



Enrichment on quality of aonla (*Emblica officinalis* G.) fruit bars by blending

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Abstract: The main objective of the study was to standardize enrichment of aonla pulp to develop fruit bars. The experiment was laid out in Completely Randomized Design (CRD) with 10 treatments. Aonla pulp was blended with 25 to 75% of different fruit (mango, papaya and jackfruit) pulp viz. Aonla pulp, Aonla with mango, papaya and jackfruit in different proportion of 3:1, 1:1 and 1:3 each fruit respectively. The initial moisture content was higher in aonla pulp enriched with mango pulp in 1:3 proportions. Enrichment of aonla pulp with fruit pulp of mango, papaya and jackfruit reduced the ascorbic acid, titratable acidity and tannin content of the resultant fruit bars compared to that from pure aonla pulp, which is an indication in the reduction of astringency. Enrichment also resulted in an increase in total soluble solids, reducing, non-reducing and total sugars of the resultant fruit bars. Enrichment of aonla pulp with fruit pulp of provitamin A rich fruits like mango, papaya and jackfruit showed a rise in total carotenoids and reduced astringency and acidity, thereby resulting in fruit bars with altered palatability and enhanced nutrition. Enriched fruit bars contained three vital antioxidants viz. Vitamin C, carotenoids and polyphenols of all the treatments, enriched fruit bar containing 25 % aonla and 75 % mango (T₄) was found superior in organoleptic evaluation.

Keywords: Aonla, Fruit bar, Nutritional properties, Sensory evaluation

INTRODUCTION

Aonla (*Emblica officinalis* G.) is valued for its nutritional qualities and pharmacological properties which belongs to the family Euphorbiaceae. It is a store house of vital antioxidants like ascorbic acid, polyphenols and is also a rich source of minerals like Fe, Ca, K etc. (Jain and Khurdiya, 2002). These qualities of aonla are utilized in the Ayurvedic and Unani systems of medicines, curing common cold, gastric troubles, acidity and scurvy (Tandon *et al.*, 2003), bronchitis, diabetes, diarrhoea, jaundice and dyspepsia (Bhosale *et al.*, 2000). It has proven to possess immensely high amount of nutritional benefits as well as therapeutic properties, but still regarded as a minor and under exploited fruit crop. The fruits are the second richest source of vitamin C among fruits after Barbados cherry (*Malpighia glabra* L.) (Singh *et al.*, 2006). Due to high acidity and astringency, the fruit is not to be relished in the fresh form. Aonla fruits can be used either fresh or in powdered form in various preparations like *Triphala*, *Arishta*, *Chyavanprash* etc. The fruit is a potent antioxidant, antimicrobial (Ahmad *et al.*, 1998), hypolipidemic, antibacterial, anti-tumour (Jose *et al.*, 2001) antiviral, antacid, antidiabetic, anti-ulcerogenic activities etc. (Khopde *et al.*, 2001; Sairam *et al.*, 2002).

India is blessed with a variety of agro-climatic conditions and therefore, our country produces a wide range

of tropical, subtropical, temperate and arid zone fruits. Many minor fruits like aonla, bael, jamun, tamarind etc. are extensively cultivated in the arid zones of our country. Limited availability and high perishability are two major bottlenecks that demand its immediate post-harvest utilization. In spite of the rapid strides made in the release of new varieties and expansion of area under cultivation, considerable losses are encountered in aonla due to lack of suitable post-harvest management practices. The fruit cannot be stored beyond a week under ambient storage conditions. Therefore, suitable innovative techniques in packaging and storage are required to prolong the availability of this fruit. (Kirtikar and Basu, 1993). Diversification of processed products of aonla with altered palatability and enhanced nutrition has been attempted to make them available throughout the year. However, excellent nutritive, antioxidant and therapeutic values of the fruit can be tapped for developing good quality products. Value added products can be prepared from aonla fruit by converting it into various processed products by employing different methods of preservation (Kadam, 2001). Hence the present study deals with the preparation of a novel, value added and nutritious product from aonla. A suitable technique for enrichment in the development of fruit bars from aonla, with fruits that are good sources of provitamin A will result in enhanced nutrition and altered palatability.

MATERIALS AND METHODS

Experimental site: The present investigation on enrichment of aonla pulp to form fruit bars were carried out under laboratory condition in the Department of Processing Technology, Kerala Agricultural University in the year 2013-14.

