RECENT ADVANCES IN LUFFA VEGETABLES

Abstract

Luffa vegetables are one of the important cucurbitaceous vegetable crops enriched with several nutritional and medicinal properties. The genus *Luffa* comprises of several species among which *Luffa acutangula* and *Luffa cylindrica* are the important domesticated species that are most common and popular under commercial cultivation throughout the World. Such vegetables are rich source of vitamin A, calcium, phosphorous, ascorbic acid, iron and found to be helpful in treating several diseases including diabetes, hypertension, inflammatory diseases, diarrhoea and several viral infections. The rapidly increasing human population is triggering a number of challenges including the food demand. *Luffa* vegetables being one of the important cucurbitaceous vegetable crop that play a vital role in fulfilling the vegetable demand also seems to be affected by such prevailing conditions. Due to such sudden rise in demand and prevalence of several biotic and abiotic stresses for successful cultivation, conventional breeding methods are found to be sterile to combat such complications. Therefore, there is a need of advancement in crop improvement technique or method at advance level including molecular breeding with major emphasis on development of high yielding superior varieties/hybrids, resistant to different biotic and abiotic stresses, containing good nutritive value, adaptable to different environment conditions, *etc.* which ultimately favours improvement of crop in different aspects Thus, this chapter deals with the recent methods or technologies opted for successful crop improvement in *Luffa* vegetables till date with recent achievements for fruitful cultivation.

Keywords: crop improvement, *Luffa* vegetables, biotic stresses, abiotic stresses, superior varieties.

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I. INTRODUCTION

Horticulture sector plays an important role in Agricultural Gross Domestic Products (GDP) of India. During the year 2017-18, it was recorded 30.4%. However, it was 33% in the year 2018-19 (NHB, 2019). Among all horticulture components, vegetable crops have been found contributing maximum (59.83%) to total horticultural production of the country followed by fruit crops (30.91%), plantation crops (5.06%), spices (2.93%) and flower and aromatic crops (1.20%) during 2019-20 (NHB, 2020). India is considered as the second largest producer of vegetables in the World after China. During 2019-20, the vegetable crops have been cultivated in 10.35 million hectares with a production of 191.7 million tonnes (NHB, 2020). The data with respect to growth trend in area and production of vegetable crops shows drastically increased during 2009-10 to 2013-14 (Anonymous, 2018) which is a positive outcome.

In spite of being second largest producer of vegetables in the World and improvement in area and production, our country is still struggling to fulfill the vegetable requirements of its growing population. The rapidly increasing human population has triggered a number of challenges including losing of our biodiversity, over-exploiting natural resources, facing food scarcity, degrading environment and performing activities that lead to increased levels of abiotic stresses in our environment. Enormous efforts are made all over the World to document as well as to use all the available resources to combat such complications.

The improvement of crop species with respect to high quality production has been a basic pursuit since the commencement of cultivation. Conventional breeding methods of crop improvement have played a vital role in prosperity of several agricultural and horticultural crops. As it is a known fact that vegetables are considered as an essential source of balanced diet because they supply vitamins, minerals, dietary fibre, phytochemicals, *etc*. Cucurbitaceous vegetables including *Luffa* group of vegetables also contributes to its maximum potential for overall horticultural production of the nation maintaining nutritional security. Improvement in such crop is also a major priority to overcome its various growth and development restricting factors for its successful and fruitful production. It has been reported that in such crops there is a need of advanced crop improvement techniques or methods at advance levels including molecular breeding with major emphasis on development of high yielding superior varieties/hybrids, resistant to different biotic and abiotic stresses, containing good nutritive value, adaptable to different environment conditions, *etc.* which ultimately favors improvement of crop in different aspects which will not only fulfills the food demand but also helps in improving the economic wealth of our nation by improving livelihood and maintaining import-export relationships with other nations.

