



A REVIEW ON STRAWBERRY CULTIVATION IN BANGLADESH: CURRENT STATUS, CHALLENGES AND OPPORTUNITY

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ABSTRACT

Gathering information on strawberry cultivation, including production, challenges, and opportunities, is critical for developing this sector. This review paper aims to compile information on strawberry cultivation in Bangladesh. Strawberry farming is expanding due to increased demand of the local market, employment opportunities for young farmers, and export potentiality. In Bangladesh, 286 tons of strawberries are produced during 2019-2020. BARI strawberry-1, Rabi 1, Rabi 2, Rabi 3, and Camarosa strawberry are the preferable species cultivated by the farmers. Mainly the young aged people adopt strawberry farming commercially in Bangladesh. The study findings revealed that strawberry farming is difficult as it requires technical knowledge and other challenges such as lack of heat-tolerance variety, less sweetness in strawberries, etc. Planting time is also a significant factor because fruits of early planted plants contained more total soluble solids (TSS) and ascorbic acid than late-planted plants. Though strawberry production increased, still some problems are confronted by the strawberry growers during cultivation and marketing, including lack of quality sapling, dying of plant, lack of capital and technical knowledge, diseases and weed, birds attacks, poor transportation, no specific strawberry market, transportation cost, etc. which are needed to be addressed for further development of this field. Considering countries limited land, lack of appropriate genotype for its commercialization, and unemployed population; strawberries production could be a sustainable option for the developing village economy, nutrition supply, employment opportunities, and export strawberries for earning foreign currency.

Keywords: Strawberry cultivation; challenges; prospects; rural economy.

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Chart 1. Taxonomic Classification of Strawberry

Kingdom	Plantae
Clade	Tracheophytes
Clade	Angiosperms
Clade	Eudicots
Clade	Rosids
Order	Rosales
Family	Rosaceae
Genus	<i>Fragaria</i>
Species	<i>F. × ananassa</i>

Source: [1]

1. INTRODUCTION

In Bangladesh, Diversified fruits are grown, and its placed 6th in world rankings in 2017 for tropical fruit production, an essential source of vitamin, antioxidants, beta-carotene, iron, zinc, copper, manganese, essential amino acid (glutamic acid, aspartic acid, leucine etc), but the benefits are not taken from this source properly as their economic conditions and regional unavailability. Averagely, people take less than half of the daily requirement consumption than per capita requirements [2-5]. Inadequate consumption of fruits has been connected with several chronic diseases, including coronary heart disease, hypertension, stroke, and cancer. So, a diet should be maintained by consuming fruits to reduce these chronic diseases; therefore, the consumption of non-starchy fruits may help facilitate weight loss [6]. Strawberry is an important cash crop for its higher marketing demand, nutritional benefits, export potentiality, and commercial cultivation in Bangladesh. It is a quick-growing fruit with wide adaptation in a geographically diverse area. In Bangladesh, strawberry produced fruits from November to April, while most of the seasonal fruits are not available. World Health Organization recommends that per capita fruit requirement is 115 gm; however, Bangladesh only has 78 gm, which is lower than our minimum requirement. From the above statements, strawberries may help increase the availability of fruits during the lean season and combat malnutrition [7-10]. However, strawberry is a temperate crop grown in China, the USA, Spain, Japan, Poland, Korea, Russia, etc, but Bangladesh is a subtropical country. Although strawberry production in Southeast Asia is complex because of the rainy climate called monsoon, the difficulty has been solved by growing high-quality strawberries in a greenhouse and using cultivars that have wide adaptation in a humid environment [11-13]. Successful strawberry cultivation requires an optimum day temperature of 22-23°C and a night temperature of 7-13°C [14]. Planting time affects the day and night temperature, which helps to affect floral induction, fruit size, TSS,

Vitamin C content, and production. But planting time is a primary limiting factor for growing strawberries in Bangladesh [8]. Nevertheless, BARI has released one new strawberry variety named BARI strawberry-1, but it is not enough for the rising demand for strawberry cultivation [15].

