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Preparation and storage stability of amla (*Phyllanthus emblica*) based instant pulihora mix - a South Indian traditional food condiment

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ABSTRACT

Amla (*Phyllanthus emblica Linn)* is an important crop, indigenous to Indian subcontinent, which is used in alternative medicine, health foods and herbal products. An attempt was made to add value to the highly perishable and seasonable raw material and produce a convenient, shelf stable instant mix for south Indian cuisines. The standardized instant amla pulihora mix (APM) consisted of amla powder (AP, 26%), roasted ground nuts, bengal gram, black gram, green chili, salt (18%) and spices. The titrable acidity of amla powder and amla pulihora mix was 15.1 and 6.4%, respectively. Amla pulihora mix was a rich source of Ca (191.18 mg/100 g), Fe (21.19 mg/100 g) and a considerable amount of proteins (11.2%). The total polyphenol content in amla powder and the amla pulihora mix was found to be 9989 and 3093 mg/100 g, respectively. HPLC analysis revealed that tannic acid and ascorbic acid contents of amla powder were 8102.1, 1601.21 mg/100 g, respectively, and ascorbic acid in amla pulihora mix was found to be 440.21 mg/100 g. Retention of ascorbic acid was higher in the amla pulihora mix (84%), when compared to amla powder (22%), over a storage period of six months. The antioxidant activity (IC_{50}) of amla powder and the amla pulihora mix, as assayed by DPPH and ABTS, were 0.7 and 0.2 mg/ml and 0.28 and 0.17 mg/ml, respectively. Sensory evaluation of the amla pulihora mix indicated that the product was highly acceptable, when mixed with cooked rice in the ratio of 1: 6.9 w/w. The shelf-life of the product was 6 months with a sensory acceptability score of 8. The equilibrium moisture content- relative humidity studies indicated that both the amla powder and amla pulihora mix were non-hygroscopic and stable at room temperature (28±2 °C) up to 6 months when packed in metalized polyester polyethylene pouches. Microbiological analysis indicated both products as safe for consumption up to 6 months storage.

Introduction

Amla (*Phyllanthus emblica Linn)* belongs to the family *Euphorbiaceae* and is native of tropical India and Southeast Asia, commonly named as 'Indian gooseberry'. It is harvested and available in abundance from December to February. The major amla producing states in India are Rajasthan, Uttar Pradesh, Gujarat, Tamil Nadu, Maharashtra, Andhra Pradesh, Karnataka and Bihar. Its nutritional, commercial and medicinal significance makes it popular all over the world (Goyal et al., 2007). It is an excellent source of ascorbic acid (300-900 mg/100 g), amino acids and minerals, along with phytochemicals such as polyphenols, tannins, emblicol, linoleic acid, corilagin, phyllemblin and rutin (Ghorai and Sethi, 1996; Jain and Khurdiya, 2004; Murthy and Joshi, 2007; Baliga and Dsouza, 2011). The fresh amla fruits are not popular as a table fruit due to their high astringency and its highly perishable nature (Kumar

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and Nath, 1993). Attention has been focused on the preparation of different value added products from amla which can have great demand in national as well as international markets. Owing to its excellent nutritional profile and physico-chemical properties, it is processed into different types of products and is generally utilized raw, cooked or in the form of a pickle. It is one of the main constituent of many ayurvedic preparations like Triphala and Chyawanprash (Pant et al., 2004; Mishra et al., 2009). During processing of amla there is a huge loss of vitamin C and other important biological components, which is the main disadvantage of developing a product from amla. Cold storage, sun drying, and hot air drying or processing to preserve, pickle, juice, syrup, squash and dehydrated powder are some processing techniques for enhancing shelf life and produce value added products (Sunil and Kaushik, 2012). Abishek et al. (2010) prepared a nutraceutical value added *supari* from amla fruit by osmotic dehydration.

Indian cuisines are a vast array of spicy delicacies. Presently, due to changing lifestyles, there is a considerable change in food habits of people with a strong demand for RTC (ready-to-cook) and RTE (ready-to-eat) foods (Sushant et al. 2021). Pickles and chutneys are popular condiments with rice, breakfast foods and snacks. Several standard blends of chutney powders for use in rice or breakfast foods based on tamarind leaf, raw tamarind, curry leaf, mint leaf, hibiscus species and raw mango are reported in the literature (Narsing Rao et al., 2008; Prasoona et al., 2020). Pulihora is a sour and spicy traditional product made from rice, tamarind extract and seasoning with oil and spices. It is popular in many South Indian households and is prepared in most of the Indian temples as prasadam (offering to God). To overcome the drudgery involved in the traditional practices, instant-mixes were introduced by using concentrated tamarind pulp/dehydrated tamarind powder, salt, fried spices and seasoning material (Sudharani et al., 2013). The present study was carried out for the standardization and quality evaluation of amla based instant pulihora mix.

