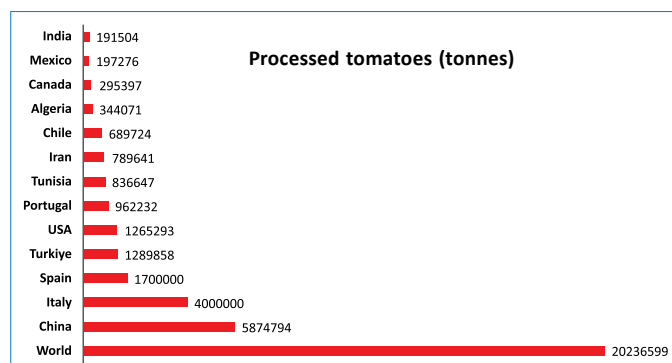


Prospects of tomato breeding for processing in India

Tomato is mostly used as fresh vegetable and very little (<1%) in processed form. Hence, breeding tomato varieties suitable for processing is very essential. The early breeding efforts developed varieties, but now they do not meet the industrial standards. Recently, two hybrids have been developed by ICAR-IIHR, Bengaluru, and some new improved lines, bred by WVC, Taiwan, have been imported to India by ICAR-IIVR for research purpose. There is a need to deploy multi-dimensional approach to address research, operational and industry related issues to benefits farmers and industry.

TOMATO (*Solanum lycopersicum* L.) is an important vegetable crop for fresh market and processed products (juice, sauce, ketchup, paste, puree, canned fruits). Tomato is a rich source of vitamins A and C, minerals and antioxidants mainly lycopene and beta-carotene, and other compounds like flavonoids, hydroxycinnamic acid derivatives. Lycopene is a very powerful antioxidant which prevents cancer. Raw tomato contains only about 20% of lycopene than in cooked tomato. Thus, tomato is considered as functional and protective food for human. In 2022, world tomato production reached to nearly 186.82 million tonnes from total area of 5 million ha with an average productivity of 36.97 t/ha (FAOSTAT 2022). India (20.57 mt, 11.01%) is the second largest producer of tomato after China (64.86 mt, 34.72%). In India, tomato is maximum produced in Andhra Pradesh (19.75 mt) with highest productivity (44.50 t/ha) followed by Madhya Pradesh (24.19 mt). Here, most of tomatoes are consumed as fresh for vegetable purpose, and hardly < 1% is only processed for making processed products compared to the developed countries like Italy (64.02%), Spain (39.41%) and USA (10.34%). Hence, there is a need of suitable varieties for processing purpose.

Importantly, tomato genotypes suitable for processing require key parameters such as high TSS (>5 °Brix), minimum sugar:acid ratio (15:1), lycopene (>10 mg/FW),



Major tomato processing countries

viscosity (7-14 Botswick cm/30 sec), low pH (<4.40) and a high colour value (>2) that enhance quality of processed products coupled with less energy consumption at low cost. In addition, other parameters are determinate growth habit, good foliar coverage, concentrated fruit maturity, vine storability, and jointless pedicel for mechanical harvesting. On the other hand, fresh market tomato can be determinate/semi-determinate/indeterminate, moderate TSS (3-4.5°Brix), acidity (0.4-0.5%) and colour (<2). A large number of cultivated and wild species are available worldwide in genebanks. The initial breeding efforts in 1980s have generated processing varieties such as Pusa Ruby, Pusa Gaurav, Roma, Punjab Chhuhara, Arka Ashish, and Arka Ahuti but these varieties do not meet



Pusa Ruby



Roma



Punjab Chhuhara



Arka Ashish



Arka Ahuti

Old tomato varieties bred for processing in India



AVTO2151



AVTO2149



Arka Apeksha



AVTO1914



AVTO1915



Arka Vishesh

Tomato improved lines (AVTO2151, AVTO2149, AVTO1914, AVTO1915) developed for processing purpose by the World Vegetable Centre, Taiwan (Source: <https://avrdc.org>); and dual purpose hybrid varieties (Arka Apeksha and Arka Vishesh) bred by ICAR-IIHR, Bengaluru (Source: Dr. AT Sadashiva, Ex-PS, ICAR-IIHR, Bengaluru)

Table 1. Major tomato producing states in India

State	Area ('000 ha)	Production ('000 tonne)	Productivity (t/ha)
Andhra Pradesh	61.67	2744.32	44.50
Madhya Pradesh	84.53	2419.28	28.62
Karnataka	64.25	2081.59	32.39
Gujarat	46.61	1357.52	29.12
Odisha	91.01	1312.07	14.41
West Bengal	57.46	1265.25	22.01
Chhattisgarh	63.29	1087.33	17.18
Maharashtra	45.50	1086.56	23.88
Telangana	41.48	1171.50	28.24
Uttar Pradesh	21.24	841.61	39.62
Tamil Nadu	29.08	887.08	30.50
Total	841.00	20336.00	24.18

(Source: NHB 2021-22)