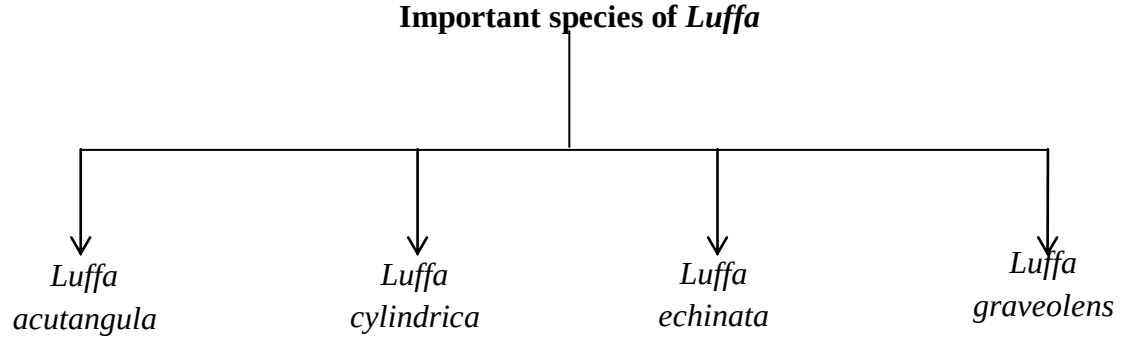
II. LUFFA VEGETABLE

Luffa is the genus name of numerous tropical and subtropical grown plants which belongs to the family cucurbitaceae (Stephens, 2018). Crop belonging to such genus produces fruit with fibrous vascular system. The crop has been grown since ages in the tropical countries of Asia and Africa (Oboh and Aluyor, 2009).

Table 1: Scientific classification of *Luffa*

Botanical name	:	*Luffa* spp.
Order	:	Cucurbitales
Family	:	Cucurbitaceae
Sub-Family	:	Cucurbitoideae
Tribe	:	Benincaseae
Sub-tribe	:	Luffinae
Genus	:	*Luffa*
Species	:	*cylindrica, acutangula, etc.*
Chromosome number	:	2n=2x=26
Origin	:	Old world origin in Subtropical Including India.

The genus *Luffa* comprises of ten species *viz.*, *L. cylindrica*, *L. acutangula*, *L. graveolens*, *L. echinata*, *L. umbellate*, *L. tuberosa*, *L. quinquefida*, *L. astorii*, *L. saccata* and *L. hermafrodita*. Out of these species, *L. cylindrica* and *L. acutangula* are the domesticated species most common and popular under commercial cultivation throughout the world. *Luffa hermaphrodita,* popularly known as Satputia bears hermaphrodite flowers and is cultivated species in some areas of India (Marr *et al*., 2005).



Source: Kalloo (1993)

1. ***Luffa acutangula:*** Ridge gourd botanically known as *Luffa acutangula* L. (Roxb.) is a very important summer vegetable crop of South East Asia and few African countries. It is an annual plant with trailing growth habit grown primarily for its immature fruits which can be eaten raw, cooked or in processed form. It is a good source of vitamin A, B, C and minerals (Wills *et al.,* 1984). It also possesses considerable medicinal properties such as curing jaundice and diabetes along with additional benefits as anti-inflammatory and antibiotic, excellent blood purifier, possessing laxative properties fortifying the immune system and skincare (Bora *et al.,* 2015).

2. ***Luffa cylindrica*:** It is commonly known as sponge gourd and is widely grown in Tropical Asia and China. It is known by different names such as Jhinga in Bengali, Sankirah in Hindi and Turiyain Gujarati. Such crop possesses several types of sex forms which include monoecious, andromonoecious, gynoecious and hermaphrodite (Choudhury and Thakur, 1965).

3. ***Luffa echinata*:** *L. echinata* also known as 'Bristly *Luffa'* is another species of genus *Luffa*. It is mostly found in East Asia and some parts of Africa. Dried fruit obtained from such plant has a great importance in ayurvedic medicine for treating several illnesses such as fever, chronic bronchitis, dropsy, nephritis, intestinal disorders and jaundice.

4. ***Luffa graveolens*:** It is a wild type species of *Luffa* bearing some traditional medicinal value. *L. graveolens* is also considered as a progenitor of cultivated smooth and ridge gourd species (Muthukumar and Selvakumar, 2013).

