A review on post-harvest technology of an underutilized vegetable bitter tomato (Solanum aethiopicum L cv. gilo) of Northeastern region of India

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Abstract. Northeastern region of India is endowed with variety of local vegetables that are highly nutritious and health-promoting. One of which is Solanum aethiopicum L which has a bountiful source of nutrients and bioactive chemicals. It has several pharmacological benefits and are used in indigenous medicine to treat various conditions. Nonetheless, the crop is highly perishable with a short shelf life (3-5 days) which significantly contributes to postharvest losses. Techniques used to extend the shelf life of the crop are freezing, drying and refrigeration. The crop can be stored at low temperatures about 10-12°C. Fruits kept in perforated polyethylene bags had the longest shelf life. Important materials include polyethylene, polypropylene, and polystyrene are commonly used and coating can be applied to increase the crop's shelf life. The crop has a huge potential in making value added products like pickles, dehydrated products and many more. However, concerns related to postharvest and production of the crop have not received equal attention due to scant research with the crop being neglected and underutilized due to lack of awareness and limited market. Considering the crop offers many advantages, popularization of the crop is essential but adapting to the bitter taste and flavor of the fruit could be challenging for the consumers. Consumer attitudes, views, and willingness to pay for products that have undergone particular post-harvest procedures require further investigation. Proper cultivation techniques, processing, value addition and marketing are required to surpass these hurdles.

Keywords: Bitter tomato; Medicinal properties; Post-harvest; Solanum aethiopicum L; Underutilized crop

1. Introduction

S. aethiopicum is an indigenous underutilized vegetable which is cultivated and has become an essential part of the food of those living in North East (NE) India [1]. It is commonly known as African eggplant, scarlet eggplant, garden eggs and bitter tomato with a chromosome number of 24 which is native to Africa is a significant crop within the Solanaceae family which contains over 1000 species worldwide [2-5]. Although Solanum gilo was once assumed to be a separate species, it is now largely accepted to be a cultivar group of S. aethiopicum [6]. It is believed that Solanum macrocarpon (Gboma eggplant) and Solanum melongena L. are two more related relatives [7, 8]. It can be grown in both tropical and subtropical regions and is a very prolific crop with a wide range of adaptability [9, 4].

The eight states make up the northeastern region of India, which is located between 21.5°N and 29.5°N latitudes and 85.5°E and 97.3°E longitudes. This region accounts for 8% of the country’s total land area and is made up of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura. Tribal people grow the bitter tomato in their homesteads and jhum fields under rainfed conditions [10]. It is called samțawk in Mizo, khamen akhaba in Manipuri and in Darjeeling, Sikkim, they're known as Titay bii, or just bii [11]. The fruits’ taste varies based on the saponin content, ranging from bitter to sweet [12, 13, 4]. It can be consumed either raw or cooked [14]. The garden eggs have a short shelf [15]; and due to rot caused by moulds, shrivelling, enzymic browning, and other physiological disorders including ripening and senescence greatly hinders the ability of fresh bitter tomato fruits to last longer. In addition, this crop is a neglected and underutilised horticultural species even though it has the potential to greatly improve nutrition and food security and more genetic diversity is produced by growing underutilised crops [5]. As of February 28, 2011, there were 9118 lines of solanaceous vegetables in the National Gene Bank of the National Bureau of Plant Genetic Resources (NBPGR), New Delhi. These include wild species of tomato, eggplant, chilli, and sweet pepper [16]. And gathered an estimate 1800 landraces cultivars, and wild species of eggplant in India [17].

The development of India's food processing industry might be greatly aided by the fruits and vegetable sector and some possible areas in the future that need to be given top priority: The development of low-cost...
indigenous vegetable processing equipment, the post-harvest handling of indigenous vegetables, ready-to-eat sector and the cut fruit and vegetable sector. The Indian government's Ministry of Food Processing also plans to raise value addition from 7% to 35%, increase the percentage of horticulture crops processed from 2% to 20%, and increase the country's part of international trade from 1% to 3% [18].