The health effects of strawberries depending on their content of micronutrients, especially folate, vitamin C, Vitamin A, Vitamin E and its precursors such as carotenoids (β -carotene, α -carotene, and β -cryptoxanthin), low protein and fat, and minerals such as calcium, iron, phosphorus [1, 16]. Strawberry's ascorbic acid content ranges from 5-50 mg/100 g of fresh weight and effectively prevents oral cancer and cardiovascular diseases [17]. Strawberries are a common fruit in the Mediterranean diet because of their diverse nutritional profile [18]. Strawberry juice extracts have a higher level of antioxidants which works against superoxide radicals, hydrogen peroxide, hydroxyl radicals, and singlet oxygen free radicals [1, 19, 20]. Therefore, the biological evaluation of these metabolites is indispensable because the beneficial effects of strawberry polyphenols are related to gut-produced metabolites [21]. 25-50 strawberry plants are enough for medium-sized families [22].

Additionally, there is a promising future of strawberry cultivation in Bangladesh, a high-value crop grown everywhere, especially in the northern area except coastal districts [23]. However, some problems during the cultivation and marketing of strawberries need to be solved by scientists and policymakers step by step and enhance the production of this crop. Nevertheless, less information is known about the status of strawberry cultivation, its potential benefits, problems, and scope in Bangladesh. Therefore, this review summarizes the available information on strawberry production, challenges and prospects. Finally, some recommendations have been made to help enhance strawberry production and strengthen this sector in Bangladesh.

2. STRAWBERRY PRODUCTION IN BANGLADESH

2.1 Morphology of Strawberry

The strawberry plant is classified as a perennial herb or forb, which means the plant doesn't have much woody tissue above the ground but is still vascular, with a fibrous root system and basal leaves arising from the crown. There are five morphological structures of strawberries: leaf, crown, root system, stolon (runner), and daughter strawberry plant (Figure 1). The root and leaves are engaged in photosynthesis and absorb vitamins and minerals for plant growth

and reproduction. Initiation of flower bud and fruiting depend on time and depend on day length; there are two main types of strawberry plants: short-day types (initiation of flower buds less than 14 h a day) and day-neutral types (initiation of flower buds season-long). The compressed modified stem is the crown where leaves, runners, branch crowns, and flower clusters arise. It has two root systems- primary roots (conduct water and nutrients, lives one year) and feeder roots (branch off from the primary roots and live for a few days or weeks). The physiological function of primary roots and feeder roots is to encourage new primary root development and absorption of water and nutrients. Strawberry plants have a shallow root system which results in sensitivity to drought, excess water, and salt. Strawberry plants are propagated by runners or stolons, as daughter plants produce from them. After developing lateral roots in daughter plants within 2-3 weeks attachment of mother plants, it can act as an independent plant. Daughter plants take more time than mother plants for developing larger crowns and more flower buds, indicating higher yields [24-26].

2.2 Current Status of Strawberry Production

Strawberry (*Fragaria × ananassa* Duch.) is an exotic and lucrative fruit belonging to the family Rosaceae with commercially started and high demand fruit in

Bangladesh. In Bangladesh, strawberry is a new cash crop is grown in Joypurhat, Rajshahi, Bogra, Chapainawabganj, Tangail, Sathkhira, Khagrachari, Comilla, and Coxbazar districts. Still, commercial cultivation of strawberries has got momentous in the Rajshahi region as its cultivation is easier and has high profitability [28, 29]. Small-scale strawberry farming is increasing among young Bangladeshi farmers, with diverse production efficiency in various districts. Khatun's findings showed that about 41% of farmers were 18 to 30 years old, 60% of farmers had primary education level, 61% farmers had a small farm, and 69% farmers had 1 to 3 years of experiments [28]. According to the Bangladesh Strawberry Association, about 6500 bighas of land have been bought under strawberry cultivation throughout the country this year, where Rajshahi is ahead of other districts in farming the fruit [30]. But in 2019, strawberry cultivation in 15 acres of land and production was 54 M. Ton (BBS, 2019). According to Dash's research, when seasonal fruits typically are not available: one acre of winter strawberries could earn a Bangladeshi farmer anywhere from \$6,000 to \$7,500 yearly[31]. In 2018, 8,337,099 tons of strawberry produced in the world, where 46.65% in Asia, 26.15% in America, 20.15% in Europe, 6.31% in Africa, and 0.75% in Oceania, but China was the main producer with 2964263 t which represent 35.55% and second was USA (15.55%). Even in 2018, the USA was the