5. ***Luffa acutangula* sub sp. *hermaphrodiata*:** Satputia botanically known as *Luffa acutangula* sub sp. *hermaphrodiata* or hermaphrodite ridge gourd is an underutilized cucurbitaceous vegetable crop that produces fruits in clusters. It is widely cultivated in Bihar, Eastern Uttar Pradesh, West Bengal and Assam as mixed crop and mono crop in both spring summer and kharif seasons. Fruits of such cluster bearing species of *Luffa* are very nutritious and good source of vitamin C, calcium, phosphorous and iron (Choudhary *et al.*, 2014).

6. **Other *Luffa* species includes:** *Luffa operculata, Luffa saccate, Luffa tuberosa, Luffa umbellate* and *Luffa quinquefida.*

Table 2: Medicinal importance of *Luffa* vegetables are given in tabular form below

Crops	Research Findings	References
Ridge gourd	Leaves and fruit powder obtained from ridge gourd are used for curing jaundice in some parts of Madhya Pradesh and Maharashtra.	Samvatsar and Diwanji (2000)
Ridge gourd	It has been reported that leaves or juice extracted from ridge gourd are used as a dressing material for the treatment of diseases such as inflammation of spleen, leprosy, piles and ringworms.	Manikandaselvi *et al*. (2016)
Ridge gourd	Ridge gourd is also found to be helpful in preventing premature graying of hair.	Manikandaselvi *et al*. (2016)
Sponge gourd	The leaves, seeds, and fruits of sponge gourd have been found useful for the treatment of several viral infections, diarrhoea and inflammatory diseases.	Abdel-Salam *et al*. (2019)
Sponge gourd	It has been reported that problems of diabetes and hypertension can be cured with the help of alcalase or tryptic protein hydrolysates present in seeds of sponge gourd.	Arise *et al*. (2019)

III. CROP IMPROVEMENT

Crop improvement in simple term refers to "an art or science" or technology of improving the genetic makeup of plants with the view of its better economic use for the mankind. Crop improvement aims at improving the various characteristic features of the plants so that they become agronomically as well as economically desirable. Hence, the chief objective of crop improvement focuses on developing superior varieties of the crop plants

that will be commercially valuable.

1. Objectives of crop improvement in *Luffa* vegetables:

Major objectives of crop improvement in *Luffa* vegetables

- Earliness
- High female: male sex ratio
- Uniform, thick, cylindrical fruits free from bitterness
- Tender, non-fibrous fruit for longer time
- High fruit yield
- Resistance to various biotic and abiotic stresses.

2. Major constraints in improvement of *Luffa* vegetables:

- **Flowering behavior**: Anthesis time of different *Luffa* species are reported to be different which creates problems in various crop improvement activities in *Luffa* vegetables.
- **Different sex forms:** Several types of sex forms which exist in different Luffa species are considered as one of the barrier for successful crop improvement in Luffa vegetables.
- **Vine growth habit:** Most of the Luffa species bears vines which sometimes much longer that it becomes problematic in undertaking some sort of crop improvement programmes.

3. Methods of cop improvement in *Luffa* vegetables

Methods for crop improvement generally used in the *Luffa* vegetables includes-

- **Selection**: Selection in a simple term refers to the choosing of desirable or superior from the population eliminating the unwanted or undesirable ones from the population for the further generations. It is one of the basic and the oldest methods of crop improvement which is still employed for various crop improvement programmes. Some fruitful achievements of selection on *Luffa* vegetables includes: Sponge gourd- Pusa Chikni (selection from Bihar collection and released by IARI, New Delhi), Phule Prajakta (selection released by MPKV, Rahuri), Pusa Supriya (selection released by IARI, New Delhi), Pusa Sneha (selection released by IARI, New Delhi) and GFE-SMG-108 (selection released by MPKV, Rahuri). Ridge gourd- Pusa Nasdar (selection from Neemuch collected from Madhya Pradesh and released by IARI, New Delhi), Khonkan Harita (selection released from Konkan Krishi Vidyapeeth, Dapoli), CO-1 (selection from Aduthurai and released by TNAU) and CO-2 (selection from germplasm type released by TNAU).