1.1 Origin and Botany

It is believed that the semi-domesticated *Solanium distichum* Schumach and Thonn is claimed to have contributed to the domestication of *Solanan aethiopicum* from the wild *Solanan anguivi* Lam [19]. Cultivars of *Solanan aethiopicum* can be categorized into flour groups: Shum, Kumba, Aculeatum, and Gilo Group [20, 21, 22]. The Kumba and Gilo cultivars are grown for their fruit, whilst Shum is grown for its leaves [23]. The most widely grown group is the Gilo cultivar [24]. It is a deciduous shrub with branches that can reach a height of approximately 2.5 meters. Ovate to oblongovate lamina on upper leaves, which are frequently paired unevenly. The maximum length and width of a leaf blade are 30 cm and 21 cm, respectively. The species possesses both male and female organs, making it hermaphrodite [5]; and in cultivation, the flowers are white, 5-merous, and 6-9-merous [25]; shaped like a star [26]; which develops into an oval or spherical in shape, with a fruit diameter ranging from 2.5 to 12cm, the top and bottom are flattened and have grooved portions with a length of 5-6cm longitude and width of 6-7cm [10, 27]. When the fruits are in the commercial stage (physiologically immature), they might be white, green, or even purple in colour. Additionally, the fruit turns red or reddish-orange when it achieves full maturity, a colour change linked to a high carotene content [28, 29, 22]. The fruit is categorized as a berry since it has a firm firmness, a vibrant green calyx, and numerous tiny delicate seeds [30, 31, 14]; the kidney-shaped seeds have a diameter of 2.35 mm [26]. The stalk may have a curved or erect shape [27]. Researches indicated that there are significant differences both within and across the species, including variances in traits such as fruit shape, colour, branching pattern, corolla diameter, petiole length, and leaf blade width.

1.2 Nutritional Properties

Bitter tomato is a neglected horticultural crop that is nutritious and is among the healthiest foods available [32]. It is mostly made up of water with a small amount of fat, dietary fiber and protein. It has high concentrations of folate, niacin, thiamine (vitamin B1), vitamin B3 and vitamin K, as well as minerals including potassium, manganese, copper, magnesium, and phosphorus [33]; and high zinc levels [34, 31]. Alkaloids, flavonoids phytosterols, saponins, vitamin C; moderate presence of cardiac glycosides, steroids, tannins, and trace amount of terpenoids were also found in the fruits [35, 36]. The total phenol content and antioxidant activity of African eggplants were found to be high [37, 38]. Owing to the nutritional value of garden eggs, it has been shown to offer numerous health advantages, such as decreasing cholesterol, and weight reduction as well as improving vision [29, 33]. Fructose and glucose are the most prevalent sugars in scarlet eggplants, although sucrose concentration is low and starch level is higher than the total soluble sugar content [24]. The bitterness in eggplants is caused by alkaloids, primarily glycoalkaloids. The percentage of a-solamargine varied between 48 and 89%. The glycoalkaloid levels of *S. aethiopicum* were found to be similar to those of S. melongena (about 14% of values classified as dangerous) and might be considered as safe for human consumption [39, 19]; although researchers advised being caution when utilising the fruit and stressing that minimal amounts should be consumed [5]. Table 1, which was taken from earlier research, shows the proximate composition of *S. aethiopicum* fruits [40, 36]. Since the crop has a high concentration of secondary metabolites, which have applications in both crop protection and medicine. It would be more profitable for nearby farmers to cultivate this kind of plant and then sell the products to a chemical firm so they may begin researching natural remedies and insecticides. The essential genetic resource needs to be improved and given a lot of study attention if we are to boost the consumption and cultivation of this vegetable. Realising its full potential in these diverse sectors will need ongoing research and innovation.

1.3 Pharmacological Properties

Since ancient times, bitter tomato has been prized for its allure in tribal mentality. Long before modern medicine with its synthetic medications and antioxidants was developed, people used natural antioxidants for thousands of years to prevent and heal human ailments [41]. According to Bello et al., (2005) [42] and Lahmingsanga et al., (2018) [10]. *S. aethiopicum* are used in indigenous medicine to treat a variety of conditions, such as asthma, allergic rhinitis, nasal catarrh, skin infections, rheumatic disease, swollen joint pains, gastro-oesophageal reflux disease, constipation, and dyspepsia. They also treat colic and high blood pressure with its fruits and roots, which are used as sedatives and carminatives. The alcohol extract of leaves is used as anti-emetic and treats tetanus after abortion.
[37]. Garden eggs have phytonutrients including chlorogenic acid and the fruit’s skin contains nasunin [43, 44, 33]. Garden egg intake also helps diabetics control [45]. Amino acids are also present and they are the precursors for the synthesis of secondary metabolites and have a variety of biological functions [36]. Thus, these pharmacological characteristics have been linked to specific chemical components found in the plants [39, 41].