Materials and methods

Materials

Amla fruits were purchased from local market in Hyderabad, Telengana. Other raw materials for the preparation of instant amla pulihora mix such as salt, rice, turmeric, curry leaf, green chili, red chili, black gram, bengal gram, mustard, cumin seeds, peanuts, asafoetida and oil were procured from the local supermarket. All the chemicals and solvents used in this study were of analytical grade and procured from M/s. SD Fine Chemicals Ltd, Mumbai. Ascorbic acid and tannin standards were procured from Sigma Aldrich Chemicals Pvt. Ltd, Bangalore.

Methodology

Preparation of Amla powder (AP)

Exactly 25 kg of amla fruits were purchased from the local market and thoroughly washed to remove dust and other extraneous materials. The fruits were soaked in sodium hypochlorite (0.1%) for about 30 min followed by washing and superficial drying at room temperature. Randomly selected 10 fresh fruits were taken for evaluation of physical parameters such as weight and diameter. The fresh fruit was evaluated for proximate composition (moisture, fibre, ash and fat) colour, brix, pH, acidity, sugars, total polyphenols, antioxidant activity, ascorbic acid, non-enzymatic browning and minerals (iron, phosphorous and calcium) as per standard methods (Ranganna, 2010). The cleaned amla fruits were cut along the vertical segments manually, with gloved hands, followed by pre-treatment with 1% KMS (potassium metabisulphite solution) for 5 minutes. The amla segments were then weighed, spread and dried in a tray drier at 55±5 °C for about 8-10 hrs. The dried segments were ground to a fine powder to pass through British Standard 30 mesh. The amla powder was stored in metallised polyester polyethylene (MPE) pouches for further analysis and product development.

Preparation of instant amla pulihora mix (APM)

Trials were carried out for the standardization of the composition of instant amla pulihora mix. Whole red chillies, peanuts and black gram were roasted individually in a pan using small quantity of groundnut oil. Cumin seeds were dry roasted to remove the raw odour and also to improve the flavour. Amla powder was mixed with salt, turmeric, red chilly powder, roasted chickpea, groundnut, whole red chili, mustard, cumin seeds, de-husked black gram, curry leaf and asafoetida. The composition of the mix was standardized by conducting various trials by varying the quantities of dehydrated amla powder, salt, pulses and other ingredients. The flow chart for the preparation of amla powder and amla pulihora mix is presented in Figure 1. The instant amla pulihora mix (APM) obtained was an acidulant ready mix for the application into cooked rice to yield highly acceptable pulihora.

Packaging, physico-chemical, sensory evaluation and storage studies of AP and APM

The AP and instant APM were evaluated for moisture, fibre, ash, fat, colour, acidity, protein, sugars, total polyphenols, antioxidant activity, ascorbic acid, tannins, non-enzymatic browning, minerals such as iron, phosphorous and calcium as per standard methods (Ranganna, 2010) at 0 days. Selected parameters, namely moisture, ascorbic acid by titrimetric method and HPLC, microbial quality, colour and non-enzymatic browning (NEB), were evaluated in AP at monthly intervals during the storage period of 6 months. The instant APM was evaluated for sensory attributes like colour, appearance, taste and overall acceptability by a trained panel of 10 judges on a 9 point Hedonic scale. The evaluation was conducted by mixing the instant APM with cooked rice in the ratio of 1:6.9 with small quantities of oil (10 g/100 g rice). The traditional tamarind based pulihora was served as control. The instant APM was packed in 100 g unit packs (14 cm × 12 cm) of metallized polyester-polyethylene laminated pouches and stored at room temperature (28 ± 2 °C) for six months. Selected parameters, namely moisture, free fatty acids (FFA), peroxide value (POV), ascorbic acid by titrimetric method and HPLC, microbial quality, colour using Hunter colorimeter (Model No.USVIS1417, Hunter Associates Laboratory, USA) and NEB by spectrophotometer, were evaluated at regular monthly intervals (1, 2, 3, 4 and 6 months) in instant APM during the storage period of 6 months.

Quantification of ascorbic acid and tannins by HPLC in AP and APM

Sample preparation, chromatography conditions, identification and quantification of ascorbic acid (vitamin C) by HPLC (Shimadzu LC 20 A, Kyoto, Japan) method was performed using the method described by ASEAN Manual of Food Analysis (2011). The mobile phase was 0.3 mM potassium dihydrogen phosphate in 0.35% orthophosphoric acid. The flow rate was maintained at 0.5 ml/ min using C18 column and detector wavelength was 248 nm. Tannic acid was analysed based on a method described in the literature (Pratik et al., 2016). The mobile phase was prepared by mixing methanol and water in the ratio of 50:50 and filtered through 0.2 µm filter using vacuum pump and sonicated for 30 min. C18 column was used with the flow rate of 1 ml / min and the detector wavelength was 270 nm.

Antioxidant activity

2,2-Diphenyl-1picrylhydrazyl (DPPH) and 2,2'-azino-bis(3-ethylbenzothiazoline, 6-sulphonic acid) radical scavenging activity of methanolic extracts of AP and APM were determined following the methods reported by Nanjo et al. (1996) and Yildrim et al. (2001), respectively. The IC_{50} values were computed as mg/ml of sample and presented.

