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Full Length Research Paper

Study on changes of nutritional and organoleptic quality of flavored candy prepared from aonla (*Emblica officinalis* G.) during storage

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Aonla is an important crop indigenous to Indian subcontinent which is used in alternative medicine, health foods and herbal products. It has got great potential in processed forms but little information is available regarding the dehydration and storage quality of aonla. The aonla fruits of each cultivar (Krishna, NA-7, NA-10 and Chakkaiya) were washed and blanched in boiling water containing 2% alum for 8 to 10 min. The segments were separated after cooling the fruits in tap water. The segments were stepped for 24 h in successively increasing concentration of sugar syrup (50 to 70^{0}B); added flavors of ginger and cardamom in syrup having 70^{0}B for three days. The excess syrup drained out and the segments were dried in cabinet drier. The segments were packed and stored under ambient conditions. The nine months storage study revealed that the moisture content in the candy was found to decrease with storage. It decreases from an initial value of about 16% to a final value of about 14% at the end of storage. All the treatments reduced vitamin C content candy. The tannin content of the various aonla candies was statistically significant with respect to aonla varieties. Total soluble solids, acidity, total reducing and browning was found to increase with storage period, while the non reducing sugar was decreased with storage period. On the basis of organoleptic evaluation and biochemical characters concluded that the candy prepared from cv. Krishna and flavored with cardamom powder found to be the best aonla candy.

Key words: Aonla, dehydration, drying, blanching, candy.

INTRODUCTION

Fruits are amongst the first food items known consumed prehistorically by human beings. Fruits, whether fresh or dried, have always formed a part of the staple diet of human beings because they are rich in nutrients and provide some of the essential minerals, vitamins, and the like, apart from that, they also help in curing a number of diseases. Aonla, among fruits commonly known as Indian Gooseberry (*Emblicaofficinalis.* Gaertn syn. *Phyllanthus emblica* L.) finds a special place in India as it has got tremendous medicinal values. It belongs to the family Euphorbiaceae and comprises about 350 (Hooker, 1973) to 500 species (Baileri, 1917). Aonla has been cultivated in India since time immemorial (Singh et al., 2009). Besides India, naturally growing aonla trees are also found in different parts of the world, *viz*. Sri Lanka, Cuba, Puerto Rico, China, Thailand and Japan. Aonla is a rare example of an edible material, which is rich in tannins as well as ascorbic acid (Kalra, 1988). The vitamin C content in aonla varies from 200-900 mg /100 g depending upon the variety and size of the fruit (Anonymous, 1988; Barthakur and Arnold, 1991).

Aonla is presently an underutilized fruit, but has enormous potential in the world market. It is almost

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Table 1. Physical characteristics of different aonla cultivars.

Cultivars	Weight (g)	Stone (%)	Fiber (%)	Moisture (%)
Krishna	44.7	4.90	1.90	83.4
NA-7	48.1	4.30	1.10	84.7
NA-10	44.8	5.13	1.30	84.5
Chakaiya	30.7	4.20	2.00	85.6

entirely unknown in the world market and needs to be popularized. Aonla is being exported under the category of Ayurvedic and Unani herbs. Its medicinal and nutritional properties and culinary uses need to be highlighted. The fresh fruits are generally not consumed as it is highly acidic and astringent; therefore it is not a popular table fruit. But, it has got great potential in processed forms (Nayak et al., 2011). Hence attention has been focused on the preparation of different value added products from aonla. Aonla can be made into various products such as pickles, preserve (murabba), sauce, jam, jelly, dried chips, tablets, etc.

Aonla candies are becoming more and more popular because of high acceptability, minimum volume, higher nutritionally value and longer storage life. These have additional advantage of being least thirst provoking and ready to eat snacks. The dried products save energy, money and space in packaging, storage and transportation. Plain aonla candies have now been fused with other richly valuable and effective herbs like tulsi, mint etc. Herbal inclusion not only gives a new flavor but also enriched the candy with more medicinal qualities. In present investigation an attempt has been made to evaluate a product, aonla candies, prepared from fruits of different aonla cultivars and flavored with different herbs.

MATERIALS AND METHODS

Mature aonla fruits of cultivars Krishna, NA-10, NA-7 and Chakaiya were procured from the experimental farm of Central Institute for Subtropical Horticulture, Lucknow, India. Matured, uniform sized and disease free fruits of each variety were selected. Fruits were washed in running water to remove adherent dirt (Figure 1).