- **Hybridization**: Hybridization refers to the crossing between genetically dissimilar plants. In plants, crossing is done by transferring pollen grains from the male parent onto the stigma of female plant. The first artificial hybrid in plants was produced by Thomas Fairchild in 1717 and since then this method is being used for various crop improvement program. Some *Luffa* varieties developed through hybridization includes: Ridge gourd- Arka Sujata (IIHR 54 x IIHR 18), Arka Sumeet (IIHR 54 x

IIHR 24), Swarna Manjari (Hybridization followed by selection), Swarna Uphar (Hybridization followed by selection).

- **Mutation breeding:** Mutation refers to the sudden heritable change in the characteristics of an organism. According to Eriksson and Amman (2016) mutations induced through chemicals or radiation has created a revolution which led to development of at least 3240 improved varieties of several crops. It is considered as one of the powerful tool for the crop improvement program as it is useful in development of superior varieties, haploids production, creation of genetic variability, induction of male sterility, overcoming self-incompatibility and improvement in adaptation of the crop plants. PKM-1 variety of ridge gourd is a best outcome of mutation breeding developed through induced mutant from H-160 type which was released by TNAU, Coimbatore.

- **Back cross method**: Back cross refers to the crossing of F_1 with one of its parents. In simple term this method is usually practiced to transfer some specific characters such as disease resistance and some important quality characters to the needed ones. This method holds a great importance when crop improvement in vegetable is concerned. In sponge gourd, Sidhu and Kaur (2021) successfully transferred gynoecious and cluster bearing character from Satputia with high yield using back cross and triple cross method. Similarly, Shah *et al.* 2015 in their experiment reported that segregation of backcross and F_2 generations played a vital role in elimination of bitterness in fruits with fertile vines developed by a cross between *L. aegyptiaca* crossed with *L. acutangula*.

- **Heterosis breeding method**: Heterosis refers to the superiority of F_1 hybrids in one or more characters over its parents. This breeding has been recognized as a major tool for breeders in increasing yield and other economic traits (Preethi *et al*., 2019). Varalakshmi *et al.* (2019) reported significant heterosis in hybrids over the standard check during an experimentation on heterosis and combining ability for yield and its related traits in ridge gourd. Such hybrids can be utilized in commercial purpose in crop improvement program of ridge gourd.

- **Genetic engineering:** Genetic engineering is a technique in which new gene is introduced by recombinant DNA technology and genetic transformation. Considerable success has been achieved since last few years in introducing several quality traits, abiotic stress tolerance and expression of various proteins and enzymes of pharmaceutical and industrial importance through genetic engineering (Dalal *et al*., 2006). Sujatha *et al.* (2013) obtained a practical idea regarding particle gun mediated genetic transformation of *gus* gene into nodal explant with callus in sponge gourd. Such techniques will play a crucial role in crop improvement in *Luffa* vegetables.

- **Biotechnological method:** Biotechnology simply refers to a group of technologies that employ biological entities or processes to create new and useful products and processes (Singh *et al*., 2019). Such technology provides a platform which enables amelioration which would be not possible with age old crossing technique of related species alone. The various approaches used in biotechnological aspects for increasing yield and other quality of crop include micropropagation, somaclonal variation, anther

culture and genetic engineering. In *Luffa* vegetable such as sponge gourd in vitro plantlet regeneration was achieved through micro propagation (Sujatha *et al.*, 2013).

- **Use of molecular markers:** Molecular markers are now being widely used in improvement of *Luffa* vegetables. Tyagi *et al.* (2020) after a successful experiment on genetic diversity and population structure detection in *Luffa cylindrica* using Inter Simple Sequences Repeat (ISSR), Start Codon Targeted (SCoT) and morphological markers revealed that markers are reported to have a great potential for identifying valuable data based on genetic correlation and structure in sponge gourd which can be further utilized in genetic improvement of other *Luffa* vegetables mainly ridge gourd.

