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Studies on development of mango roll (bar) without added sugar by blending technique

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Abstract
Blended mango fruit rolls(bars) without added sugar were prepared by blending Alphonso and Arka Udaya pulp at different ratio of 30:70, 40:60, 50:50, 60:40, 70;30, 100:0 and 0:100 respectively. Blended pulp then dried in a cabinet drier at 55 °C till the desired moisture content is achieved. The rolls were subjected to physico-chemical and sensory quality studies. The data was statistically analysed using Completely Randomized Design with 3 replications. The results indicated that blended Alphonso and Arka Udaya roll from pulp ratio 30:70 was found superior than other pulp ratios, having a good yield of 26.93% with moisture content 12.99%, water activity 0.524 and titratable acidity 0.238%. It improved the nutritive value with 104.82 mg/100g ascorbic acid content and 23.30mg/100g carotenoids per 100 g of prepared roll. Non-enzymatic browning (NEB) measured at optical density at 440 nm had 0.036 reading which was far below unacceptable level. From sensory quality studies, 9-point hedonic scale it was highly acceptable in terms of colour, texture, taste and over acceptability.

Keywords: Fruit roll, blended pulp, mango, alphonso, arka udaya, no-added sugar

1. Introduction

Mango (*Mangifera indica* L.), often referred to as the 'King of Fruits', is a globally cherished stone fruit belonging to the family Anacardiaceae and the order Sapindales. This succulent and aromatic fruit native to Southeast Asia, is known for its rich flavor, vibrant color, and juicy texture. Grown across tropical and subtropical regions worldwide, the mango holds a special place in the hearts and cultures of many countries. India is the largest producer of mango in the world, contributing about 41% of the total global production (FAO, 2022) [6].

Mango is both delicious and highly nutritious, serving as a rich source of vitamin A (4800 IU) and vitamin C (13 mg/100 g). It also provides essential nutrients such as protein, carbohydrates, fats and minerals like potassium and sodium. The pulp is particularly abundant in beta-carotene and natural sugars, including sucrose, glucose and fructose (Bayarri *et al.*, 2001) [3].

The Alphonso mango is renowned for its superior taste, texture and aroma, making up about 60% of India's mango exports (Mallik *et al.*, 2004) [13]. This fruit offers an excellent sugar-acid balance and strong flavour, making it popular both as a table variety and for processing, as it retains its flavour even during processing (Haldavnekar *et al.*, 2018) [10].

Arka Udaya is a hybrid cultivar developed by ICAR-IIHR, Bengaluru, resulting from a cross between Amrapali and Arka Anmol. The fruit has firm, deep yellow pulp, with an average weight of 230-250g. Pulp recovery is between 68% and 70%, and the shelf life ranges from 12 to 15 days.

Fruit leather is a dehydrated, ready-to-eat snack which can be an alternative to undesirable high- calorie snacks that are intense in sugars, fats, artificial colors, flavors, and chemical preservative and can be prepared from a single fruit/vegetable or with combination. (Aggarwal *et al.*, 2022; Ciurzynska *et al.*, 2019) [1, 4]. Processing fruits into fruit leathers serves not only to reduce postharvest losses but also to generate a novel range of value-added products with the potential for higher nutritional value compared to their fresh counterparts (Ofoedu, 2020) [15]. Fruit bar has to be prepared by the specifications of moisture less than 20.0%, total soluble solids less than 75.0%,

fruit content not less than 25.0% and yeast & mould count positive in not more than 100 count/gm as per 'Food Safety and Standard Authority of India (FSSAI, 2010) [7].

Blended fruit leather can serve as a rich source of health-promoting phytochemicals, offering a distinct taste and acceptability. Additionally, it demonstrates storage stability, ensuring safe consumption up to four months (Singh, 2020) [18].

The growing consumer preference for plant-based, clean-label foods has further increased the demand for healthy snack alternatives like fruit leather. Modern consumers look for foods that are free from synthetic colors, preservatives, and artificial sweeteners.