Ginger

Fresh ginger rhizomes were washed thoroughly in running water and peeled manually. They were then grated using grater and dried in the sun for 3 to 4 days until the ginger was fully dried and then powdered using a grinder.

Cardamom

Pods of green cardamom (*Elettaria subulatum*) were opened and the seeds collected and grated. The biochemical parameters, *viz*. total soluble solids (TSS), acidity, vitamin-C, tannin, total sugar, reducing sugar, non-reducing sugar were estimated in fruits and the product, however non-enzymatic browning was estimated only in the product (Ranganna, 1997). The product was also assessed organoleptically on the 9 point Hedonic scale as described by Ranganna, (1997). The data were analyzed statistically and reported at the 5% significance level (Panse and Sukhatme, 1961).

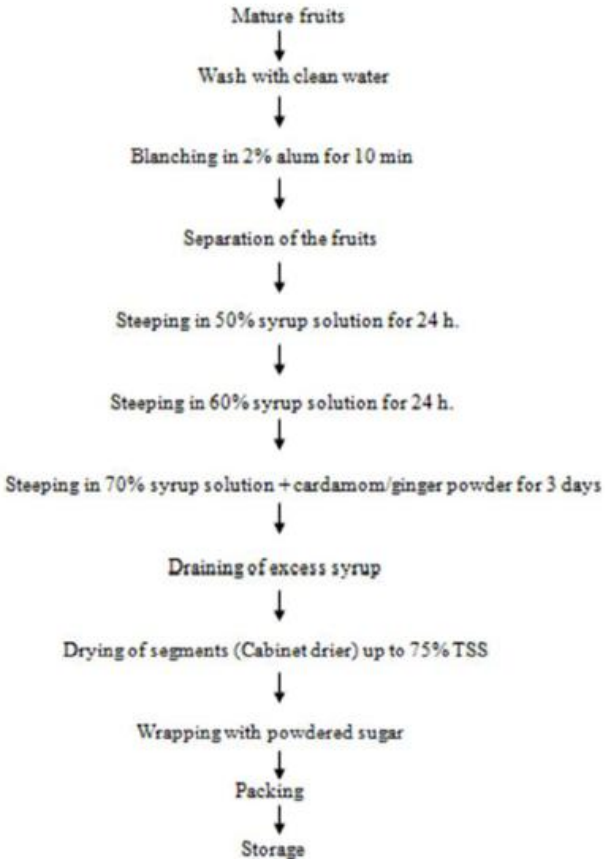

Figure 1. Flow chart for preparation of Aonla candy.

RESULTS

The physical characters of the fresh aonla fruits clearly indicate that there were significant differences between the aonla cultivars in terms of physical and biochemical characters (Table 1). Average weight of fruit varied from 30.7 to 48.1 g. The maximum average fruit weight was recorded in cv. NA-7 (48.1 g), while the minimum fruit weight was recorded in cv. Chakaiya (30.7 g). The stone percentage varied from 4.20 to 5.13%. The fibre content

Table 2. Chemical characters of fresh fruits of different aonla cultivars.

Cultivars/Characters	TSS (^{O}Bx)	Titratable acidity (%)	Ascorbic acid (mg/100 g)	Tannins (%)	Total sugars (%)	Reducing sugars (%)	Non-reducing sugars	Non-enzymatic browning
Krishna	11.0	1.5	339	1.54	9.1	1.7	1.7	0.03
NA-7	9.3	1.7	238	1.81	6.8	1.5	1.4	0.04
NA-10	9.5	1.8	285	1.80	6.8	1.6	1.4	0.04
Chakaiya	9.7	1.7	309	1.73	7.4	1.6	1.4	0.03
CD at 5%	0.63	0.17	1.7	0.06	0.17	0.17	0.006	NS

Table 3. Effect of aonla cultivars and flavor on moisture content (%) of aonla candy during storage.

