties in fruit colour. In a variety trial, Bezert (2002) evaluated 35 processing tomato cultivars and found a/b Gardner value between 1.12 and 1.67 in early cultivars and between 1.24 and 1.67 in late cultivars. Similarly, Dadomo *et al*. (2000) in a second level trial with 28 varieties found a significant difference between them in colour. Gardner value (a/b) obtained varied between 2.13 and 2.42 in early planting and between 2.20 and 2.37 in late planting.

2. Flavour and healthy compounds

Flavour and healthy compounds are becoming very important to the purchasers of fresh or tomato processed products. Flavour comprises sugars, acids and aroma volatile (Baldwin *et al*. 1998). Healthy compounds comprise vitamin A, vitamin C and antioxidants, particularly lycopene which has received a great attention in recent years (Leoni 2003) due to its abundance in tomato and its powerful antioxidant activity.

Studies on the effect of genetic material on tomato flavour and healthy compounds content have revealed clearly great differences among cultivars. In a study of five processing varieties, Helyes *et al*. (2003) observed significant differences between them in lycopene content, vitamin C and organic acid. Baldwin *et al*. (1991) evaluated six tomato cultivars for flavour parameters and found that one of them showed the highest volatile levels, while another showed the lowest. Different sugars content among different varieties were also reported (Leoni *et al*. 1994). Significant differences were found between different cultivars of tomato in antioxidant content (Lenucci *et al*. 2006; Kacjan Maršić *et al.* 2010). In the same context, Sandei *et al*. (2003) evaluated seven commercial tomato cultivars claiming high pigment content and found that high pigment content is verified only in three of them. In addition, cultivars, which contain the Crimson gene, that gives them a deeper red colour, were usually found to have higher lycopene content than those lacking the gene (Thompson *et al*. 2000).

Recently Lenucci *et al*. (2006), Cantore *et al.* (2008) and Ilahy *et al*. (2009) reported that high-pigment tomatoes are characterized by the highest lycopene content and attained more than 200 mg/kg fw. The differences in lycopene content between ordinary and high-lycopene tomato cultivars are mainly due to genotypic factors. In fact, it has been reported that high-lycopene tomato cultivars derive from spontaneous mutants characterized by deeply pigmented fruits due to their exaggerated light responsiveness with respect to wild-type plants (Atanassova *et al*. 2003). From the molecular viewpoint, the considerable lycopene accumulation in high-lycopene tomato cultivars can be due to the reduced cycling rate of this molecule to synthesize carotenes. It is also of interest to underline that, increased levels of lycopene synthesis and storage can also be due to an enhanced enzymatic activity of phytoene synthase I, through a massive accumulation of lycopene precursors in ripening tomato fruits.

Along with carotenoids, other antioxidant compounds present in tomatoes, such as ascorbic acid and phenolics, play also a determinant role in disease prevention (Robards *et al*. 1999; Karakaya *et al*. 2001).

VARIETIES AND PROCESSED PRODUCTS

Tomatoes are processed into a wide variety of products such as tomato puree or paste, peeled tomato, tomato juice, sliced or diced tomato, and dried tomato. This processing tomato industry depends on the availability of tomato varieties that provide maximum yield and quality of the final products. As discussed earlier, tomato cultivars differ in their fruit characteristics, chemical composition and cellular structure. This leads to difference in suitability to end products. A tomato variety that is suitable for paste may be quite unsatisfactory for peeling. Soluble solids content is a basic characteristic of the fruit of a tomato variety for processing into paste. However, for canning as peeled tomatoes, skin or peel should be easily and readily remove. The most important fruit characteristics determining whether a variety is suitable to respond to the processing demands of any given processed product are well discussed and fruit quality characteristics are found extremely linked to final products (Leoni 1993). Indeed, Cerne and Resnik (1994) studied 12 tomato cultivars and found only three of them suitable for

processing in concentrate and two for processing in juice. D'Amore *et al*. (1994) examined 21 cultivars for processing into peeled tomato and noted a difference in yield and canned peeled tomato between them. Similarly, studying 13 varieties, Macua *et al*. (2001) reported clear difference between varieties in their aptitude or suitability to produce peeled tomato.

The importance of the tomato variety in the quality of other final products was reported. Rodriguez *et al*. (2001) and Leoni *et al*. (1999) comparatively evaluated tomato cultivars for processing into diced tomato products and found that only some cultivars exhibited a generally positive behavior with regard to agronomic aspects, fruit quality, processing yield and quality of the diced product. Duzyaman (2003) also signalled adaptation of suitable varieties for dried tomato.

Differences in suitability to final products were thus reported among tomato cultivars and this highlights the importance of the tomato variety in the quality of the final product and suggests that an accurate choice of cultivars for processing needs to be made to improve yield and quality and minimize losses. In general, processing tomatoes are grown under contract to specific processors and contracts often specify which variety(s) are acceptable.