IV. RECENT ATTEMPTS ON IMPROVEMENT IN LUFFA VEGETABLES

1. **Recent approach for resistance to biotic stress in *Luffa* vegetables:** Biotic stress resistance such as resistance to insect-pest and diseases is considered as one of the key objective of any crop improvement programmes because they cause huge economic losses. Tomato Leaf Curl New Delhi Virus (ToLCNDV) and downy mildew (DM) are the major biotic constraints to successful loofah vegetable production .In order to overcome such production barrier Dhillon *et al.* in 2020 evaluated 467 accessions of ridge gourd and 783 accessions of sponge gourd from 10 Asian countries for resistance against ToLCNDV and DM along with key horticultural traits of loofah such as color of the fruit, shape, length, bitterness, and duration of fruit harvest and reported that 82 lines of ridge gourd and 65 lines of sponge gourd were found to be resistant against ToLCNDV and DM along with desirable key horticultural traits. Result also revealed that most of the lines resistant to both diseases belong to Bangladesh origin and concluded with the fact that the identified resistant loofah lines against ToLCNDV and DM provides an ample opportunity for the loofah vegetable development with respect to early maturity, virus resistant F_1 hybrid cultivars along with various market segments such as dark green and green fruit free from bitterness which is a general demand of a consumers.

2. **Recent approach for resistance to abiotic stress in *Luffa* vegetables:** India is blessed with several agro-climatic conditions including hot, mild and cold climatic conditions depending on the geographical locations. As many literatures indicates that the qualitative attributes of a crop are also found to be affected with the several existing abiotic stresses, development of suitable and stable varieties resistant to various abiotic stresses is one of the major objectives of crop improvement. Therefore, with the objective of developing high temperature tolerant variety of ridge gourd for arid region an experiment was conducted with an evaluation of 7 genetically different inbred lines of ridge gourd along with Arka Sujath and Pusa Nasdar (as a check) for different horticultural traits with special reference to high temperature tolerance and revealed that AHRG-29 (IC-0621468) which as identified as variety "Thar Karni" showed desirable performance with respect to different horticultural traits and high temperature tolerance as compared to all other evaluated lines. It also showed tolerance to mosaic disease having 7.50% incidence and resistance against melon fruit fly with 17.67% fruit infestation under filed conditions ultimately withstanding the high temperature upto 42^0C with good yield potential (Choudhary *et al*., 2018).

3. **Recent biotechnological approach in improvement of *Luffa* vegetables:**

Biotechnological approaches are currently emerging as an important adjunct to crop improvement. Cucurbitaceous vegetable crops are reported to be seriously affected by several growth limiting viral diseases including the Water Melon Mosaic Virus (Greber, 1978), Cucumber Green Mottle Mosoic Virus (Nijsden, 1984), *etc*. Development of virus free plants is one of the key objectives of crop improvement. Tissue culture is considered as a beneficial technique to produce virus free plants and bulk multiplication of the crop plants favoring the overall production and productivity. Similarly, Georges Morel in 1952 reported that virus free plants can be developed from infected plants with the help of shoot tip cultures. With respect to the above mentioned facts Venkateshwarlu in 2020 conducted a research aiming development of shoots from tendril explants of ridge gourd in different MS medium supplemented with various cytokinins *i.e.,* 6- Benzyl Amino Purine, NAA and L-Glutamic acid along with addition of coconut water at different concentrations and reported that addition of 6- Benzyl Amino Purine @ 2.0mg/l concentration or NAA @ 3.0 mg/l to the MS medium, induced regeneration of shoots from the tendril explants of ridge gourd. Similarly, addition of coconut water also triggered multiple developments of shoots. He also concluded that the medium supplemented with 6-Benzyl Amino Purine @ 1.0 mg/l + NAA @ 2.0 mg/l and L-Glutamic acid @ 2.0 mg/l was reported to be best in inducing shoots in ridge gourd.

Roly *et al.* (2013) in their experiment on in vitro multiple shoots regeneration from cotyledonary nodes, shoot tips and nodal segments of ridge gourd revealed that in case of direct multiplication of shoots from nodal segment and shoot tips, MS containing 1.5 mg/l BAP + 0.3 mg/l GA_3 and 1 mg/l BAP + 0.3 mg/lGA_3 showed the best outcome for cotyledonary node development. In addition, average value of shoot/culture for nodal segments, shoot tips and cotyledonary nodes was 5.20, 3.80 and 4.40 respectively with highest callus induction in nodal segments using 2 mg/l BAP + 0.4 mg/l.