Cultivars	Flavors	Storage period (days)			
		0	90	180	270
Krishna	Cardamom	16.85	16.40	15.65	14.95
	Ginger	16.75	16.05	15.35	14.80
NA-7	Cardamom	16.55	16.15	15.70	15.20
	Ginger	16.85	16.40	15.70	14.95
NA-10	Cardamom	16.60	15.90	15.30	14.80
	Ginger	16.90	16.25	15.65	15.10
Chakaiya	Cardamom	16.75	16.10	15.60	14.75
	Ginger	16.65	16.15	15.60	15.20
CD (5%)		NS	NS	NS	NS

of fruits ranged between 1.10 to 2.00%. The highest fibre content was recorded in cv. Chakaiya (2.0%) and the lowest in cv. NA-7 (1.1%). The moisture content of aonla cultivars differed significantly, and ranged from 83.4 (cv. Krishna) to 85.6% (cv. Chakaiya). The data of biochemical characters for fresh fruits are shown in the Table 2. The total soluble solids (TSS) content of fresh fruits ranged from 9.3 to 11.0^{O}Bx. Cultivar Krishna showed maximum TSS content (11.0^{O}Bx), which was significantly higher compared to other cultivars. The minimum TSS content was obtained in cv. NA-7 (9.3^{O}Bx). A significant variation in acidity was also observed in different cultivars of aonla. Acidity in fresh fruit ranged from 1.5 to 1.8%. Fresh fruits of cv. Krishna recorded maximum vitamin C (339 mg/100 g), while the minimum was recorded in cv. NA-7 (238 mg/100 g). The tannin content in all the fruits differed significantly and ranged from 1.54 to 1.81% in fresh aonla fruits. The highest total sugar (9.1%) was observed in fresh fruits of cv. Krishna, while lowest (6.8%) in cv. NA-7 and NA-10. The highest reducing sugar content was recorded in fresh (1.7%) as well as blanched fruits (1.4%) of cv. Krishna, while lowest in fresh fruits of cv. NA-7 (1.5%). The non-reducing sugar in all the cultivars differed significantly, and ranged from 1.4 to 1.7%.

Changes in biochemical characters during storage of the product

The moisture content of various aonla candies prepared from different aonla cultivars was recorded during storage as shown in Table 3. The data revealed that the moisture contents of the various aonla candies were statistically nonsignificant with respect to aonla varieties. The moisture content decreased with an increase in storage period. After 270 days of storage, the moisture content decreased from an intial range of 16.5 to 17.2% to a final of 14.7 to 15.4%.

The organoleptic evaluation of the product was assessed on the basis of color, appearance, texture and taste and the overall average (Table 6). Generally, a decrease in the quality of the product was recorded during storage. However, in some treatments a slight improvement in quality was observed after storage. The product from all the treatments was acceptable even after

270 days of storage. In the beginning, the product from cv. Krishna flavored with cardamom scored highest (8.3), while product from cv. NA-10 scored lowest (7.3). An improvement in organoleptic quality (average score) was noticed in the candy prepared from cv. Chakaiya flavoredwith cardamom during storage. However, the overall organoleptic quality of the product prepared from cv. Krishna (cardamom) was the best throughout the storage period followed by candy from cv. Krishna (ginger) and cv. Chakaiya (cardamom).

DISCUSSION

The average weight of aonla fruit harvested in this investigation varied from 30.7 to 48.1 g. Ghorai and Sethi (1996) recorded an average fruit weight of 43.5 g for cv. Krishna. Singh and Pathak (1987) mentioned an average fruit weight of 38.2 g. Singh et al. (2004) recorded maximum fruit weight in cv. NA-10. The difference in average fruit weight might be due to varietal characteristics and agro-climatic conditions in which they are growing. The stone percentage varied from 4.20 to 5.13 and its content was lowest in cv. Chakaiya (4.20%). Singh et al. (2005) reported maximum seed weight in cv. Krishna. The lowest fibre content in present investigation was recorded in cv. NA-7 (1.1%) and highest in cv. Chakaiya (2.0%). Teaotia et al. (1968) reported that the fibre intensity varied from slightly fibrous to highly fibrous and little variation existed in stone percentage of aonla cultivars. Sharma et al. (1989) observed 3 to 4% fibre in aonla fruits, which seemed to be the highest value reported in literature. Singh et al. (2004) have reported that cv. Chakaiya has the highest (1.93%) fibre content which is consistent with our results. The moisture content of aonla cultivars ranged from 83.4 to 85.6%. Pathak et al. (2003) reported that moisture content ranged from 85.2 to 87.7% in various aonla cultivars. A variability in physical composition of aonla cultivars have also been reported by many other workers (Pathak, 1988; Sharma et al., 1989; Deen, 1992), which might possibly be due to differences in genetic characters of cultivars, soil, cultural practices and climatic conditions.