Moisture sorption studies

Equilibrium relative humidity (ERH) data of the instant APM was carried out to assess the effect of various humidity conditions on the storage behaviour of the product. (Labuza, 1984). Moisture sorption isotherm was plotted by exposing the APM to varying conditions ranging between 10-100% relative humidity (RH) in glass desiccators maintained using sulphuric acid at room temperature (28±2 °C). The moisture uptake or losses in APM samples were measured at regular weekly intervals by weighing 5 g of mix in petri plates exposed to the above conditions until equilibrating to constant weight or until the appearance of fungal growth. Lump formation, discoloration or mould growth in the samples during the experiment were carefully monitored for determining the critical moisture content.

Microbiological studies

Microbiological quality of AP and instant APM was assessed during the storage period of 6 months. Aerobic mesophilic bacteria, yeast and moulds were determined by using pour plate technique (Bacterial Analytical Manual, 1998).

Sensory evaluation

The storage stability of the instant APM was carried out by subjecting it to sensory evaluation at monthly intervals (1, 2, 3, 4, 6 months) during the storage period of 6 months. The pulihora was rated for appearance, colour, flavor, taste and overall acceptability (Amerine et al., 1965).

Presentation of results and statistical analysis

The data were statistically analysed using the SPSS 19.0 software. Significant differences between the mean values were evaluated with one-way analysis of variance (ANOVA), followed by Tukey's post-hoc

multiple comparisons test. Results are presented as mean ± SD. A value of alpha level at $p < 0.05$ was considered to be statistically significant. If a pair of values is significantly different, the values have *different* superscript letters assigned to them in the results.

