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Value addition in wood apple (*Limonia acidissima* L.)

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Abstract
The present investigation "Study on Scope of Value Addition in Wood Apple (*Limonia acidissima* L.)" was undertaken to develop and asses the quality of fruit bars utilizing wood apple, pomegranate and dragon fruit in varying proportions. Physico-chemical properties of the developed fruit bars were studied during six months of storage at refrigerated condition with eleven treatments replicated thrice and data analysis was done following Completely Randomized Design. The moisture content of the blended fruit bars changed from18.00 per cent and 20.50 per cent to 15.08 to 16.38 per cent. The total sugar content was highest (22.84%) in the fruit bars blended with 60% wood apple and 40% pomegranate which showed an increasing trend and after six months was 24.51%. Total soluble solids (^{0} Brix) of the fruit bars showed an increasing trend throughout the storage period whereas ascorbic acid content of the fruit bars showed a decreasing trend during the period of study. The wood apple blended fruit bars were qualitatively and organoleptically accepted and fit for consumption up to 6month of storage at refrigerated condition.

Keywords: Fruit bar, physicochemical properties, storage duration, TSS, total sugar

Introduction
Wood apple is such an underutilized fruit, largely grown, rather seen mostly in eastern part of the state of Odisha. The wood apple, (*Limonia acidissima* L.) (Allen, 1967) is the only species of its genus, in the family Rutaceae is a dryland fruit. It is an ideal tree which can be exploited for growing in wasteland. Wood apple is a nutrient rich fruit which contains a remarkably high amount of protein (3-7g) and low levels of sugar and carbohydrates compared to many other fruits. In addition to that, the pectin content of the fruit pulp is 3-8%. The fruit pulp contains 31g of carbohydrate and 2g of protein, (per 100 g) which adds up to nearly 140 calories. It is rich in β carotene, a precursor of vitamin-A in addition with significant quantities of the vitamin B such as thiamine and riboflavin and small amounts of vitamin C. It also contains flavonoids, glycosides, saponins and tannins. There are some reports in which some coumarins and tyramine derivatives were also isolated from the fruits of wood apple (Ilango and Chitra, 2009) [6]. Fruits of wood apple are very well known for their medicinal properties due to its high nutritive value. Geda and Bokadia (1980) [5] reported antimicrobial activity of essential oil extracted from wood apple fruits and noticed its effectiveness against 12 different human pathogenic bacteria. Maiti and Mishra (2000) [9] also noticed the presence of antivenom activity in wood apple fruits. Wood apple in the form of chutneys or sherbet can be used in treating hiccups. It has been studied those fruits, leaves and stem bark of wood apple have anti-tumor and antimicrobial activity. Wood apple has anti-diabetic and antioxidant potential. It acts by reducing the blood glucose level and malondialdehyde (Patel *et al*., 2012) [10]. Fruit is much used as a liver and cardiac tonic in India. When unripe, it is used for treating diarrhoea and dysentery. In addition to this, wood apple also has hypoglycemic activity, anti-hyperlipidemic activity, wound healing activity, anticancer activity, diuretic activity, larvicidal and antimicrobial activity, hepatoprotective activity, anti-inflammatory, antipyretic and analgesic activity (Vidhya and Narain, 2011) [15].
Wood apple is a highly perishable and seasonal fruit, it can be preserved by processing into various value-added products like chutney, fruit bar, RTS, squash, nectar, pickle, jam, jelly, pulp powder to use it all round the year. The fruit may be eaten raw but it has a resinous taste so it requires sweetening. The ripe fruit pulp mostly used to prepare excellent chutney and it can also be consumed fresh adding sugar to it. (Anuradha K., 2015) [2]. A fruit with such diverse values and immense potentialities indicates its potential for processing into value added products and their commercialization.

But the fruit is being utilized to a limited extent in the preparation of products and there is very few detailed information are available for the systematic study on processing of wood apple and its organoleptic scores.
This study was, therefore, planned keeping all the above facts in view to use this nutritionally rich, cheap, underutilized, perishable and seasonal fruit by preserving it as fruit bar for best utilization of wood apple.

Materials and Methods

The experiment was carried out at the ICAR-IIHR Regional Centre, Central Horticultural Experiment Station and Post-Harvest Laboratory, Department of Fruit Science and Horticulture Technology&, Odisha University of Agriculture and Technology, Bhubaneswar, to prepare Wood apple blended fruit bar by taking 11 number of treatments and 3 replications with different combinations of3 fruits i.e. Wood apple (local cultivar), Pomegranate (Bhagwa), Dragon fruit (*Hylocereus monacanthus* i.e Red-fleshed Pitaya). The fruits bars are stored for 180 days and physicochemical analysis like moisture, TSS, ascorbic acid, total sugar were carried out at different intervals of 0, 60, 120 and 180 days. The experimental design was completely randomized design.