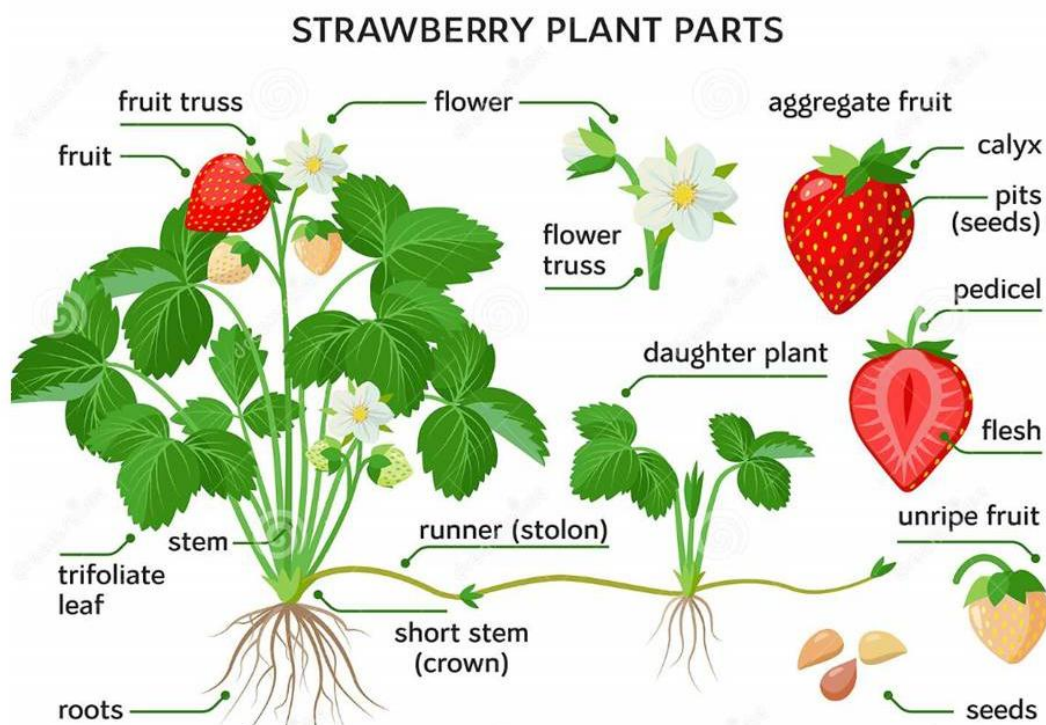


Fig. 1. Different morphological parts of a strawberry plant [27]

main strawberry importer in the world with 161889 t, which was 17.93% of the world, while Canada (2nd), Germany (3rd), and France (4th) [32]. So, Bangladesh can earn huge foreign currencies by exporting strawberries if it starts commercial farming at the national level and needs farmers to motivate strawberry cultivation. According to the Department of Agricultural Extension (2019-20), local production strawberry was 286 t from 64 ha of land which brought in about Tk. 7.2 crore in revenue [33].

2.3 Strawberry Cultivation Practices, Season and Variety

Strawberry is grown in Bangladesh from October to March, but planting time is crucial for growing strawberries because of the prevailing short winter season. A seedling was planted in Mid-November to make a short fruiting season, which reduced fruit yield. Several reports said that strawberries could be planted at different times depending on the variety and climate, but planting time plays a vital role in successful strawberry cultivation [8, 34]. To get maximum benefit, Strawberry can be planted well-plowed raised-bed as its shallow root system. Near about 100000 seedlings (runners) are required for planting one hectare of land and late afternoon is the best time for plantation. Frequent irrigation is needed as it is susceptible to drought conditions. Strawberry plants started flowering after one month of the plantation, and fruit can be collected in February-March [35]. Above 20 *Fragaria* species and cultivars are commercially cultivated in different countries throughout the world [36]. Research organizations and the university of Bangladesh develop strawberry varieties named BARI strawberry-1, Rabi 1, Rabi 2, Rabi 3, FTIP-BAU-Strawberry, BADC Strawberry,

FA 008, Festival, and Camarosa, which can meet the increasing demand for strawberry cultivation [15].