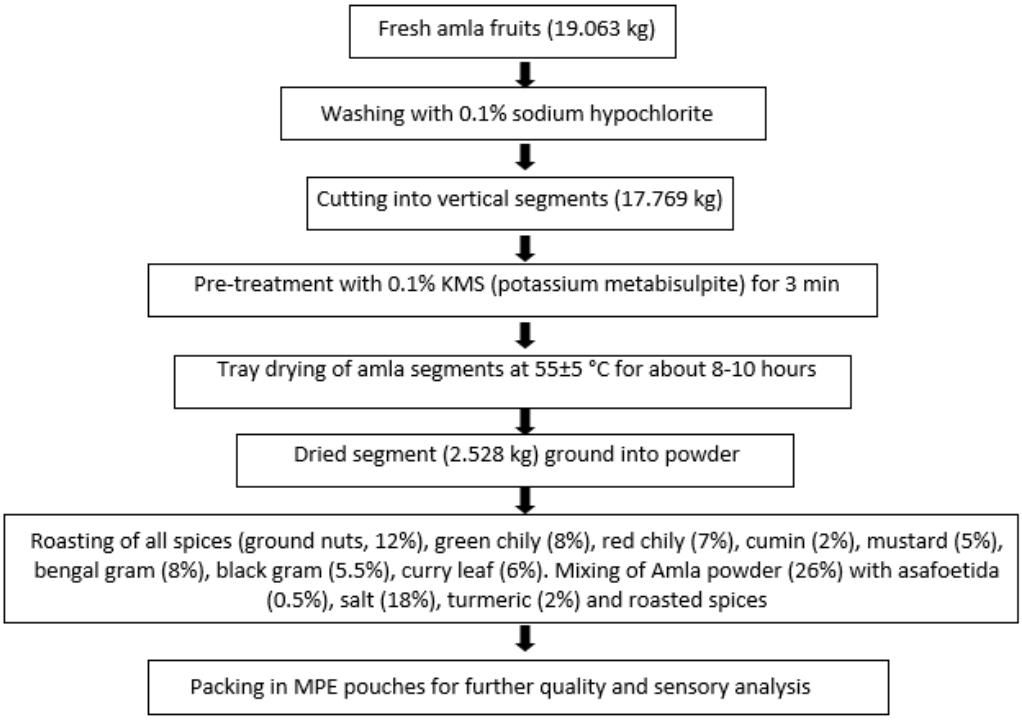

Figure 1. Flow chart for the preparation of instant amla pulihora mix

Results

Nutritional analysis of fresh amla fruit and AP

The proximate composition of the fresh amla fruit was analyzed and presented in Table 1. Data showed that fresh amla fruit contained 85.71% of moisture content, 0.33% of total mineral matter, 361.97 mg/100 g of ascorbic acid and 2662.27 mg/100 g of total polyphenols. The total soluble solids and acidity were found to be around 10 °B and 2.23%, respectively, in the selected amla fruits. The colour of selected amla fruits was light greenish yellow, with an average diameter and weight of 3.9 cm and 25-30 g, respectively. Dried amla powder is easy to store as it has long shelf life when compared to fresh amla fruit. Pre-treatment of fresh amla fruit with KMS before drying checks the enzymatic spoilage and also improves the colour and texture of the shreds (Prajapati et al., 2011). In the present study, amla slices were soaked in 0.1% KMS for 3 min before drying. The yield of amla powder on drying was 13%. The dried amla was ground and analyzed for its nutritional composition during the storage period of six months. The results are presented in Table 2. AP was found to be a good source of minerals such as calcium (132.25 mg/100 g), iron (10.43 mg/100 g) and phosphorus (75.22 mg/100 g). The total tannin content of AP was 8102 mg/100 g. The total polyphenol content in ethanolic extract of AP as estimated by using Folin-Ciocalteu reagent (Sadasivam and Manickam, 1996) was 9989. 47 mg/100 g of ascorbic acid, one of the most important quality parameters, and tannic acid in AP were quantified by HPLC (Figures 2 and 3). From an initial value of 1601.21 mg/100 g, ascorbic acid declined to 847.19 mg/100 g during the storage period of 6 months. During the initial months, the decline was slower followed by a sharp decrease during peak months of summer (April-June), which could be due to the temperatures as high as 45 °C. The retention of ascorbic acid was around 53% during the storage period of 6 months. The analysis of tannic acid showed 8102.1 mg/100 g in the amla powder. Another change observed in AP was in terms of slight increase in NEB. The presence of SO_2 as a preservative might have prevented the reactions leading to NEB. The increase in titrable acidity during storage was negligible.

Table 1. Physico-chemical composition of fresh amla fruit

Parameters	Fresh Amla
Moisture (%)	85.71 ± 1.300
Ash (%)	0.325 ± 0.005
Acidity (%)	2.23 ± 0.010
Titrable Ascorbic acid (mg/100 g)	361.97 ± 3.700
Polyphenols (mg/100 g)	2662.27 ± 23.500
Colour	L - 76.65 ± 0.150
	a - 1.19 ± 0.080
	b - 18.30 ± 0.210
Total Soluble Solids (Brix)	10.00º ± 0.000
Average Weight (g)	30.00 ± 0.900
Average Diameter (cm)	3.90 ± 0.210
Colour	Light Greenish Yellow

Values are mean ± SD

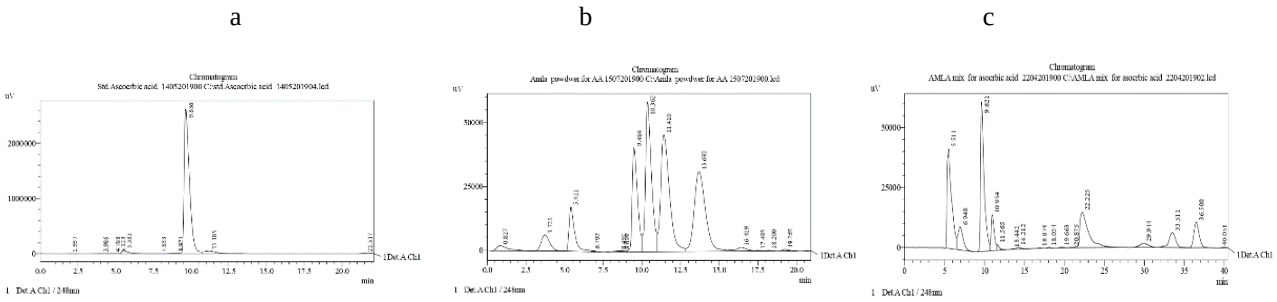

Figure 2. HPLC analysis of ascorbic acid
(a) Standard ascorbic acid; (b) Amla powder; (c) Amla pulihora mix

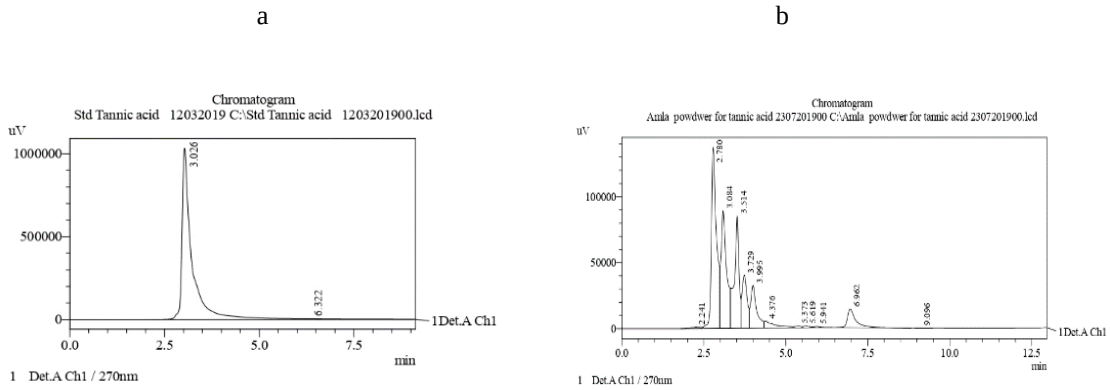

Figure 3. HPLC of (a) Standard tannic acid;
(b) Tannic acid in amla powder

Quality analysis of instant amla pulihora mix (APM)

The proximate composition, mineral content and total polyphenols are presented in Table 3. It was observed that the amla pulihora mix was a good source of protein (11.2%), fat (16.60%) and crude fibre (5.18%). Minerals such as Ca, Fe and P were found to be 191.18, 8.37 and 187.79 mg/100 g, respectively. Total polyphenols were observed to be 3092.65 mg/100 g. From an initial value of 425.83 mg/100 g, the ascorbic acid as quantified by HPLC (Figure 2) decreased to 401.64 mg/100 g during the storage period of 6 months.