4. **Recent sex modification approach in improvement of *Luffa* vegetables:** Although high proportions of femaleness have been developed and being utilized in hybrid production, gynoecious in sponge gourd is very rarely reported (Jianning, 2000). The male sterile and gynoecious populations are always been desired for various crop improvement programmes when it is concerned with *Luffa* vegetables especially sponge gourd. A sponge gourd genotype VRSG-52-1 which bears fruits in clusters has been obtained from the open pollinated landraces and from this genotype four sponge gourd plants *viz.* Gy25S, Gy27S, Gy28S and Gy29S with proper expression of gynoecium were identified through sib pollination. These identified populations will be helpful in future crop improvement programmes and commercial hybrid seed production of sponge gourd for fruitful outcome (Singh *et al*., 2012).

   Varalakshmi and Suchita (2016) studied inheritance of andromonoecy in ridge gourd and revealed that Andromon-43 which possesses andromonoecious sex form in ridge gourd can be used to transfer andromonoecious gene to other long fruited monoecious line of ridge gourd to develop andromonoecious varieties with increased in fruit numbers and fruit length.

5. **Recent mutational approach in improvement of *Luffa* vegetables:** Plants with dwarf phenotypic growth habit is one of the most important breeding objectives in cucurbitaceous vegetable crops because it saves labour and ultimately increases the yield.

With the objective of obtaining dwarf phenotype in sponge gourd Zhao *et al.* (2021) conducted an experiment and reported the first dwarf mutant WJ209in their study which possesses small cell size and internodes. Dwarf character in plants is reported to be obtained if the genes in GA synthesis or signal transduction are mutated. BSA-Sequence strategy which they adopted revealed a dwarf mutant gene which was designated by Lacd1 from a dwarf mutant of sponge gourd *i.e.* WJ209. Sequencing analysis done by them also disclosed an insertion of approximately 4 kb in the first intron of the Lacd1 gene in WJ209 as a result of which transcription of the Lacd1 gene occurred in an incorrect way that resulted in reduced amount of bioactive GAs in WJ209 causing dwarfism in sponge gourd.

6. **Recent molecular marker approach in improvement of *Luffa* vegetables:** Trivedi *et al.* (2015) conducted a morphological and molecular analysis in sponge gourd seeds treated with biofield energy and revealed that the plants developed from the treated seeds showed better performance with healthy leaves, fruits, and less incidence to insect-pest with strong, thin leaves, and uniform colour having higher immunity content as compared to control. In addition, fruits obtained from treated sponge gourd showed antigravity property during its early stages along with strong stem when compared to the control plants. The true polymorphism (%) witnessed between the treated and control samples also showed significant difference with a conclusion suggesting that such biofield energy treatment has the capacity to create genetic modification in the plant character which can be useful in future crop improvement programmes.

   Kaur *et al.* (2021) in their research on identification of molecular markers linked to yellow mosaic disease resistance loci in an F_2 population obtained from a cross between susceptible variety 'Arka Prasan' and resistant variety 'IIHR-Sel-1' of ridge gourd reported that among all molecular markers used in the experiment, primers named LaRGAP 63 led to production of polymorphic DNA fragment that segregated with yellow mosaic disease reaction phenotypically in F_2 population. Such primers will be beneficial in introgression of resistance loci in future for fruitful outcome.

7. **Recent hybridization approach in improvement of *Luffa* vegetables:** Inter specific hybridization has played a vital role in the introgression of several beneficial traits from the wild species to the cultivated one in countless vegetable crops (Manzur *et al*., 2015; Katche *et al*., 2019). Similarly, interspecific hybridization with the aim of transferring useful characters was carried out between sponge gourd and Satputia. The normal cross between sponge gourd and Satputia resulted in some inferior undesirable outcome such as minimum fruit setting percentage, minimum fruit developed per cent, total seeds per fruit, develop seeds per fruit *etc.* while, when the cross was undertaken in a reciprocal manner between the same parents it showed positive outcome. Similarly, introgression of desirable characters such as gynoecious and cluster bearing in sponge also appeared after backcross and two triple cross progenies. Such study resulted in initial introgression of cluster bearing, gynoecism and high yield in sponge gourd that can further be improved through backcross breeding (Sidhu and Kaur, 2021).