Table 1: Approximate composition of Solanum aethiopicum L. fruits.

<table>
<thead>
<tr>
<th>Phytochemical compounds</th>
<th>Content (mg/100g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkaloids</td>
<td>2.05 ± 0.11</td>
</tr>
<tr>
<td>Flavonoids</td>
<td>1.46 ± 0.01</td>
</tr>
<tr>
<td>Saponins</td>
<td>0.81 ± 0.23</td>
</tr>
<tr>
<td>Tannins</td>
<td>1.28 ± 0.05</td>
</tr>
<tr>
<td>Phenol</td>
<td>4.17 ± 0.03</td>
</tr>
<tr>
<td>Vitamins</td>
<td></td>
</tr>
<tr>
<td>Ascorbic acid (vitamin C)</td>
<td>4.17 ± 0.03</td>
</tr>
<tr>
<td>Retinol (vitamin A)</td>
<td>2.05 ± 0.11</td>
</tr>
<tr>
<td>Thiamin (vitamin B₃)</td>
<td>1.46 ± 0.01</td>
</tr>
<tr>
<td>Folate (vitamin B₉)</td>
<td>1.28 ± 0.05</td>
</tr>
<tr>
<td>Minerals</td>
<td></td>
</tr>
<tr>
<td>Magnesium (Mg)</td>
<td>1.98 ± 0.10</td>
</tr>
<tr>
<td>Potassium (K)</td>
<td>200.50 ± 0.79</td>
</tr>
<tr>
<td>Calcium (Ca)</td>
<td>9.03 ± 0.03</td>
</tr>
<tr>
<td>Phosphorus (P)</td>
<td>4.51 ± 0.07</td>
</tr>
<tr>
<td>Nutrients</td>
<td></td>
</tr>
<tr>
<td>Protein</td>
<td>2.10 ± 0.07</td>
</tr>
<tr>
<td>TSS ('Brix)</td>
<td>3.53 ± 0.07</td>
</tr>
<tr>
<td>Fat</td>
<td>2.91 ± 0.11</td>
</tr>
<tr>
<td>Fibre</td>
<td>3.35 ± 0.09</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>7.11 ± 0.03</td>
</tr>
</tbody>
</table>

Source of data of S. aethiopicum: Khatoon & Sharma, 2019; Edeke et al., 2021 [40, 36]

2. Cultivation & harvesting techniques of bitter tomato

The Bitter tomato is generally an annual crop but under optimum growing conditions the fruiting in most cultivars extends up to 2 years making it possible to harvest the crop several times [46]. It thrives on soils that are deep and well-drained. The crop grows best in daylight temperatures of 20-30°C, while it can withstand 10-40°C. It needs a pH of 5.5-6.8 and is not tolerant of extreme cold or wet conditions [37, 5]. The range of annual rainfall is 1200-1600 mm [47]. Seeds are used for propagation and the completely mature fruits are used to extract the seeds for planting. After the seeds are being sown in nursery beds with sandy soil, it takes 5-9 days to germinate and after 30 to 35 days, when the seedlings have 5-7 leaves and are 15-20 cm tall, they are moved to the field. Depending on the cultivar, gilo group can be placed 50-100 cm within a row and 75-100 cm between rows. A variety of growing methods are used to cultivate Bitter tomato, including Monocultures, mixed cultures, and intercropping. It can be intercropped with crops like sorghum, cowpea, Solanum lycopersicum, Capsicum annuum, and Abelmoschus esculentus [5]. The crop usually begins flowering, pollination, and fruit formation about 1.5 months after field transplantation, and fruits are usually ready to be picked about 1 month after fruit set [48]; and is harvested both at mature and unripe stage and usually before full seed maturation [46]. The main method of harvesting is by hand, either by pulling or twisting the fruit pedicel or by using clippers, secatoreus, or scissors to harvest individual fruits or fruit bunches; early morning fruit harvesting allows for quicker pre-cooling and higher quality fruit production [5]. Fruits can be picked twice a week during harvest season to prevent premature ripening, however harvesting is usually done every 5-6 days to balance the amount and expense of the fruit. Fruit weights can range from 25-110 g, and yields from 8.9 t/ha to over 50 t/ha, with major regional variations [48]. Additionally, under different growing conditions, a single plant can yield up to 8 kgs of fruits [47]. Findings showed that the ideal planting time and spacing have a significant impact on the growth and yield of the crop [1]. Additionally, several commercial crop-affecting pests, bacteria, and fungus have been reported to be hosted by the crop. As a result, it can be employed as bait to draw these diseases and pests away from the primary crops.