The retention of ascorbic acid was around 94%. Only slight increase in NEB was observed, which can be explained to the presence of SO_2 as a preservative. The decrease in titrable acidity during storage was negligible. The slight decrease in acidity might have been due to the action of acids on starch during the formation of sugars.

Antioxidant activity

The antioxidant activity (IC_{50}), as assayed by DPPH for AP and instant APM, was 0.7, 0.2 mg/ml and by ABTS was 0.28 and 0.17 mg/ml, respectively (Figure 4). The higher activity of APM can be explained on the basis of other dried and roasted spice and seasoning ingredients. Among the assays, ABTS assay showed higher sensitivity for both AP and APM samples.

Moisture sorption, sensory and microbiological quality studies

The moisture sorption isotherm of AP and APM is presented in Figure 5. The curve starts rising above 56% RH indicating that the product deteriorates faster above 56% RH. The amla powder with an initial moisture content of 13.8 % equilibrates to 56% RH. The product equilibrating up to 32% RH with moisture content of 7.61% was found to be good. Product equilibrating to 44% with moisture content of 9.32% was good, and the product equilibrating at 56% RH with moisture content of 12.46% had a slight tendency for caking, but could be broken by applying little pressure.

Similar results were reported earlier in the moisture sorption characteristics of hazelnut kernel at 3, 10 and 30 degrees C, determined by the static gravimetric method (Lopez et al., 1995). At higher RH, the colour darkened and the product became soggy and developed moulds at 92% RH in 3 weeks time. Hence, the moisture content equilibrating to 64% RH was taken as critical for AP.

The moisture tolerance of the product is 14.54-12.37=2.17% (The difference between initial and critical moisture contents), respectively. The critical RH being low requires a high moisture barrier packaging material like MET/ PET/PE for a required shelf life of 6 months. In instant APM, the EMC-RH curve starts rising above 64% RH, indicating that the product deteriorates faster above 64% RH. The product with an initial moisture content of 3.51% equilibrates to 29% RH. The product equilibrating to 32% RH with moisture content of 3.90% was acceptable, based on free flowing nature. Product equilibrating to 44% with moisture content of 4.86% was good, and the product equilibrating at 56% RH with moisture content of 7.22% was good, but slightly dark in colour. At higher RH, colour darkened and the product became soggy and developed moulds at 92% and 86% RH in 3 and 4 weeks' time.

Hence, the moisture content equilibrating to 64% RH was taken as critical for instant APM. The moisture tolerance of the product is 7.22-3.51=3.71% (The difference between initial and critical moisture contents). The critical RH being low, the APM requires a high moisture barrier packaging material like MET/PET/PE and Al laminate for longer shelf life.

Results indicated that flavour, taste and overall acceptability of instant APM are significantly different over time at 5% level of significance. Sensory scores for the flavour, taste and acceptability reduced over the storage time of 6 months. The instant APM was acceptable to the sensory panelist for all the parameters such as colour, flavour, taste, and overall acceptability with a score of 8 (Table 4). The product was acceptable even after six months of storage when mixed with cooked rice in the ratio of 1: 6.9.

Microbiological quality

Total plate count (TPC) of AP and APM during the storage period of 6 months was 0 (NG) & (3 cfu/0.1 g), respectively. Yeast and mould were also within the critical limits (2 cfu/0.1 g) (Table 2).