The experiment was carried out with *aonla* fruits of the local variety and fruits of papaya (Red Lady), jackfruit (Then Varikka) and mango (Bangalora) were procured from the fruit market, Thrissur.

Preparation of fruit bars from pure *aonla* pulp and blended pulp: Fruit bars were prepared from pure *aonla* fruit and also from blended fruit pulp in which pulp of *aonla* was mixed in different ratios with mango (*Mangifera indica*), papaya (*Carica papaya*) and jackfruit (*Artocarpus heterophyllus*) pulp. The fruit pulp thus prepared was mixed with powdered cane sugar, which was ground in a grinder. The total soluble solids content of the pulp was raised to 35^oBrix and the acidity of the pulp was adjusted to 0.6 per cent. Clean stainless steel trays, smeared with vegetable oil were taken and the prepared pulp was spread on these trays to a thickness of 10mm. These trays were loaded into a cabinet drier maintained at 58 ± 2^oC. The pulp was dried to a thickness of 5 mm. After drying to optimum moisture content, the dried pulp was cut into bars.

Treatments	Preparation of fruit bars
T ₁	<i>Aonla</i> pulp (100%)
T ₂	<i>Aonla</i> (75%) + Mango (25%)
T ₃	<i>Aonla</i> (50%) + Mango (50%)
T ₄	<i>Aonla</i> (25%) + Mango (75%)
T ₅	<i>Aonla</i> (75%) + Papaya (25%)
T ₆	<i>Aonla</i> (50%) + Papaya (50%)
T ₇	<i>Aonla</i> (25%) + Papaya (75%)
T ₈	<i>Aonla</i> (75%) + Jackfruit (25%)
T ₉	<i>Aonla</i> (50%) + Jackfruit (50%)
T ₁₀	<i>Aonla</i> (25%) + Jackfruit (75%)

Physico- chemical characteristics of fruit bar viz:

Total soluble solids (TSS) were estimated by hand refractometer (0-32^oB). The readings obtained were calibrated against a standard temperature at 20^oC as per the International Temperature Correction Table and expressed as ^oBrix. The moisture content was determined by drying a known weight of the sample at 50 -60 ^oC to a constant weight and expressed as per cent (Ranganna, 1997). Acidity and ascorbic acid were determined by standard method (AOAC, 1990) and results were expressed as percentage citric acid and mg/100 ml of juice respectively. Total sugars, reducing and non-reducing sugars were estimated by the Lane and Eynon volumetric methods (AOAC, 1990). Tannin content was determined by colorimetric method (Ranganna, 1997) using a standard curve of tannic acid. Total carotenoids were measured by spectrophotometer (Ranganna, 2000).

Sensory evaluation: The products were judged by a panel of judges of different age groups for appearance, colour, flavour, texture, odour, taste, after taste and overall acceptability, based on a 9 point hedonic scale rating (Amerine *et al.*, 1965). A score of 5.5 and above was considered acceptable

Statistical analysis: Observations under each experiment were tabulated and analyzed statistically in a completely randomized design (CRD) as proposed by Panse and Sukhatme (1976). The treatments were ranked according to Duncan's Multiple Range Test (DMRT) as suggested by Duncan (1955). Data pertaining to organoleptic evaluation were analysed using Kendall's coefficient of concordance.

RESULTS AND DISCUSSION

Sensory evaluation: Based on the results obtained from sensory evaluation of fruit bars, best treatment was selected in accordance with the maximum score obtained for fruit bar from each combination of enrichment (Table 1). Increase in the proportion of fruit pulps of mango, papaya and jackfruit in *aonla* pulp in the preparation of enriched fruit bars resulted in higher scores for sensory properties. Significant differences among various treatments with respect to colour and appearance scores of *aonla* fruit bars were observed. T₄ (16.90) and T₇ (16.70) respectively had the highest sensory score, which might be due to permeation of higher amount of sugar in mango and papaya in *aonla* bars, which improved the colour and appearance. In texture, T₇ (7.50) and T₃ (6.80) got the highest sensory score, which may be due to enough moisture content in these fruits providing appropriate softness to the samples. T₄ had the highest sensory score in flavor (8.70), odour (8.40) and taste (9.05), respectively. Of all the treatments, enriched fruit bar containing 25 % *aonla* and 75 % mango (T₄) scored the highest values (8.60) for overall acceptability, which was on par with the treatment T₇ (25 % *aonla* + 75 % papaya) which had a score of 8.55. This could be due to better colour and appearance, texture and taste obtained by preparation of fruit bars with different fruits. Enrichment of *aonla* with jackfruit, in the preparation of fruit bar, was found inferior, based on scores observed in the organoleptic evaluation compare with the other product like blended with mango and papaya.. Fruit bar prepared from pure *aonla* pulp was also found unacceptable to the panel of judges because of its highly acidic and astringent nature.