3. Post-harvest technology of bitter tomato

It is often recognized that after harvesting, fruit and vegetables’ quality rapidly declines and a large amount of nutrients are lost [49]. Similar to cucumbers (Cucumis sativus L.), garden eggs/bitter tomato last within 10-14 days of harvest when kept in ideal temperatures of 10-12°C and relative humidity of more than 80% [33]. Depending on the stage at which the fruit is harvested and the storage conditions, rotting losses from African eggplant fruit are reported to be 25% and can be readily bruise, shrivel, and change colour [50]. It has been shown that post-harvest handling procedures for S. aethiopicum are crude. Several factors influence the quality of the fruit after harvesting, such as temperature in storage rooms, high respiration rates, relative humidity percentages, light intensity, carbon dioxide concentration, wounding caused by cutting that encourages phytochemical synthesis, and oxygen concentration that raises chlorophyll loss and causes deterioration [4]. In addition, inadequate grading and sorting causes the crop to go subpar that is being sold in the marketplaces [51]. Currently, for Solanum aethiopicum crop farmers grade by hand, although machine graders are an option as well.

Modern techniques must be used to increase storage life like processing and adding value to underutilized fruits to create a variety of products, such as jam, jelly, preserve, candy, confectionary, pickle, fruit drinks, and dried goods [52]. Traditional methods of food preservation and loss reduction involve the use of solar drying or fermentation technologies [53]. Additionally, research is required to determine how to enhance the sensory quality of the bitter tomato accessions to
increase consumer appeal. The possibility of creating value added products by adding dried pieces or powder to other foods like cereals, porridge flour, and baked goods might be taken into consideration. This will increase the number of African eggplants that are used [19]. Hence, to maximize shelf life and availability of the vegetable in its fresh state, post-harvest processing needs to be done as best as feasible. The steps for post-harvest handling are shown in the figure 2 given below.

![Flow chart showing the steps of Post harvest handling of S. aethiopicum](Image)

**Figure 2:** Flow chart showing the steps of Post harvest handling of S. aethiopicum

### 3.1 Processing techniques or innovation breakthroughs

#### 3.1.1 Application of dehydration techniques

*S. aethiopicum* drying process is straightforward, secure, and simple to understand [5]. Hot air oven drying, Vacuum oven drying, solar and freeze drying resulted in considerable shrinkage, severe weight losses, and a drop in total phenolic content (TPC), beta carotene, and antioxidant activity. In contrast to oven, vacuum and sun drying, freeze-drying preserved the total phenolic and beta-carotene contents better [54, 19]. In a study by Bisamaza & Banadda, (2017) [55], the solar dried garden eggs maintained more of the ascorbic acid, they also had a lower microbial burden making solar drying a superior method of preservation. Consequently, osmotic dehydration using NaCl solution may lessen the water activity of garden eggs, or serve as a pre-treatment method for additional drying. At 65°C in a 60% w/w osmotic solution, the ideal percentages of water loss (WL), and weight reduction (WR) were obtained [56]. Another study found that the best way to produce dried *S. aethiopicum* powder or flour was to slice the vegetable, dip it in plain water, and then use a cabinet dryer to dry it [57, 5]. Owing to the strong nutritional and health benefits of garden eggs, common culinary items like cookies, breads, cakes, and pasta have huge potential to incorporate the *S. aethiopicum* powder or flour. Therefore, it would be possible to create and use the garden eggs flour as a functional ingredient in the food sector [58].

#### 3.1.2 Fermentation (Pickling)

Another old technique for processing and preserving fruits is fermentation or pickling [59]. Fruits and vegetables that have undergone fermentation have higher nutritional value and increases food's digestibility [60]. Furthermore, indigenous crops like garden eggs (*S. aethiopicum*) could be preserved using this technique. The garden eggs are fermented for 7 days in jars filled with sugary brine at room temperature. Pickled garden eggs have a higher fibre and protein content than the unpickled garden eggs. Thus, pickling lowers the garden egg's anti-nutritional content while increasing the nutritional value by adding protein, fat, and certain minerals [33]. However, it is yet to fully realize the promise of fruit-processed products. Nonetheless, a few researchers have worked to create value-added products from underutilized fruits. It illustrates the viability of developing a few different value-added goods from the modest fruit crop farmed to reduce waste, and improve the socioeconomic of the nation’s vulnerable communities.