The chemical composition recorded in different cultivars of aonla varied significantly (Table 4). The total soluble solids (TSS) content of fresh fruits ranged from 9.3 to 11.0ºBx, whereas cv. Krishna showed maximum TSS in fresh fruits followed by cv. Chakaiya. The TSS content of aonla fruits varied widely depending on the variety and climatic conditions. Therefore, different aonla cultivars harvested at full maturity differ significantly in TSS content. Variability of TSS content in aonla cultivars was also reported by (Sharma et al., 1989; Deen, 1992; Singh, 1999). Our findings are relatively close to those of Singh and Pathak (1987), who reported 10.7 and 10.2% TSS in fresh fruits of Krishna and Chakaiya cultivars, respectively. Similarly, Singh et al. (2004) reported TSS content of 9.4% in cv. Chakaiya, while Singh and Arora (1967) reported slightly higher TSS (10.9%) in cv. Chakaiya. In present study, differences in the content of titratable acidity were also observed in different aonla cultivars. Titratable acidity in fresh fruits ranged from 1.5 to 1.8%. Organic acids are responsible for sourness of fruits. Variability in titratable acidity was also reported by Singh (1997). The data recorded on titratable acidity of cvs Chakaiya and Krishna in present study is in close conformity to the findings of Singh and Pathak (1987), who observed 1.5 and 1.2% titratable acidity in Chakaiya and Krishna cultivars of aonla, respectively. Pathak (1988); Singh and Singh (1994) have reported higher values for titratable acidity than the present findings which might be due to variation in agro-climatic conditions or stage of harvest. Fresh fruits of cv. Krishna recorded maximum ascorbic acid content (339 mg/100 g) followed by cv. Chakaiya (309 mg/100 g). Ascorbic acid plays an important role in human nutrition and due to this reason aonla fruits are preferred by the community not only as a table fruit but in a processed form too. In aonla cultivars, ascorbic acid content varies from place to place and variety to variety. The ascorbic acid content in aonla fruits grown world-wide ranged from 200 to 1800 mg/100 g of fruit pulp (Ram, 1983). Singh (1982) have reported 500 to 750 mg/100 g ascorbic acid in different aonla cultivars. Meghwal and Azam (2004) have reported highest ascorbic acid content in cv. Krishna which supports our findings. The differences in ascorbic acid content of fruits in present study and those reported in literature may be attributed to various factors including agro-climatic conditions in which fruits are grown and the maturity of fruits. The tannins content ranged between 1.54 to 1.8% in fresh fruits. The minimum content of tannins was found in cv. Krishna followed by cv. Chakaiya. Aonla is a rare example of fruits which is rich in tannins. Variability in the content of tannins was also reported by Jain et al. (1983); Srivastava and Kumar, (1994). Our findings are in close conformity to those of Mehta et al. (2005), who reported 1.51 and 1.40% tannins in cvs Krishna and Chakaiya, respectively. The total and reducing sugars recorded in fresh fruits ranged from 6.8 to 9.1 and 1.5 to 1.7%, respectively. The total and reducing sugars were most abundant in cv. Krishna followed by cv. Chakaiya in fresh fruits. Taeotia (1968) has reported 7 to 9% total sugars and 1 to 4% reducing sugars in various cultivars of aonla. Singh et al. (1993) observed a slight higher value of reducing sugars in different aonla cultivars and lower values for total sugars, while Mehta et al. (2005), recorded higher values for total and reducing sugars as compared to data obtained in the present study. This might be due to variation in climatic conditions, maturity stage and varietals characteristics.

The moisture content of the various aonla candies was statistically non-significant with respect to aonla varieties. The moisture content here was also found to decrease with an increase in storage period. The decrease in

Table 4. Effect of aonla cultivars and flavors on biochemical characters of prepared candy during storage.