2.4 Benefits of Strawberry

Strawberry is an essential fruit in the Mediterranean diet because of its high content of nutrients (Table 1) and beneficial phytochemicals (Table 2), which have relevant biological activity in human health. It is also the appropriate source of bioactive compounds because of its high folate, vitamin C, lignans, tannins, and phenolic constituents [7].

At present, strawberry consumption has become paid attention to due to its biological properties that combat chronic diseases such as cancer, metabolic syndrome, cardiovascular disease, obesity, diabetes, neurodegeneration, inflammation, and antimicrobial activities (Fig. 2). Strawberry contains phenolic compounds which have many nonessential functions in plants but are beneficial for human health [38]. Although it is difficult to prove that a portion of specific food can decrease the risk of cardiovascular and heart disease, some researchers have demonstrated that strawberries can benefit the woman's cardiovascular effects [39]. Strawberry phenolic compounds alter pathways related to cardiovascular health through different mechanisms. The phenolic compound shows anti-oxidation properties; anti-oxidation is one possible mechanism relevant to cardiovascular disease prevention [40]. Strawberry intake increases plasma TAC which is considered the most beneficial outcome of strawberries [41-43]. Consumption of strawberries has also been regarded as a valuable dietary complement to a diet designed for coronary heart disease [44]. Besides, strawberry has been shown in several research to have cancer-preventive properties [45].

Table 1. Nutrients composition of fresh strawberries [37]

Vitamins	Minerals	Proximates
Vitamin C (58.8 mg)	Calcium (16 mg)	Water (90.95 gm)
Thiamin (0.024 mg)	Iron (0.41 mg)	Energy (32 kcal)
Riboflavin (0.022 mg)	Magnesium (13 mg)	Protein (0.67 gm)
Niacin (0.386 mg)	Phosphorous (24 mg)	Ash (0.40 gm)
Pantothenic acid (0.125 mg)	Potassium (153 mg)	Total lipid (0.30 gm)
Vitamin B6 (0.047 mg)	Sodium (1 mg)	Carbohydrate (7.68 gm)
Folate (24 mg)	Zinc (0.14 mg)	Dietary fiber (2.0 gm)
Choline (5.7 mg)	Copper (0.048 mg)	Sugars (4.89 gm)
Betaline (0.2 mg)	Manganese (0.386 mg)	Sucrose (0.47 gm)
Vitamin A =, RAE (1mg)	Selenium (0.4 mg)	Glucose (1.99 gm)
Lutein + Zeaxanthin (26 mg)		Fructose (2.44 gm)
Vitamin E, α -tocopherol (0.29 mg)		
β -tocopherol (0.01 mg)		
γ -tocopherol (0.01 mg)		
δ -tocopherol (0.01 mg)		
Vitamin K (2.2 mg)		