Table 1. Storage studies of Amla powder

Parameter	0 days	1 Month	2 Months	3 Months	4 Months	6 Months
Moisture (%)	$13.8^{d} \pm 0.2$	$11.58^{a} \pm 0.13$	$11.47^{a} \pm 0.06$	$12.28^{b} \pm 0.09$	$12.37^{bc} \pm 0.06$	$12.62^{c} \pm 0.08$
Acidity (%)	$15.25^{a} \pm 0.06$	$15.23^{a} \pm 0.04$	$15.24^{a} \pm 0.06$	$15.33^{a} \pm 0.04$	$15.78^{b} \pm 0.09$	$15.84^{b} \pm 0.04$
Ash (%)	2.08 ± 0.05					
Protein (%)	2.66 ± 0.13					
Crude fibre (%)	3.62 ± 0.05					
Crude fat (%)	0.3 ± 0.02					
Calcium (mg/100 g)	132.25 ± 12.42					
Iron (mg/100 g)	10.43 ± 0.31					
Phosphorus (mg/100 g)	75.22 ± 4.55					
Tannic acid by HPLC (mg/100g)	$8102.1^{a} \pm 44.81$			$12943^{b} \pm 96.02$		$11343^{c} \pm 62.52$
Total Polyphenols (mg/100 g)	9989.5 ± 106.99					
Colour, L	$75.69^{e} \pm 0.25$	$65.74^{d} \pm 0.06$	$65.38^{d} \pm 0.22$	$62.2^{c} \pm 0.36$	$61.6^{b} \pm 0.05$	$58.66^{a} \pm 0.09$
Colour, a	$3.19^{a} \pm 0.04$	$5.65^{c} \pm 0.18$	$5.62^{c} \pm 0.04$	$6^{d} \pm 0.17$	$6.31^{d} \pm 0.17$	$5.13^{b} \pm 0.07$
Colour, b	$22.31^{d} \pm 0.17$	$20.32^{c} \pm 0.11$	$20.53^{c} \pm 0.04$	$19.51^{b} \pm 0.04$	$19.51^{b} \pm 0.03$	$14.32^{a} \pm 0.06$
Ascorbic acid (HPLC) (mg/100g)	$1601.2^{e} \pm 31.56$	$1549.7^{d} \pm 7.36$	$1505.8^{c} \pm 10.58$	$860.8^{b} \pm 7.2$	$847.2^{b} \pm 6.24$	$360^{a} \pm 7.81$
NEB (non enzymatic browning)	$0.28^{a} \pm 0.01$	$0.53^{b} \pm 0.03$	$0.67^{c} \pm 0.01$	$0.7^{cd} \pm 0.02$	$0.74^{d} \pm 0.01$	$1.07^{e} \pm 0.03$
Reducing sugars (%)	$18.68^{a} \pm 0.24$	$27.55^{b} \pm 0.95$	$27.84^{b} \pm 0.85$	$27.89^{b} \pm 1.3$	$27.89^{b} \pm 0.29$	$17.01^{a} \pm 0.22$
Total sugars (%)	$21.01^{b} \pm 0.52$	$27.78^{c} \pm 0.83$	$27.84^{c} \pm 0.65$	$27.97^{c} \pm 0.09$	$27.98^{c} \pm 0.22$	$18.97^{a} \pm 0.15$
Yeast & Mould (cfu/0.1g)	2 ± 0.00	2 ± 0.00	2 ± 0.00	2 ± 0.00	2 ± 0.00	2 ± 0.00

Values are mean ± SD. In a row, if a pair of values are significantly different, the values have different superscript letters assigned to them.
The analysis for 5 months storage have not been conducted due to variation in various parameters during monthly intervals found was not significantly different.

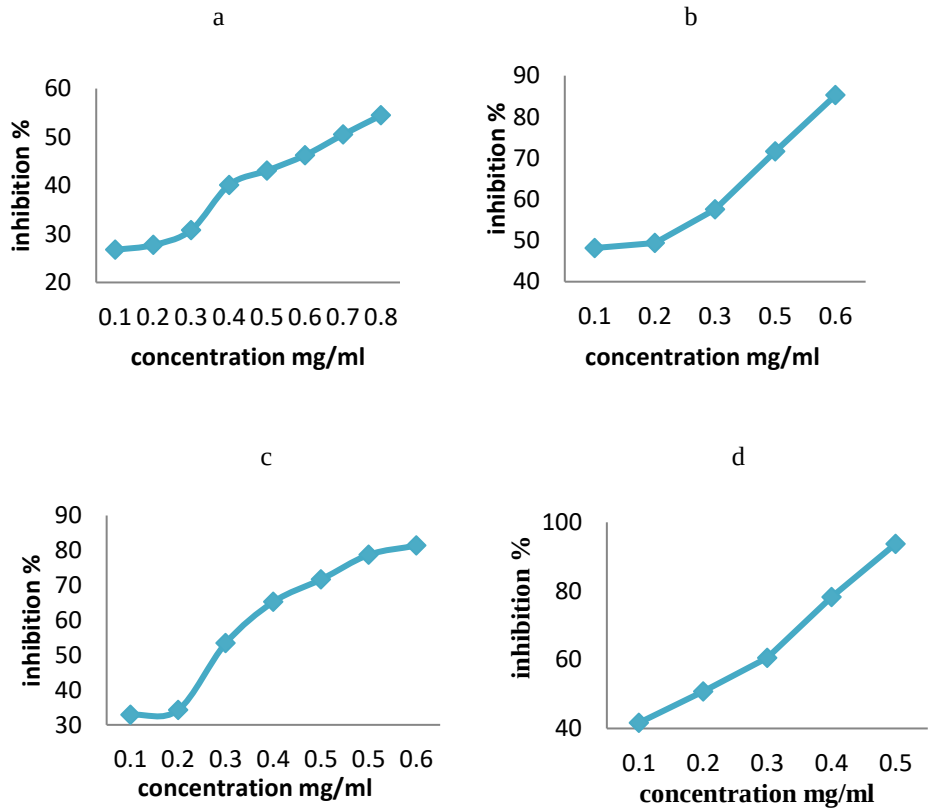

Figure 4. Antioxidant activity in Amla powder (a) DPPH assay; (b) ABTS assay and amla pulihora mix (c) DPPH assay; (d) ABTS assay