Table 2. New tomato hybrids developed for dual purpose in India

Parameter	Arka Apeksha (H-385)	Arka Vishesh (H-391)	Parameters desired by processing industry
TSS (degree brix)	4-4.7	4-4.6	5.2 or higher
Colour value	1.96-2.09	1.98-2.12	> 1.95
Acidity (%)	0.34-0.38	0.32-0.36	<0.40
pH	4.12-4.40	4.21-4.41	< 4.40
Texture/ Firmness	4.05-4.30	4.09-5.41	> 4
Lycopene (mg/100 g FW)	11.12-11.42	8.5-10.5	>8.0
Lycopene in tomato paste, 27-28° brix (mg/100 g fresh weight)	14.15	14.14	>14
Viscosity (Botswick, cms/30 sec)	12-12.50	14-14.20	7-14

(Source: Dr. AT Sadashiva, Ex-PS, ICAR-IIHR, Bengaluru).

the current processing parameters of the industries. In this direction, at our institute, recently we have imported nearly over 60 lines of tomato from the World Vegetable Centre, Tiawan, and the Tomato Genetics Resource Centre, UC Davis, USA for breeding purpose. Further, we have characterized in-house breeding materials suitable for processing traits and selected a few lines for future trials.

Challenges and way forward

Worldwide tomato is mainly consumed as fresh vegetable (89%) and only ~11% is processed. However, in India, utilization of tomato in processing sector is very low (< 1%), and per capita consumption of processed tomato is only 200 g. Hence, there is a huge scope to utilize tomato in the form of processed products such as tomato crush, pulp, paste, puree, ketchup, canned products, etc. Hence, there is a need of varieties suitable for processing. A few major Indian companies involved in tomato processing are M/s Hindustan Unilever Ltd. (Kissan), M/s Field Fresh Foods Pvt. Ltd. (Del Monte), M/s Nestle India (Maggi), M/s Dabur India (Hommade), M/s GD Foods Mfg. (India) Pvt. Ltd. (Tops), etc. In our country, processing capacity is very less (30-600 tonnes per day) and it is seasonal also, compared to the developed country like USA (59000 tonnes per day, California). There are several issues associated with development of processing varieties and successful establishment of processing industries in the country, a few of them are listed below, which requires multi-dimensional approach to augment processing industry in India.

- Strengthen genetic resources from national and international genebanks.

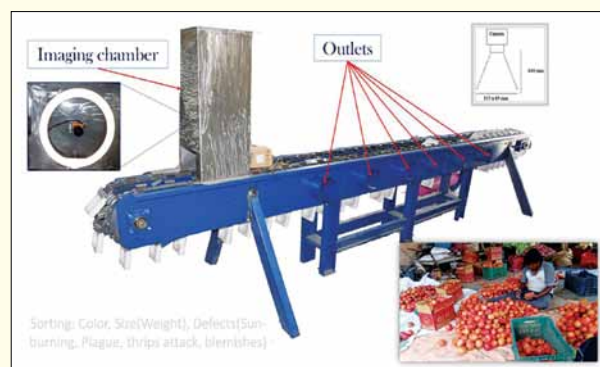
- Public-private partnership research for processing tomato varieties (open-pollinated and hybrids).
- Large scale field evaluations of available varieties/hybrids.
- Breeding for high yielding varieties suitable for processing round the year.
- Development of tomato processing varieties database in India.
- Development of region-specific package of practices for processing tomatoes.
- Presently, fresh market tomatoes are being processed which faces seasonal glut issues.
- International research collaborations for processing such as mechanical harvesting.
- Certification of processed varieties by authorised agencies/institutions.
- Establishment of processing industries and collection centers in tomato growing areas.
- Determining minimum support price for processing tomatoes.
- Ensure income to farmers and bridge the gap between farmers and industry.
- Public distribution of processed products at subsidized prices to increase demand.
- Establish export policy and encourage regular export of processed products.

For further interaction, please write to:

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Automatic sorting/grading system for tomato/pomegranate

Automatic vision-based sorting/grading system has been developed. It comprises a conveyor, diversion system, vision and sorting system. Cup type chain conveyor used to carry fruits (tomato and pomegranate) in singulation beneath the imaging chamber. The dimensions of conveyor, cup and pitch of chain have been kept in such a way that single fruit will be carried forward and should not drop down in between. The cup type chain conveyor has length and width of 6 m and 25 cm, respectively with cup diameter of 10–12 cm and depth of 5 cm with six grading compartments. Cups are hinged on the conveyor at one end and free at the other end for the ease of dropping the fruits/object. *Sherlock 7.3* software of *Teledyne Dalsa* has been used to develop a programme to detect the size of fruit along with quality, i.e. presence or absence of fruit and quantify the level of defect on the surface of the fruits. After sorting, developed system grades the commodities based on their sizes. At present, machine has the capacity to sort 45–50 fruits/objects per min.



Source: ICAR Annual Report 2022-23