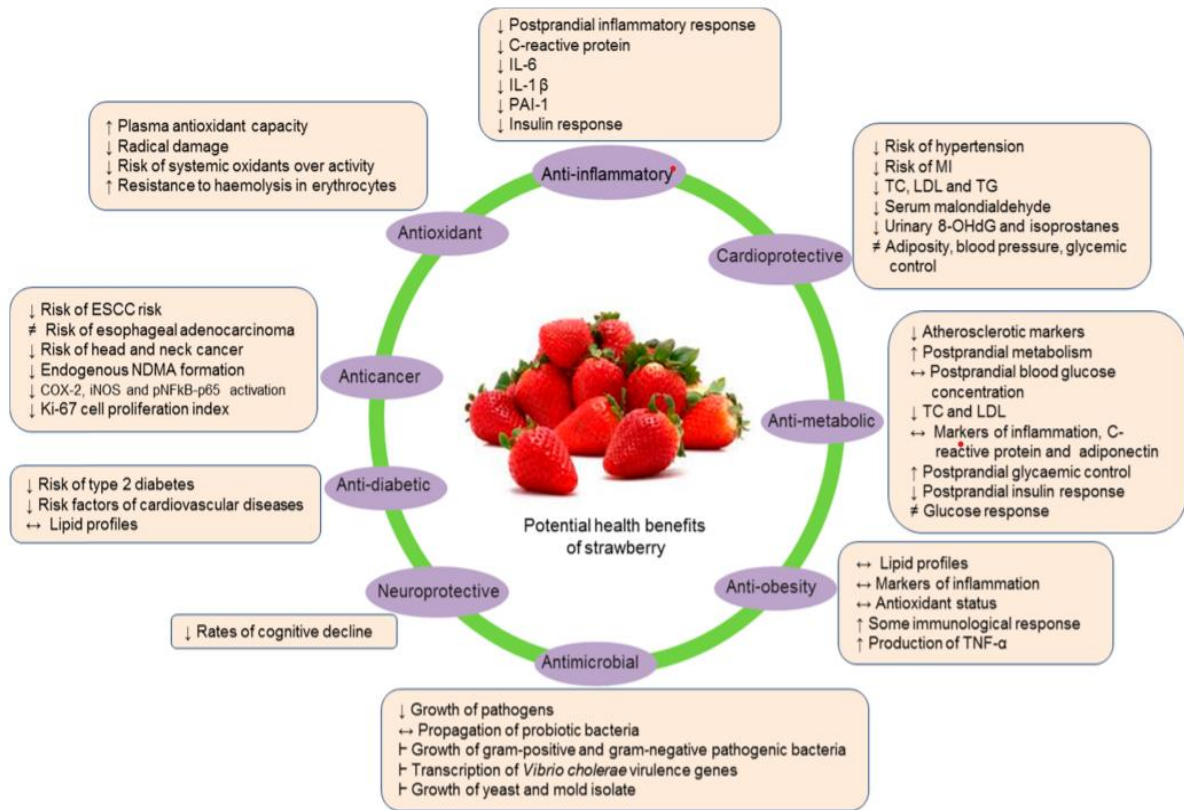


Fig. 2. Strawberry's health impacts in clinical studies in patients with oxidative stress, inflammation, cardiovascular disease, metabolic syndrome, diabetes, obesity, cancer, microbial infection, or neurological problems are summarized. The symbol (↔) denotes normalizes the effect, (↓) reduces activity, (↑) increases activity, (perpendicular) suppresses activity, and (≠) no effect. [50]

Table 2. Polyphenol compound reported in strawberries [46-49]

Class	Group	Compound
Flavonoids	Anthocyanins	Cyanidin-3-glucoside
		Cyanidin-3-rutinoside
		Cyanidin-3-malonylglucoside
		Cyanidin-3-malonylglucosyl-5-glucoside
		Pelargonidin-3-galactoside
		Pelargonidin-3-glucoside
		Pelargonidin-3-rutinoside
		Pelargonidin-3-arabinside
		Pelargonidin-3,5-diglucoside
		Pelargonidin-3-malylglucoside
		Pelargonidin-3-malonylglucoside
		Pelargonidin-3-acetylglucoside
		Pelargonidin-dissacharide (hexose þ pentose) acylated with acetic acid
		5-pyranopelargonidin-3-glucoside
		Flavonols
	Quercetin-3-malonyglucoside	
	Quercetin-rutinoside	
Quercetin-glucoside		
Quercetin-glucuronide		

Class	Group	Compound
		Kaempferol-3-glucoside Kaempferol-3-malonylglucoside Kaempferol-coumaroyl-glucoside Kaempferol-glucunoride
	Flavanols	Proanthocyanidin B1 Proanthocyanidin trimer Proanthocyanidin B3 (+)-catechin
Phenolic Acid	Hydroxycinnamic acids	p-coumaroyl hexose
Hydrolyzable Tannins	Ellagitannins	Ellagitannin Bis-HHDP-glucose Gallery-HHDP-glucose DP-galloyl-glucose Galloyl-bis-HHDP-glucose Dimer of galloyl-bis-HHDP Sanguin H-6 Methyl-EA-pentose conjugates Ellagic acid pentoside Ellagic acid

3. CHALLENGES OF STRAWBERRY PRODUCTION IN BANGLADESH

Although strawberry growing is becoming more popular among young farmers, some challenges stagnate strawberry production. The major constraint of strawberry production is heat stress as Bangladesh lies a sub-tropical country with hot summers and mild winters, which means the annual temperature has been rising. That's why strawberry production has become popular in the northern region due to favorable weather. Bangladeshi growers have few local cultivars and none of the heat-tolerance variety [31].