Alphonso mango pulp exhibits a desirable sugar-acid balance but faces limitations in texture. In contrast, Arka Udaya pulp demonstrates excellent bar-forming capacity, even without added sugar. Therefore, blending Alphonso with Arka Udaya pulp enables the development of a well-balanced mango roll with enhanced nutritional, flavour and textural property.

Hence, an experiment to standardize and evaluate different blends from two mango varieties for yield and quality of mango bar without added sugar was carried out.

2. Materials and Methods
The study was conducted at the Division of Post-Harvest Technology, ICAR-IIHR, Bangalore, using Alphonso and Arka Udaya mango varieties sourced from the institute's farm. Uniformly ripened and fruits free from physical and pest damage were selected. The fruits were washed with portable water, peeled, cut and pulped, homogenized using a mixer, and passed through a 1/32-inch sieve to obtain smooth pulp.

The pulp from Alphonso and Arka Udaya fruits were mixed at seven different ratios viz., T_1 -30:70, T_2 - 40:60, T_3 - 50:50, T_4 -60:40, T_5 - 70:30, T_6 - 100:0 and T_7 - 0:100 respectively. Preservative II (INS 224) was added at 1000 ppm to all treatments. The mixed pulp was uniformly spread as thin sheets on stainless-steel trays and dried in a cabinet drier at 55 °C until approximately 15% moisture content was achieved. The dried fruit bar was weighed and cut into 70 × 70 mm slabs, rolled and packed in pre-sterilized, labelled punnets. Samples were stored under ambient conditions (26-32 °C temperature, 58-62% RH) and fruit bar yield was recorded.

Blended dehydrated rolls were analyzed for various physico-chemical constituents as per methods described by A.O.A.C. (1995) and Ranganna (1991) [17]. Total Soluble Solids (°Brix) was recorded using handheld refractrometer (ATAGO, 0-93°Brix), water activity by water activity meter (Rotronic, Hygro Lab) and Carotenoids by UV visible spectrophotometer (Model T_{70}, PG Instrument). Sensory quality evaluation of blended mango was done by a panel of semi-trained judges by using 9- hedonic scale rating system. The experiment was laid out in completely randomized design comprising with 3 replications and statistically analyzed by critical difference (CD) test at 5% level of significance by using ANOVA (Gopinath et al., 2021) [9].

3. Results and Discussion
3.1 Yield/Recover percentage (%) and drying ratio
Table 1 presents the yield (%) and drying ratio of no added sugar blended mango rolls, which were significantly influenced by the blending ratios. The highest yield

(29.93%) was recorded in T_7 (100% Arka Udaya pulp) which may be due to higher Total Soluble Solids in Arka Udaya than Alphonso, followed by T_1 (30% Alphonso + 70% Arka Udaya), while the lowest yield (20.40%) was observed in T_6 (100% Alphonso pulp). Final dried yield across blended treatments ranged from 23.33% to 26.93%. The highest drying ratio (4.90) was noted in T_6 (100% Alphonso pulp) and the lowest (3.34) in T_7 (100% Arka Udaya pulp). This result is in conformity with the findings of Hemarkar et al. (2002) on blended mango-guava sheet and Singh et al. (2019), who reported significant variations in the yield and drying ratio of guava-papaya blends.

3.2 Physico-Chemical parameters of blended mango roll during storage at room temperature
Effects of blending on various physico-chemical characteristics of prepared rolls are presented in Table 2. Initial moisture content among various treatments ranged from 12.68 to 13.99% and was non-significant. This may be due to equal initial TSS content of pulp and uniform method of drying (Fulchand et al., 2015) [8]. Water activity and ranged from 0.505 to 0.567 and was non-significant. The highest acidity (0.498%) was observed in fruit rolls prepared from 100% Alphonso pulp (T_6), while the lowest (0.138%) was recorded in rolls made from 100% Arka Udaya pulp (T_7). Blended treatments exhibited intermediate acidity levels, ranging from 0.238% to 0.382% (Jahan et al., 2022) and Sukasih and Widayanti (2022) [12, 19].