#### 3.2 Packaging Techniques

A suitable packing material should not be abrasive to prevent harming the packaged produce within [38]. Retail Bitter tomatoes are sold in plastic bags of different packages in outdoor marketplaces and on street corners [5]. Important materials include polymers like polyethylene terephthalate and polyethylene naphthalate, polyolefins like polyethylene and polypropylene, and polystyrene like polyvinyl chloride and polyvinylidene chloride [61, 62]; and other materials like paper boxes and woven polypropene bags are used to pack the garden eggs. Perforated polyethylene (60 µm) and 0.1cm meshed perforated polyethylene retains more moisture which causes minimal percentage of weight loss with the highest chlorophyll content of the garden eggs when stored in the charcoal cooler, making it the best packaging material [38]; increasing the fruit’s freshness and shelf life however, accelerates fruit deterioration higher without lowering fruit shelf life [50]. It has been suggested that polyethylene materials are effective at reducing physicochemical and nutritional quality changes [38]. In a study by Inyang et al., (2022) [63], the ripening of the garden egg was postponed by the interaction of a polythene bag containing 3g and 9g of potassium permanganate. Recent studies also found that the best protection for the fruits treated with hot water (at 47°, 50° and 53° for 1, 3, 5, or 7minutes) was provided by 1.25 µm thick polyethylene film pouches; for fruits treated with hot air and steam, the best protection was provided by 7.5 µm thick polyethylene bags which extended the shelf life of them garden eggs for 11days.
Incorporating heat treatment and plastic wrapping into eggplant fruits can improve their wholesomeness and increase their marketability [62]. However, the usage of the plastic packaging does not enhance the microbiological quality of the garden egg when stored at temperature of 29±1°C [15].

3.3 Storage Practices

Improper postharvest storage management techniques might account for as much as 50% of vegetable crop output losses between harvest and consumption [50]. Methods have been created to lessen fruit deterioration and increase fruit storage life after harvest. The most often used storage buildings are air-cooled storage houses, which run on ambient cold air [5]; cold storage is also one of the methods [4]. Nowadays the fruits are stored in mechanical refrigerators, but these appliances are energy-intensive, out of reach for local farmers [5]. To avoid rotting, the stored S. aethiopicum needs to be kept away from water [38]. In a study by Ubani & Okonkwo, 2011 [64], garden eggs in cooler baskets had a 7-day shelf life when stored in a well-ventilated area, with an ambient temperature of 27°C and 70% relative humidity; the cooler baskets (CB) often register a temperature reduction from the surrounding air but at 37°C and 16% relative humidity the garden eggs had a shelf life for only 4 days when stored in cooler baskets. In addition, the garden eggs are stored at low temperatures-above freezing and below roughly 20°C for the longest period which slows down several metabolic processes that result in ripening [5]. However, because they are susceptible to chilling harm, most tropical fruits have a limited shelf life when stored at low temperatures. For instance, eggplants can only be kept for a maximum of 14 days at their ideal storage temperature of 12°C before they undergo undesired changes that make them unpalatable to customers [4]. The researchers stressed that commodities can spoil due to improper storage. This does not, however, eliminate possible advancements in vegetable storage. Therefore, to lower postharvest losses, it is necessary to promote and enhance storage methods, particularly during times of plenty.

3.4 Coating

Plastics are being used more often for food packaging because they exhibit properties of synthetic polymers, which make them durable, easy to produce, and less expensive to process [65, 66, 67]. To address the issues raised by synthetic polymers, edible packaging is one sustainable technology that has received a lot of attention lately [68, 67]. The benefits of edible coatings include minimizing water loss, signs of chilling injury, boosting fruit colour, reducing weight loss, and maintaining fruit firmness [4]. In a study by Dadzie, (2018) [4], beeswax coating prevented weight loss, preserved stiffness, and postponed colour changes in S. aethiopicum while being stored at 10°C although the biochemical quality of the fruits was not enhanced. In contrast to beeswax and aloe vera coating, starch coating does not stop the fruits from losing firmness, changing colour, or losing weight. Pre-treating garden eggs with citric acid prior to starch coating reduced weight loss during shelf life and storage at 10°C. In addition, aloe vera gel coating reduces weight and firmness loss and postponed colour changes in the garden eggs. It also preserves the antioxidant capacity, ascorbate levels, and phenolic contents of the S. aethiopicum [69]. The concerns related to coating of the crop have not received equal attention in scientific studies. Therefore, more research is needed regarding the coating of S. aethiopicum.