Physicochemical characteristics of the *aonla* fruit bars moisture: The moisture content of the bars was recorded immediately after preparation. The result revealed that the treatment T₄ (25 % *aonla*+ 75 % mango) had the highest moisture content (17.17 %) and the lowest moisture content (13.23 %) was observed in the treatment T₁ (100 % *aonla*). This might be due to hygroscopic nature of sucrose and

Table 1. Mean sensory scores for the pure and enriched *aonla* fruit bars.

Samples	Appearance	Colour	Flavour	Texture	Odour	Taste	After taste	Overall acceptability	Total score
T ₁	6.40	3.95	3.80	4.70	4.50	6.50	3.55	4.35	37.75
T ₂	4.65	4.95	5.00	5.75	5.20	6.00	4.75	5.75	42.05
T ₃	5.45	7.10	6.20	6.80	5.35	6.70	5.65	5.80	49.05
T ₄	8.60	8.30	8.70	6.35	8.40	9.05	8.10	8.60	66.10
T ₅	2.75	3.60	4.55	5.30	4.55	5.05	5.45	4.90	36.15
T ₆	5.80	5.80	5.80	4.85	5.60	4.00	5.25	5.35	42.45
T ₇	8.00	8.70	8.00	7.50	7.65	6.65	9.10	8.55	64.15
T ₈	5.10	4.50	3.75	5.55	5.50	3.95	4.70	4.15	37.20
T ₉	3.85	3.70	3.10	3.95	3.60	3.50	3.25	2.90	27.85
T ₁₀	4.40	4.40	6.10	4.25	4.20	3.60	5.20	4.65	36.80
Kendal's W test	0.827	0.454	0.403	0.159	0.516	0.397	0.405	0.416	

glucose in mango, which absorbed moisture from the environment. Similar trend in moisture content was observed by Mir and Nath (2000) in mango bar enriched with desiccated coconut powder and soy protein concentrate, which contained 18.7 and 18.4 % moisture, respectively. However, Hemakar *et al.* (2000) evaluated a moisture content of 11.0 per cent in mango bars. Take *et al.* (2012) also reported moisture content in the range of 14.64-15.91 per cent in fortified sapota-papaya fruit bar. The maximum moisture content in sweet and spiced *aonla* segments were observed in sucrose treatments, which may be attributed to almost twice the molecular weight of sucrose compared with glucose, which resulted in roughly half the molecular concentration of sucrose solution, and therefore lower osmotic pressure than the glucose solution and thus less water loss (Panagiotou *et al.*, 1999). Garrote and Bertone (1989) also found that glucose and mixture of salt and sucrose improved water loss from fruits.

Titrateable acidity (%): Enrichment of *aonla* fruit pulp with fruit pulps of mango, papaya and jackfruit resulted in reduction of titrateable acidity in all enriched fruit bars as compared to that from pure *aonla* pulp. It may be due to higher content of TSS and sugars and lower acidity in the pulp of fruits used for enrichment. The treatment T₁ (100 % *aonla*) recorded highest acidity (0.313 %) and which was on par with the treatment T₈ (0.297 %) and T₅ (0.296 %) and significantly different from all other treatments and the lowest acidity (0.15 %) was recorded in T₁₀ (25 % *aonla* + 75 % jackfruit). Mishra *et al.* (2012) recorded 0.4 % titrateable acidity in enriched fruit bar from pulp of *aonla* and guava. Shanthi (2000) reported an acid content of 0.43 per cent in green gram enriched mango bar. Bhardwaj and Mukherjee (2011) observed similar reduction in acidity from 0.72 to 0.51 %, when kinnow juice was blended with juice of pomegranate and ginger. Decrease in acidity of *aonla* juice was also reported by Jain and Khurdiya (2004) when *aonla* juice was blended with fruit juices of apple, grapes and pomegranate in the preparation of RTS beverages.