Cultivars/ Characters	Flavors	TSS (°Bx)				Acidity (%)				Vitamin C (mg/100 g)				Tannin (%)			
		Storage period (days)				Storage period (days)				Storage period (days)				Storage period (days)			
		0	90	180	270	0	90	180	270	0	90	180	270	0	90	180	270
Krishna	Cardamom	75.2	75.9	77.3	130.4	0.48	0.51	0.55	0.62	132.8	102.0	83.8	57.0	0.22	0.21	0.18	0.17
	Ginger	75.2	75.8	77.4	132.8	0.49	0.50	0.56	0.63	130.4	99.4	83.8	55.7	0.22	0.20	0.19	0.17
NA-7	Cardamom	75.2	76.2	78.0	115.4	0.49	0.52	0.58	0.66	115.4	94.5	73.2	47.3	0.23	0.21	0.20	0.18
	Ginger	75.1	76.0	77.7	114.0	0.52	0.55	0.61	0.69	114.0	95.2	74.0	47.2	0.24	0.22	0.19	0.17
NA-10	Cardamom	75.1	75.8	76.7	104.9	0.55	0.56	0.62	0.75	104.9	90.5	68.7	43.7	0.22	0.20	0.18	0.17
	Ginger	75.1	75.8	76.8	106.6	0.56	0.59	0.66	0.74	106.6	88.8	66.8	44.1	0.22	0.20	0.18	0.17
Chakaiya	Cardamom	75.2	75.7	77.2	127.3	0.50	0.54	0.63	0.68	127.3	96.5	77.7	52.8	0.22	0.21	0.19	0.18
	Ginger	75.2	75.8	77.1	126.2	0.53	0.57	0.64	0.71	126.2	100.1	66.2	52.2	0.24	0.22	0.20	0.19
CD (5%)		-	0.005	0.14	0.11	0.012	0.014	0.016	0.014	2.66	0.76	1.84	0.96	0.005	0.003	0.002	0.002

Table 5. Effect of aonla cultivars and flavors on biochemical characters of prepared candy during storage.

Cultivars/ characters	Flavors	Total sugar (%)				Reducing sugar (%)				Non-reducing sugar (%)				Non-enzymatic browning (OD at 440 nm)			
		Storage period (days)				Storage period (days)				Storage period (days)				Storage period (days)			
		0	90	180	270	0	90	180	270	0	90	180	270	0	90	180	270
Krishna	Cardamom	66.6	65.8	68.1	68.2	38.1	40.0	42.2	44.3	28.5	27.2	26.0	25.3	0.04	0.11	0.14	0.16
	Ginger	66.4	65.6	67.7	69.1	37.5	38.7	42.0	44.2	28.3	27.7	25.4	25.1	0.05	0.12	0.15	0.17
NA-7	Cardamom	66.5	66.4	68.1	69.5	36.5	37.6	40.4	43.0	27.8	27.4	26.9	25.4	0.04	0.10	0.13	0.15
	Ginger	66.5	66.4	68.1	69.8	37.2	39.1	41.3	43.5	28.4	27.5	26.4	25.1	0.05	0.12	0.15	0.17
NA-10	Cardamom	64.9	64.2	66.2	67.4	35.0	36.5	37.1	39.5	29.2	28.9	28.1	27.5	0.05	0.12	0.14	0.16
	Ginger	64.3	63.8	66.4	67.5	35.5	36.8	38.2	40.4	29.1	28.6	28.2	27.1	0.05	0.13	0.15	0.18
Chakaiya	Cardamom	65.1	64.2	66.5	67.8	36.1	37.8	40.1	42.3	28.2	27.3	26.1	25..2	0.04	0.10	0.13	0.16
	Ginger	64.5	64.0	66.5	67.6	36.6	38.4	40.8	42.8	28.3	27.4	25.9	25.1	0.05	0.12	0.15	0.17
CD (5%)		NS	NS	NS	NS	NS	NS	NS	NS	0.26	0.24	0.38	0.40	NS	NS	NS	NS

Table 6. Effect of aonla cultivars and flavors on sensory quality of prepared candy during storage.