The highest ascorbic acid content (114 mg/100 g) was recorded in fruit rolls made from 100% Arka Udaya pulp (T_7), while the lowest (83.40 mg/100 g) was observed in rolls made from 100% Alphonso pulp (T_6) as presented in Table 2. Blended treatments exhibited intermediate values, ranging from 92.58 to 104.82 mg/100 g. Carotenoid content ranged from 17.55 to 36.73 mg/100 g, with the highest observed in rolls made from 100% Alphonso pulp (T_6) and the lowest in 100% Arka Udaya pulp (T_7). Treatments with higher proportions of Alphonso pulp exhibited greater carotenoid levels, likely due to its inherently richer carotenoid profile. Blended Alphonso and Arka Udaya had improved ascorbic acid and carotenoids content due to contribution from both fruits. These results are in accordance with finding of Tiwari (2000) [20] where blended guava and papaya pulp increased Ascorbic content.

Lowest non-enzymatic browning 0.034 was observed in T_7 (100% Arka Udaya pulp). While highest 0.074 in T_6 (100% Alphonso pulp). However, the extent of non-enzymatic browning in all treatments was far below the unacceptable level. These are similar to the findings of Chen and Martynenko, 2018; Tontul and Topuz, 2017 [5, 21] where addition of potassium metabisulphite and additional ascorbic acid helped to achieved lower non-enzymatic browning.

3.3 Sensory quality studies:
Sensory evaluation showed that all combinations was acceptable as given in Table 3. The colour score indicated T_1 (30% Alphonso + 70% Arka Udaya) was superior to other with a maximum colour score of 8.2 which was at par with T_2, T_3, T_4 and T_5. While T_6 (100% Alphonso pulp) was least preferred. Highest texture and taste score was found in 30% Alphonso + 70% Arka Udaya roll (8.25) and (8.5) which was on par with T_2. Overall acceptability score indicated that fruit roll made by blending Alphonso and Arka Udaya at 30:70 ranked best in terms of colour, texture and taste (8.37) which was on par

with T_2 (7.62). These results are in conformity with the findings on organoleptic properties of wild apricot bar by Raju *et al.*, (2012) [16] and in mixed fruit leather from apple, banana and pineapple (Offia-Olua and Ekwunife, 2015) [14].

Fig 1: Blended Alphonso and Arka Udaya mango rolls without added sugar

Table 1: Effect of blending ratios of Alphonso and Arka Udaya pulp on yield and drying ratio of no added sugar blended mango roll

Treatment	Treatment pulp composition	Yield (%)	Drying ratio
T_1	Alphonso 30% + Arka Udaya 70%	26.93	3.71
T_2	Alphonso 40% + Arka Udaya 60%	26.53	3.77
T_3	Alphonso 50% + Arka Udaya 50%	25.27	3.96
T_4	Alphonso 60% + Arka Udaya 40%	24.80	4.03
T_5	Alphonso 70% + Arka Udaya 30%	23.33	4.29
T_6	Alphonso 100%	20.40	4.90
T_7	Arka Udaya 100%	29.93	3.34
	SEm ±	1.25	0.20
	CD at 5%	3.79	0.60

Table 2: Physico-chemical properties of blended Alphonso and Arka Udaya no added sugar mango roll

Treatment	Treatment pulp composition	Moisture content (%)	Water activity	TSS(°Brix)	Titrable acidity (100%)	Ascorbic acid (mg/100g)	Carotenoids (mg/100g)	NEB (OD at 440nm)
T_1	Alphonso 30% + Arka Udaya 70%	12.99	0.524	71.93	0.238	104.82	23.30	0.036
T_2	Alphonso 40% + Arka Udaya 60%	13.09	0.530	70.99	0.274	101.76	25.22	0.044
T_3	Alphonso 50% + Arka Udaya 50%	13.22	0.536	70.62	0.310	98.70	27.14	0.046
T_4	Alphonso 60% + Arka Udaya 40%	13.37	0.542	69.95	0.346	95.64	29.06	0.054
T_5	Alphonso 70% + Arka Udaya 30%	13.52	0.548	68.90	0.382	92.58	30.98	0.072
T_6	Alphonso 100%	13.99	0.567	67.61	0.498	83.40	36.73	0.074
T_7	Arka Udaya 100%	12.68	0.505	76.17	0.138	114.00	17.55	0.034
	SEm ±	0.65	0.03	3.48	0.02	4.92	1.44	0.036
	CD at 5%	NS	NS	NS	0.05	14.92	4.37	0.044