3.1 Problems Confronting during Production [28]

- ❖ Strawberry farming is costly but profitable
- ❖ Limited land resources and rising demand in the local region
- ❖ Strawberry plants were attacked by nematode and soil-borne pathogens
- ❖ Lack of technical knowledge about strawberry farming
- ❖ Scarcity of quality sapling
- ❖ Plant is dying
- ❖ Lack of capital
- ❖ Fruit damage due to raining
- ❖ Insects and births attack
- ❖ The sapling's production is quite difficult
- ❖ Fog-related plant damage
- ❖ Shortage of labor

3.2 Problems Confronting during Marketing [28]

- ❖ Poor transportation facilities

- ❖ You can't sell without Arath
- ❖ Commission of Arthdar is high
- ❖ No specific strawberry market
- ❖ The cold storage facility is poor
- ❖ Higher transportation cost

4. PROSPECTS OF STRAWBERRY PRODUCTION IN BANGLADESH

Bangladesh has 162.7 million people on its small land (147,570 Km²) and is the 8th largest populated country globally [51]. Statistics anticipated that the population of Bangladesh will be 220 million by the year 2050 [52]. So, to feed the growing population of Bangladesh, food crop production should be doubled by the intensification of agriculture. Although fruits and vegetable production has been increased in the last few years, the production is not much enough, and still, there is enormous demand [53]. Furthermore, 27 lakh people are unemployed, and around 12% of youths with tertiary education were unemployed, nearly three times superior to the national unemployment rate of 4.2% [53, 54]. However, strawberry cultivation has become a game-changer in creating employment opportunities and meeting nutritional demand.

On the other hand, Strawberry cultivation is a mostly untapped sector in Bangladesh, which can provide health benefits, job opportunities and meet growing demand backed by rising middle-class income in the nation. Suppose modern technology, resources, and an effective storage system are maintained. In that case, Bangladesh can move towards mass cultivation and production of the fruit, thus generating economies of scale and making it a profitable business sector. At the

beginning of strawberry cultivation in Bangladesh, experts predicted that strawberry cultivation would alter the agriculture sector positively, which will create an export potential industry. However, the data indicates that current production is still lagging behind increased demand. According to the National Board of Revenue, Bangladesh now imports Tk. 7 lakh worth of strawberries in 2014 and 1.35 million in 2015 [55, 56]. Policymakers and the agriculture industries should work together to establish an efficient distribution channel with mobile technology, bringing pricing lucidity and keeping farmers informed about the market. As strawberries have a short shelf life, cutting down the costs will make them more palatable to the customers because of the pricing and quality of the fruit. Besides, adequate storage and freezing facilities can extend strawberries' shelf life and allow customers to purchase strawberries throughout the year.

5. CONCLUSIONS

Strawberry is a nutritious fruit and contains dietary supplements, including vitamins, minerals, folate, and fiber, and the people of Bangladesh have consumed a rich source of phytochemicals. As strawberry production increased last year and earned about Tk. 7.2 crore of revenue, but there were some problems during production and marketing. However, there is an excellent opportunity strawberry business in Bangladesh with colossal unemployment and malnutrition. Small scale strawberry production has the opportunity for small entrepreneurs and farmers to eradicate poverty and meet nutritional demand. The development of strawberries based industries also created a scope to export strawberry and strawberry products like jam, jelly, strawberry milk, etc. Thus it can generate employment for unemployed people. Based on the above conditions, some recommendations are provided: Strengthening technical support to the strawberry growers, supply capital and quality planting material, establishing the strawberry market, storage facilities, and establishing strawberry industries to develop strawberry production in Bangladesh. The department of agriculture extension of the Bangladesh government should provide more extension programs to boost its production and consumption.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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