Total soluble solids (⁰B): Enrichment of *aonla* pulp

with fruit pulps of mango, papaya and jackfruit increased the TSS content of fruit bars. The maximum TSS (53.33⁰Brix) was observed in the treatment of T₄ (25 % *aonla* + 75 % mango) while the treatment T₁ (100 % *aonla*) had the minimum TSS (45.23⁰ Brix). However, the TSS content in all the enriched fruit bars was significantly superior as compared to that of fruit bar from pure *aonla*. Increase in TSS was reported by Jain and Khurdiya (2004) when *aonla* juice was blended with fruit juices of apple, grapes and pomegranate in the preparation of RTS beverages. Shanthi (2000) reported a TSS content of 55.0⁰B in soy protein enriched mango bar. Bhardwaj and Mukherjee (2011) also reported an increase in TSS when kinnow fruit juice was blended with juice of pomegranate.

Sugars (%): Blending of *aonla* pulp with treatments resulted in an increase in reducing, non-reducing and total sugar content of fruit bars. Treatment T₄ (25 % *aonla* + 75 % mango) had the highest reducing sugar content (37.80 %) and the lowest (30.07 %) was in T₁ (100 % *aonla*). Non reducing sugar content was maximum (14.84 %) in T₆ (50 % *aonla* + 50 % papaya) and minimum (10.30 %) in T₁ (100 % *aonla*). Blending 25 % *aonla* pulp with 75 % jackfruit pulp (T₁₀) resulted in maximum total sugars (50.5 %) and the minimum (40.24 %) was in fruit bar from pure *aonla* pulp (T₁). Mir and Nath (2000) reported a reducing sugar content of 21.8 per cent in mango bar containing desiccated coconut powder. Hemakar *et al.* (2000) reported a total sugar content of 60.0 per cent in plain mango bar. Increase in total sugar content was also reported by Bhardwaj and Mukherjee (2011) in kinnow juice blended with pomegranate juice. Minimum levels of reducing, non-reducing and total sugars in fruit bar from pure *aonla* pulp may be due to the naturally low level of sugars in fresh *aonla* fruit.

Ascorbic acid (mg 100 g⁻¹): Ascorbic acid content of fruit bars from *aonla* showed a declining trend when enriched with fruit pulps of mango, papaya and jackfruit which may be due to the lower initial ascorbic acid content in the pulp of these fruits, as compared to pure *aonla* pulp. Maximum ascorbic acid content (85.34 mg) was observed in fruit bar from pure *aonla*

Table 2. Biochemicals attributes of enriched *aonla* fruit bars by blending.

Samples	Moisture (%)	Titratable acidity(%)	TSS (°B)	Reducing sugar (%)	Non-reducing sugar (%)	Total sugar (%)	Ascorbic Acid (mg/100g)	Tannins (%)	Carotenoids (mg/100g)
T ₁	13.23	0.31	45.23	30.07	10.30	40.24	85.34	7.34	0.22
T ₂	13.73	0.29	50.77	31.27	11.91	43.15	72.90	6.10	0.34
T ₃	14.40	0.26	51.30	34.50	13.23	47.64	58.77	5.08	0.69
T ₄	17.17	0.22	53.33	37.80	12.72	50.42	50.87	3.01	0.89
T ₅	15.70	0.29	50.53	30.25	10.21	40.45	64.41	5.08	0.27
T ₆	15.17	0.23	51.73	32.74	14.84	47.58	50.22	3.06	0.94
T ₇	16.60	0.19	52.27	37.07	12.95	50.04	31.00	1.56	1.33
T ₈	14.13	0.29	50.43	31.03	12.04	43.06	56.00	5.11	0.21
T ₉	15.33	0.28	51.40	31.69	11.91	43.65	54.17	4.06	0.34
T ₁₀	16.10	0.15	52.27	36.64	13.74	50.50	21.79	2.05	0.69
SE	1.055	0.004	0.077	0.029	0.019	0.007	0.383	0.008	0.009
CD	3.114	0.013	0.226	0.085	0.059	0.023	1.130	0.024	0.027

(T₁), which was significantly higher than that of the enriched fruit bars. Lowest ascorbic acid (21.79 mg) was observed in the treatment T₁₀(25 % *aonla* + 75 % jackfruit). Similar trend in declining of ascorbic acid content was observed in *aonla* based blended RTS beverages by Jain and Khurdiya (2004). Inyang and Abah (1997) also observed that with increase in proportion of orange juice, the ascorbic acid content of cashew apple juice decreased, when blended with orange juice. Maximum ascorbic acid retention in kinnow juice was reported by Bhardwaj and Mukherjee (2011) when it was blended with *aonla* juice.