8. **Recent approach in sponge gourd fibre improvement:** Al-Mobarak *et al.* (2018) studied improvement in mechanical properties of sponge-gourd fibers through different chemical treatments such as sodium hydroxide, acetic anhydride and benzoyl chloride at

different concentrations (5-15 wt %) and revealed that the tensile strength, elastic modulus and thermal stability of the fibers increased significantly after the chemical treatment.

9. **Recent approach in *Luffa* vegetables quality improvement:** Based on a de novo assembly of public transcriptome data Saensuk *et al.* (2022) identified betaine aldehyde dehydrogenase (LcBADH) gene responsible for enhancing an aroma (2-acetyl-1-pyrroline) in sponge gourd and through interspecific hybridization they transferred LcBADH gene using the AroLuf marker from the sponge gourd to the ridge gourd for improving the aroma in fruits of ridge gourd. They concluded that such marker can be used in improving the aroma characteristics in *Luffa* species.

Table 3: Recent Achievements in Luffa Vegetables (last 5 years)

Ridge gourd			
Variety	**Developed from**	**Specific characters**	**Source**
Kashi Shivani (VRRG-27)	IIVR	Variety possesses green foliage, medium vine length with high yielding capacity bearing fruit at every internode .Average fruit weight of the variety ranges from 100-150g with a yield potential of 180-200q/ha.	IIVR Annual Report, 2016-17.
IIHR Sel-18-13	IIHR	Superior one with respect to fruit weight, yield and quality.	IIHR Annual Report, 2020.
KRH-1	KAU	Highly heterotic variety with high yield (7.41kg/plant) developed by exploiting cytoplasmic genic male sterility. KRH-1 is a result of cross between male sterile female line (KAU-MS-LA 101) and male fertile male line LA-102.	Kumar and Ashwini, 2020.
Sponge gourd			
Variety	**Developed from**	**Specific characters**	**Source**
Pusa Shrestha	IARI	1^{st} F_1 hybrid of sponge gourd suitable for spring summer season. Average yield 19.5 t/ha.	IARI News, October-December, 2017
Thar Tapish	CIAH	Result of hybridization between AHSG-4 x AHSG-16. Suitable for abiotic stress condition such as high temperature. Yield potential is 14.22 – 15.58 t/ha	ICAR News (A Science and Technology Newsletter), 2018.
DSG-7	IARI	High resistance to Tomato Leaf Curl New Delhi Virus.	IARI Annual Report, 2020.

V. FUTURE PERSPECTIVE

1. Collection and identification of elite germplasms and its conservation.
2. Proper utilization of advance breeding techniques such as mutation breeding, polyploidy breeding, molecular markers techniques for fruitful outcome.
3. Development of suitable varieties resistant to low temperature.
4. Standardization of postharvest processes for maintaining the freshness and reducing the spoilage.

VI. CONCLUSION

Luffa vegetable being an underutilized cucurbitaceous vegetable crop is still unpopular due to lack of awareness regarding its nutritional and medicinal properties to the consumers. Therefore, such crops need to be explored in a better way for fruitful outcome which will also contribute to the overall horticultural production scenario of the nation. In addition, use of different crop improvement techniques such as evaluation and selection of varieties, its multiplication through various crop improvement techniques, use of advanced biotechnological approaches such as tissue culture, superior character or gene transfer, development of suitable varieties resistant to several biotic and abiotic stresses *etc.* can be adopted to obtain high and quality yield of *Luffa* vegetables which will not only favors sustainable vegetable production along with utilization of minor vegetable crops but also ultimately favours "Atma Nirbhar Bharat" which is a precious aim of the nation.

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