Table3: Sensory score of blended Alphonso and Arka Udaya no added sugar mango roll

Treatment	Treatment pulp composition	colour	texture	taste	overall acceptability
T1	Alphonso 30% + Arka Udaya 70%	8.20	8.25	8.50	8.37
T2	Alphonso 40% + Arka Udaya 60%	7.63	7.73	7.80	7.62
T3	Alphonso 50% + Arka Udaya 50%	7.60	7.47	7.53	7.42
T4	Alphonso 60% + Arka Udaya 40%	7.40	7.23	7.23	7.40
T5	Alphonso 70% + Arka Udaya 30%	7.37	7.14	7.12	7.27
T6	Alphonso 100%	6.20	6.23	6.90	6.63
T7	Arka Udaya 100%	6.92	7.07	7.02	6.97
	SEm ±	0.39	0.24	0.28	0.29
	CD at 5%	1.19	0.72	0.83	0.87
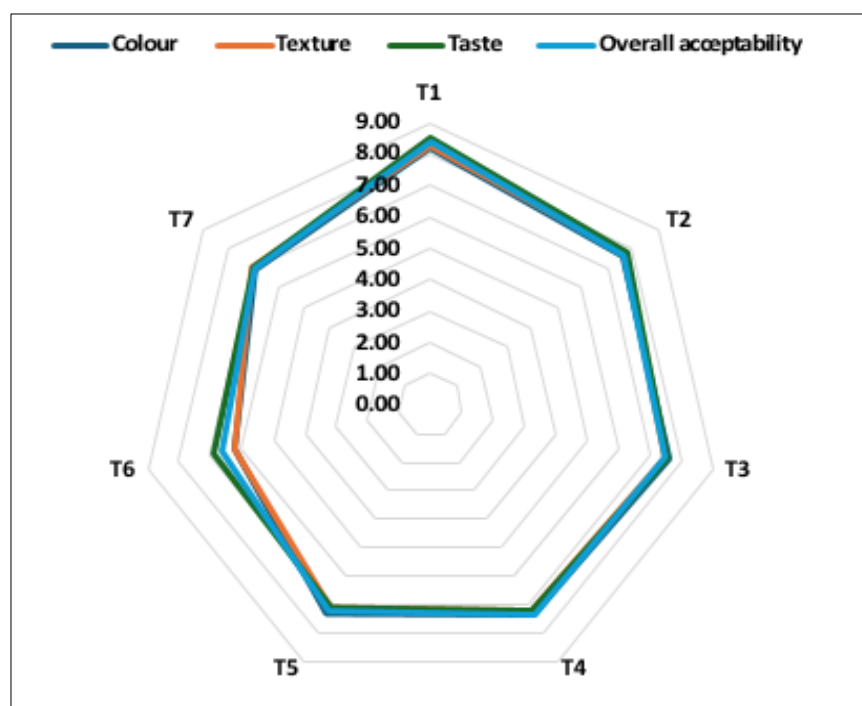
Fig 2: Sensory score of blended Alphonso and Arka Udaya no added sugar mango roll

4. Conclusion

In blended Alphonso and Arka Udaya fruit roll, physico-chemical and sensory evaluation showed significant differences with respect to yield, acidity, ascorbic acid, carotenoids, non-enzymatic browning, as well as sensory attributes such as colour, texture, taste and overall acceptability. Blended no added sugar fruit roll from Alphonso and Arka Udaya pulp 30:70 ratio (T1) was found superior to other treatments with good physico-chemical qualities, water activity 0.524 ascorbic acid 104.82mg/100g, carotenoids 23.30mg/100g and higher sensory qualities. Therefore, blending of Alphonso and Arka Udaya pulp for preparation of no added sugar mango roll has great potential and it can be successfully explored for making ready-to-eat fruit roll without added sugar.

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