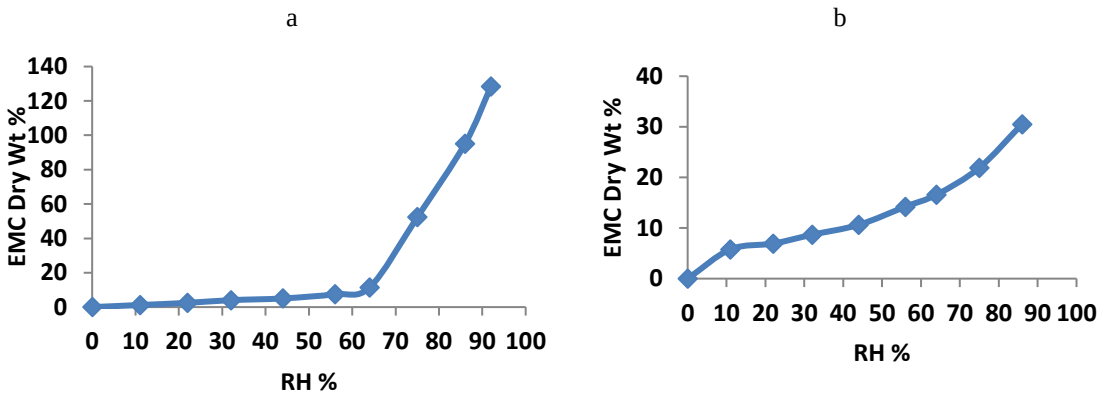

Figure 5. Moisture Sorption isotherm of (a) Amla powder; (b) Instant Amla pulihora mix

Table 2. Storage studies of instant amla pulihora mix

Parameter	0 days	1 Month	2 Months	3 Months	4 Months	6 Months
Moisture (%)	$3.17^{a} \pm 0.04$	$3.57^{b} \pm 0.05$	$3.76^{c} \pm 0.08$	$3.76^{c} \pm 0.06$	$3.83^{c} \pm 0.05$	$3.46^{b} \pm 0.08$
Ash (%)	22.05 ± 0.13					
Protein (%)	11.20 ± 0.1					
Fat (%)	16.60 ± 0.1					
Fibre (%)	5.18 ± 0.05					
Salt (%)	18.00 ± 0.17					
Phosphorus (mg/100 g)	191.17 ± 12.26					
Iron (mg/100 g)	8.37 ± 0.54					
Calcium (mg/100 g)	187.29 ± 12.06					
Polyphenols (mg/100 g)	3092.7 ± 22.72					
Acidity (%)	$5.52^{a} \pm 0.16$	$5.33^{a} \pm 0.23$	$6.04^{b} \pm 0.26$	$6.08^{b} \pm 0.08$	$6.13^{b} \pm 0.12$	$6.36^{b} \pm 0.08$
Ascorbic acid by HPLC (mg/100 gm)	$440.20^{a} \pm 11.28$	$425.83^{ab} \pm 9.94$	$418.23^{abc} \pm 8.0$	$403.47^{bc} \pm 2.58$	$401.6^{c} \pm 7.93$	$370.10^{d} \pm 7.23$
Non Enzymatic Browning (NEB)	$0.67^{a} \pm 0.07$	$0.69^{a} \pm 0.02$	$0.75^{a} \pm 0.03$	$0.78^{a} \pm 0.02$	$0.79^{a} \pm 0.10$	$0.83^{a} \pm 0.09$
Colour_L	$56.97^{a} \pm 0.15$	$58.26^{b} \pm 0.28$	$61.09^{c} \pm 0.12$	$61.34^{c} \pm 0.10$	$58.71^{b} \pm 0.29$	$58.41^{b} \pm 0.40$
Colour_a	$5.58^{a} \pm 0.05$	$11.93^{e} \pm 0.07$	$8.31^{bc} \pm 0.28$	$7.94^{b} \pm 0.1$	$8.94^{d} \pm 0.12$	$8.64^{cd} \pm 0.13$
Colour_b	$31.76^{a} \pm 0.07$	$33.19^{b} \pm 0.26$	$35.87^{d} \pm 0.72$	$34.42^{c} \pm 0.13$	$31.61^{a} \pm 0.17$	$31.21^{a} \pm 0.13$
Free fatty acids %	$0.68^{a} \pm 0.03$	$0.84^{ab} \pm 0.06$	$0.97^{bc} \pm 0.13$	$1.03^{c} \pm 0.02$	$1.07^{c} \pm 0.03$	$1.33^{d} \pm 0.06$
Peroxide value %	$3.53^{ab} \pm 0.36$	$3.19^{a} \pm .0.3$	$3.84^{abc} \pm 0.53$	$4.15^{bc} \pm 0.12$	$4.56^{c} \pm 0.07$	$6.15^{d} \pm 0.2$
TPC (cfu/g) x 103	$0.90^{a} \pm 0.04$	$1.00^{ab} \pm 0.09$	$1.10^{b} \pm 0.12$	$1.30^{c} \pm 0.03$	$1.30^{c} \pm 0.03$	$1.80^{d} \pm 0.03$
Yeast & molds (cfu/0.1 g)	3.00 ± 0.0	3.00 ± 0.0	3.00 ± 0.0	3.00 ± 0.0	3.00 ± 0.0	3.00 ± 0.0