Cultivars/ characters	Flavors	Color				Appearance				Texture				Taste				Overall average (Out of 9)			
		Storage period (days)				Storage period (days)				Storage period (days)				Storage period (days)				Storage period (days)			
		0	90	180	270	0	90	180	270	0	90	180	270	0	90	180	270	0	90	180	270
Krishna	Cardamom	8.6	8.2	8.0	7.8	8.2	8.0	8.8	8.8	8.2	8.0	8.8	8.8	8.4	8.2	8.4	8.4	8.3	8.1	8.5	8.2
	Ginger	8.0	7.8	6.8	7.0	7.8	7.6	7.4	7.2	7.8	7.0	7.8	8.2	7.6	7.2	7.3	7.1	7.8	7.2	7.4	7.6
NA-7	Cardamom	7.5	7.5	7.8	6.8	7.7	7.0	7.2	7.0	8.2	6.8	7.0	6.8	7.8	7.1	6.8	6.6	7.8	7.1	7.2	6.8
	Ginger	7.5	7.0	7.0	6.3	7.5	7.0	7.0	6.8	7.8	7.0	7.0	6.8	7.2	6.6	6.6	6.1	7.5	6.9	6.9	6.5
NA-10	Cardamom	7.7	7.0	7.2	7.0	7.5	7.5	7.8	6.8	7.5	7.0	7.0	6.3	7.6	7.0	6.8	6.4	7.5	7.1	7.2	6.6
	Ginger	7.5	7.0	7.0	6.8	7.2	6.6	6.6	6.1	7.4	7.0	7.0	6.1	7.4	6.8	6.4	5.8	7.3	6.8	6.7	6.2
Chakaiya	Cardamom	8.0	7.8	7.2	7.0	7.8	7.6	7.4	7.2	7.6	6.8	8.0	8.4	7.8	7.0	7.8	8.2	7.8	7.2	7.4	7.6
	Ginger	7.8	7.6	7.4	7.2	7.5	7.5	7.8	6.8	7.8	7.0	7.0	6.8	7.8	7.1	6.8	6.6	7.7	7.3	7.2	6.8
CD (5%)		0.05	0.07	0.09	0.05	0.05	0.05	0.03	0.04	0.04	0.05	0.07	0.06	0.05	0.04	0.04	0.05	0.07	0.06	0.05	0.04

moisture content in the various aonla candies with an increase in storage period might be due to the evaporation of moisture from the product. Decrease in moisture with storage of candies were also reported by Tripathi et al. (1988) in aonla candy, Mehta et al. (2005) in galgal peel candy and Rani and Bhatia (1985) in pear candy.

TSS gradually increases with increase in storage period. This might be due to conversion of polysaccharides into sugars during hydrolysis process. Increase in TSS might also be attributed to the reduction in moisture content of the product with storage. Increase in TSS with storage was also found to be reported by Tandon et al. (2003); Tripathi et al. (1988); Kumar and Singh (2001) in aonla candy, Manivasagan et al. (2006) in karonda candy and Rani and Bhatia (1985) in pear candy. Acidity content did not change in the beginning of storage, thereafter it increased during storage. Pectic acid has been reported to increase the acidity in fruit products, hence, degradation of pectic substances into soluble solids might have contributed towards an increased in acidity of aonla products. An increase in acidity with storage period has also been observed in aonla preserve. Similar findings were also observed by Sethi (1980); Kumar and Singh (2001) in aonla products. These results were contrary to the results obtained by Rani and Bhatia (1985); Tripathi et al. (1988) in which the acidity decreases with storage. The ascorbic acid content of the products decreased continuously during storage.

Reduction in vitamin 'C' could be due to oxidation by trapped oxygen in the jars which results in formation of dehydroascorbic acid. Loss in ascorbic acid content was also observed by Sethi (1980) in aonla preserve, Tripathi et al. (1988) in aonla products, Rani and Bhatia (1985) in pear candy and Kumar and Singh (2001) in aonla products. Decrease in ascorbic acid content might be attributed to the increase in Tannin. Decrease in tannin content was also reported by Mehta and Tomar (1979); Jain et al. (1983); Tandon et al. (2003). The total sugars, reducing sugars and NEB (non-enzymatic browning) increased gradually in candy during storage, while non-reducing sugar and sensory quality decreased in the product prepared from all the varieties flavored with different herbs.

On the basis of the observations recorded on various biochemical characters and organoleptic quality, it is clear that cv. Krishna and cardamom flavor is most suitable for the preparation of quality product candy. Cultivar Chakaiya could also be used for product preparation. Hence, a processed product of good quality could be made only from good quality raw material. The cultivar selection is one of the most important factors for preparation of a quality product. Thus, the cultivar

evaluated showed great potential for becoming a commercial cultivar of processing industry.

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