VARIETY EVALUATION

Every year, new varieties are developed that promise to better satisfy the requirements of field performance and processing quality. However, it is important to take into account that, besides genetic characteristics, the behaviour of each variety also depends on the type of climate, date of sowing, growing conditions, among others. One given variety, grown under different conditions, can produce completely opposite results. Therefore, adequate tomato variety trials are required before growing on large scale. These trials provide a good opportunity to realistically evaluate and make side-by-side comparisons of various new and commercial standards under actual grower field conditions.

Applied researches to evaluate processing tomato variety performance has been and still a regular and coordinated activity in almost all the major tomato producing countries of the Mediterranean region (Machado *et al*. 1994; Vassiliou and Christou 1999; Bezert 2001; Dadomo *et al*. 2001; Macua 2001; Hdider *et al*. 2002; Yoltas *et al*. 2003). This is also the case in other major processing tomato production area (Murray 1999). The objectives of tomato variety trials are to evaluate adaptability of recently developed varieties to local conditions, and to identify which best suit the requirements of growers, processors and consumers.

Variety evaluation system in different countries is heterogeneous and no standardized methods are available. The experimental protocols vary according to the country and are generally updated according to the changes of demands, keeping, at the same time, a scheme that could grant continuity and possibility of comparison. Dadomo *et al*. (1994) have mentioned the importance of a homogenous method for data collecting and the foundation of data bank. They also attempted to evaluate common varieties in four Mediterranean different countries using the same work procedures and found some of them interesting, despite the great interaction with the environment registered. Trials are then intended for local use rather than for comparisons between trials in different countries.

Trials are carried out on research stations, technical centres and production tomato fields in collaboration with seed companies, growers and processors. Design and protocols used in trials are generally under research supervision. Seed companies, growers, and governments provide financial support.

Varieties are subjected to a progressive evaluation phases for two or more years before making a judgment on their adaptability. Moreover, variety tests were generally conducted throughout major processing tomato production regions of each country to identify tomato cultivars appropriate for that specific region. New introduced varieties were generally screened for at least one year in non-replicated observational plots before being selected for testing in replicated trials.

Trials are generally separated in different categories according to earliness, harvest method or industrial destination. Reference varieties like for mechanical harvest, earliness, agronomic characteristics, fruit quality attributes or the most cultivated cultivars in the country or the region are generally included.

The evaluation is composed of different agronomic and technological criteria. The choice of pertinent agronomic criteria and their weight in the overall ranking depends on their technical and economic importance and vary in each country and even in each region of the same country. In Tunisia, where 90% of processing tomatoes are used for paste production, the main fruit quality criteria from a technical point of view is the soluble solids content (Hdider 1999). Evaluation may include other comments on area adaptability, machine or hand harvest adaptability, etc. Processing yields on a pilot scale processing plant and quality of the final product are in certain cases simultaneously evaluated (Leoni *et al*. 1999; Sandei *et al*. 2003).

The results obtained are widely disseminated through publications in periodical reviews, reports to the funding sources, farm advisor research reports, newsletters, magazines, guides, popular media, web sites and other methods. In addition, field days, organized visit to the trials and regional meetings are also used to inform and help making intelligent cultivar choice. The information obtained for fruit yield potential, fruit quality and plant horticulture characteristics can help processors, growers, and seed companies to make intelligent choice of the most suitable variety to be adopted for improving quality and yield. This evaluation process has proven to be an effective way to make intelligent processing tomato cultivar decisions, but proper, on-site large scale trial and evaluation of varieties, with grower high priority traits, under his specific management system, soil and microclimate is also generally recommended.

CONCLUSION

The present review has clearly demonstrated that tomato varieties are numerous and various and could be classified into different distinct categories for their description. It has also presented current evidence on some of the agricultural and fruit quality characteristics considerably affected by genetic factors, which highlights the importance of variety choice in tomato production. Differences in suitability to final products were also presented among tomato cultivars and this show the importance of the tomato variety in the quality of the final product and suggest that an accurate choice of cultivars for processing needs to be made to improve yield and quality and minimize losses. It is therefore important to remain at forefront of developments in these species.

Generally it is difficult to find a variety, which cumulate in the same time all the complex characteristics required by growers, processors and consumers. Variety choice must be reasoned function of the objectives to meet and constrains of the exploitation and the processor. The final choice of a variety is always a compromise between a whole set of characteristics.

Local evaluation of recently introduced variety is necessary. Although the experimental protocols must be updated in the course of the years, a same schema that could grant continuity and possibility of comparison must be respected. With improvement and simplification of analytical techniques, a more complete picture of cultivar suitability for different end uses can be achieved.

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