Values are mean ± SD. In a row, If a pair of values are significantly different, the values have different superscript letters assigned to them

Table 3. Sensory evaluation of instant gooseberry pulihora mix

Parameter	0 days	1 Month	2 Months	3 Months	4 Months	6 Months
Appearance	$8.9^{a} \pm 0.32$	$8.8^{a} \pm 0.42$	$8.7^{a} \pm 0.67$	$8.5^{a} \pm 0.53$	$8.4^{a} \pm 0.52$	$8.4^{a} \pm 0.52$
Colour	$8.9^{a} \pm 0.32$	$8.8^{a} \pm 0.42$	$8.8^{a} \pm 0.42$	$8.5^{a} \pm 0.53$	$8.5^{a} \pm 0.53$	$8.5^{a} \pm 0.53$
Flavor	$8.5^{a} \pm 0.53$	$8.5^{a} \pm 0.53$	$8.5^{a} \pm 0.53$	$8.3^{a} \pm 0.48$	$8.1^{b} \pm 0.32$	$8^{b} \pm 0.00$
Taste	8.5b ± 0.53	8.5b ± 0.53	$8.1^{ab} \pm 0.32$	$8^{ab} \pm 0.00$	$7.9^{a} \pm 0.32$	$7.6^{a} \pm 0.52$
Overall acceptability	$8.9^{a} \pm 0.32$	$8.9^{a} \pm 0.32$	$8.5^{a} \pm 0.53$	$8.5^{a} \pm 0.53$	$7.9^{b} \pm 0.32$	$7.6^{b} \pm 0.52$

Values are mean ± SD. In a row, If a pair of values are significantly different, the values have different superscript letters assigned to them

Discussion

Fresh amla with a moisture content of 85% was dehydrated to yield amla powder with moisture content of 13.8%. The dried powder was rich in calcium (135.25 mg/100 g), phosphorous (75.22 mg/100 g), polyphenols (9985.9 mg/100 g) and ascorbic acid (1601.2 mg/100 g). Higher polyphenolic content in both amla powder and instant amla pulihora mix resulted in higher antioxidant activity. The reduction in ascorbic acid in amla powder was slower initially followed by a sharp decrease during peak months of summer, which could be due to the higher temperatures (40-45 °C) during summer months. The retention of ascorbic acid was around 53% during the storage period of 6 months. A similar observation was made by Bhattacharjee et al. (2014) in the spray dried amla powder. Fresh amla was found to have 6644.305 mg/100 g ascorbic acid when sun-dried, oven-dried and freeze-dried, having 748.427 mg/100 g, 641.364 mg/100 g,

791.233 mg/100 g, respectively, and bread made by the incorporation of amla powder at 1% was found to be acceptable (Dina et. al., 2019). The retention of ascorbic acid was higher in the pulihora mix when compared to the amla powder, which can be explained on the basis of matrix of other ingredients which may be having a protective action. The dehydrated amla powder was utilised in the preparation of amla pulihora mix with the addition of spices and other ingredients, which resulted in an acceptable mix with protein content of 11.2 %, fat 16.6%, crude fibre 5.18%, calcium 187.29, phosphorous 191.17 mg/100 g., and polyphenols 3092.7 mg/100 g. Sudharani et. al., (2013) prepared highly acceptable juice and instant soup mixes by blending of ash gourd and amla powders in various combinations. The equilibrium moisture and relative humidity data indicated the product as non hygroscopic and, hence, economical packaging material, such as HDPE or PE packaging, may be sufficient. The acceptability of the product was high for its taste and convenience even after 6 months storage. The microbiological analysis of the product indicated a product which is safe for consumption during 6 months storage.

Conclusions

In the present study, an attempt has been made to develop a novel product like instant amla pulihora mix (APM) by mixing of *amla* powder with other spices. The product was highly acceptable when mixed with cooked rice throughout the storage period. Value added products from amla fruit will not only open new dimensions for establishing commercial processing industries, but will also provide convenience and health benefits to consumers. The study clearly indicates the existence of a greater scope for developing novel, value added amla products. Such type of a novel product could improve the nutritional value of an Indian meal.

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