Tannins (%): Tannin content of enriched fruit bars showed a decreasing trend when *aonla* pulp was enriched with mango, papaya and jackfruit. Tannin content of fruit bar prepared from pure *aonla* pulp (T₁) was the highest (7.34 %) as compared to all other treatments. Lowest tannin content (1.56 %) was observed in the fruit bar in which *aonla* pulp was enriched with 75 % papaya (T₇). *Aonla* is not only rich in vitamin C, poly phenols and minerals and also for tannins (Jain and Akhurdiya, 2000) in comparison to other fruits selected in present study. So decline in tannin content may be due to the lower initial tannin content in the pulp of these fruits. Mehta (1995) stated that the total tannins were found to be reduced in the blended pulp with other fruits would have happened as the action of enzyme polyphenoloxidase converting tannin into other products. Reduction in tannin content of cashew apple juice was reported by Inyang and Abah (1997), when it was blended with orange juice. Similar trend in decline of tannin was also observed by Mishra *et al.* (2012) when pulp of *aonla* and guava fruits was blended in 50:50 proportion.

Total carotenoids (mg 100 g⁻¹): Enrichment of *aonla* fruit bars with carotenoid rich fruit pulps resulted in an increase in the levels of total carotenoids in the enriched fruit bars which may be due to higher level of carotenoids in these fruits as compared to pure *aonla* pulp. The increase was significantly superior in all the treatments with increase in the proportion of mango, papaya and jackfruit. Enriched fruit bar containing 25 % *aonla* and 75 % papaya pulp (T₇) had the highest total carotenoids (1.33 mg) was the lowest (0.21 mg) in the fruit bar containing 75 % *aonla* and 25 % jackfruit pulp (T₈) which is on par with the fruit bar prepared from pure *aonla* pulp (T₁), which contained 0.22 mg of total carotenoids. Similar trend was observed by Mir and Nath (2000) in mango bar enriched with desiccated coconut powder and soy protein concentrate and Shanthi (2000) in mango bar enriched with green gram. Increase in carotenoid content in fortified sapota-papaya fruit bar was reported by Take *et al.* (2012).

Conclusion

It has been concluded that blending of *aonla* pulp with pulp of provitamin A rich fruits viz. mango, papaya

and jackfruit in different ratios indicated that the initial moisture content was higher (17.17 %) in *aonla* pulp enriched with mango pulp in 1:3 proportion. Enrichment also resulted in an increase in TSS (45.23⁰ Brix to 53.33⁰ Brix), reducing (30.07 % to 37.80%), non-reducing (10.30% to 14.84%) and total sugars (40.24% to 50.50%) of the resultant fruit bars from pure *aonla* pulp, may be due to the naturally low level of sugars in fresh *aonla* fruit. Fruit bars prepared from *aonla* pulp enriched with pulp of fruits containing provitamin A, showed a rise in total carotenoids (0.21mg/100gm to 1.33 mg/100gm), the increase being higher with greater proportion of the pulp of these fruits. Enrichment of *aonla* pulp with fruit pulp of mango, papaya and jackfruit reduced the titratable acidity, ascorbic acid (85.34 mg/100gm to 21.79 mg/100gm) and tannin content (7.34% to 1.56%) of the resultant enriched fruit bars as compared to that from pure *aonla* pulp, due to the lower initial tannin content in the pulp of these fruits as compared with *aonla*, which is an indication in the reduction of astringency. Enrichment of *aonla* pulp with fruit pulp of mango and papaya significantly improved acceptability with increasing proportion of these fruits. However, a reverse trend was observed when *aonla* was blended with jackfruit. Of all the treatments, enriched fruit bar containing 25 % *aonla* and 75 % mango (T₄) had higher acceptability score. Enrichment of *aonla* pulp with mango and papaya resulted in enhanced acceptability of the fruit bar.

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