3.5 Transportation and Marketing scenario

Before the end consumer is reached in the market, three key players: a farmer, a wholesaler, and a retailer are important. Trucks made up 100% of the primary mode of transportation by the farmers. The crop (S. aethiopicum) transports to the market in open trucks. In addition, the vehicles that were utilized did not have a suitable covering to shield the vegetables from dust or other harmful outside elements [51]. This corresponds to vegetable losses for S. aethiopicum of 13.3% and 5.2%, respectively, in the field and market locations. 13.3% of the harvested crop does not make it into the commercial supply chain, accounting for most losses on the farm. Retail losses come in second at 3.5%, and wholesale losses accounted for the least amount at 1.7% [70]. Vegetables are provided in fresh state by the traditional food supply chains, but as the value chain lengthens and grows more complex, fresh vegetables tend to lose nutritional value more quickly and their sensory quality more quickly. In these supply networks, vegetables are inexpensive and readily available, but these costs and amounts vary according to the vegetables' availability or season [51]. In addition, it is advised to transport fresh vegetables in covered and refrigerated vehicles and more research on technology that lower post-harvest losses should be prioritized.

4. Future outlook

The growing interest in traditional crops such as Solanum aethiopicum may be attributed to the growing global knowledge of the significance of varied and nutrient-rich diets. Growing consumer health consciousness may result in increasing demand for high-nutrient fruits and vegetables, which could drive up the production and use of S. aethiopicum. Further investigation of the fruit extracts and supplements are to be done for their therapeutic potential as interest in natural medicines and preventive healthcare develops. There may also be potential to use the crop in a greater variety of meals as culinary trends change and consumers look for new flavours and ingredients. Adapting to the bitter taste and flavor of the fruit could be challenging for the consumers so to bring out the distinctive flavours and textures of the fruit, chefs and food aficionados may experiment with various cooking methods and recipes, which will boost the demand on the market. The crop has a reputation for being able to
withstand a wide range of environmental factors, such as poor soil and scarce water supplies. Crops that are resilient and able to flourish in difficult growing conditions may see a resurgence of attention considering climate change and the mounting strain on agricultural resources. Initiatives pertaining to sustainable agriculture may benefit greatly from the use of *S. aethiopicum*, particularly in areas that are vulnerable to environmental stress. Continued study of the crop’s breeding and genetics may result in superior varieties with increased yield, disease resistance, and shelf life. These developments may increase interest in growing the crop and increase the crop’s potential for commercial use. There may also be increasing prospects for the export of *S. aethiopicum* fruit to new markets as consumer preferences become more varied and global trade networks keep growing. There might also be potential to create value-added products and food innovations in addition to fresh produce. These could include functional food products fortified with powdered or extracts from *S. aethiopicum*, as well as processed foods. Also, with the increasing demand for locally grown produce and the global trend towards urbanization, there may be opportunities to cultivate the crop in urban environments through cutting-edge farming techniques like hydroponics, aquaponics, or vertical farming. All things considered, the future seems bright for *Solanum aethiopicum* however the real results will rely on several variables, such as customer preferences, agricultural policies, market dynamics, and scientific study, socio-economic dynamics, and technology developments.

5. Constraints

Outside of its traditional growing regions, *Solanum aethiopicum* faces several major challenges, including a lack of awareness and limited market. There may be little awareness of its culinary or nutritional benefits in areas where it is not widely consumed, which would lead to minimal demand and little financial prospects for growers. The propensity of consumers to buy or eat *S. aethiopicum* fruit may be impacted by cultural prejudices or false beliefs about native or traditional cuisine in some areas. The crop face difficulties due to extreme weather and climate unpredictability although it can adapt to any growth conditions. Forecasts of climate change point to rising levels of unpredictability and variability in weather patterns, which could make these problems worse in the future. In comparison to other crop species, *Solanum aethiopicum* has comparatively less genetic diversity which can hinder efforts to develop improved varieties with desirable traits like increased yields, disease resistance, and improved nutritional quality. The advancement of crop improvement and the creation of robust varieties that are suited to shifting environmental conditions may be hampered by limited access to genetic resources and breeding instruments. To overcome these obstacles, a concerted effort involving a range of stakeholders, researchers, legislators, extension agents, growers, and market participants will be needed to create sustainable production systems, improve market accessibility, and value chain effectiveness, and raise consumer acceptance of the crop.

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Conflict of interest

The authors declared no conflict of interest.

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