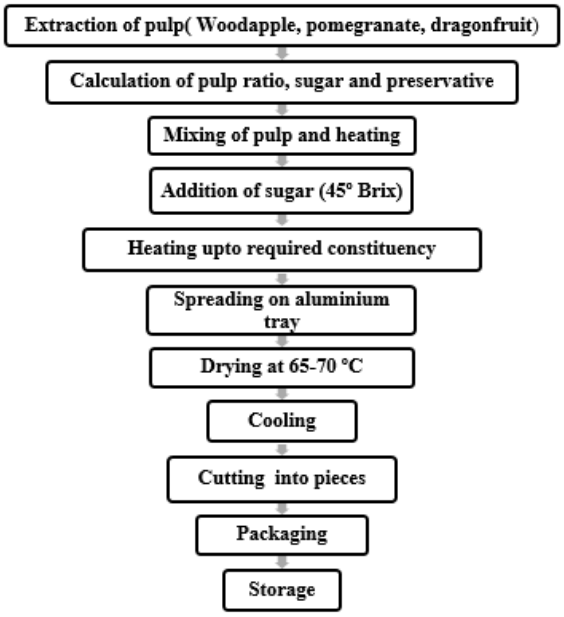

Chart 1: Method of Preparation of Wood apple blended fruit bar explained in the following flow chart

Result and Discussion

1. Effect of storage period (in days) on moisture content

The highest moisture content (20.5%) was observed in the wood apple fruit bar and lowest (18.00%) in the fruit bar prepared from 50 per cent wood apple, 40 per cent pomegranate and 10 per cent dragon fruit. A close perusal of data indicates that there was a decrease in moisture content of fruit bar with the advancement of storage period irrespective of blending ratios.
The decrease in moisture content may be due to evaporation of water from fruit bar during storage (Bhatt and Jha, 2015) [4]. These findings are also in conformity with observations made by other workers in case of guava leather by Safdar *et al*. (2014) [11].

Table 1: Effect of storage period (in days) on moisture content

Treatments	Initial	60	120	180
T1(100% Wood apple) Control	20.50	19.70	18.63	16.38
T2(90% Wood apple + 10% Pomegranate)	19.58	18.32	17.12	15.22
T3(80% Wood apple + 20% Pomegranate)	19.39	18.20	16.92	15.12
T4(70% Wood apple + 30% Pomegranate)	19.22	18.10	16.98	15.10
T5(60% Wood apple + 40% Pomegranate)	19.12	18.02	16.78	15.02
T6(90% Wood apple + 10% Dragon fruit)	18.22	17.58	16.38	15.28
T7(80% Wood apple + 20% Dragon fruit)	18.25	17.42	16.26	15.22
T8(70% Wood apple + 30% Dragon fruit)	18.12	17.35	16.18	15.19
T9(60% Wood apple + 40% Dragon fruit)	18.10	17.28	16.16	15.16
T10(50% Wood apple + 40% Pomegranate + 10% Dragon fruit)	18.00	17.22	16.10	15.11
T11(50% Wood apple + 30% Pomegranate + 20% Dragon fruit)	18.05	17.12	16.06	15.08
SE(m)	0.02	0.02	0.02	0.02
CD at 5%	0.04	0.05	0.05	0.06

2. Effect of storage period (in days) on TSS

There was gradual increase in the TSS content of the fruit bars during the storage period under study from initial to 6 months, irrespective of the treatments. The fruit bars, where pomegranate was used as a component, are found to contain more TSS, which might be due to the presence of comparatively more TSS in the pulp of pomegranate. The little increase in total soluble solids content during storage

might be due to conversion of insoluble to soluble fraction (Aradhitha *et al*., 1996) [3].

An increasing trend in TSS content during storage corroborates with the investigations on guava leather by Sandhu *et al.* (2001) [12], blending ratios of papaya and guava pulp by Jain *et al*. (2011) [7].

Table 2: Effect of storage period (in days) on TSS

Treatments	Initial	60	120	180
T1(100% Wood apple) Control	45.16	45.85	46.82	48.44
T2(90% Wood apple+ 10% Pomegranate)	45.21	45.92	46.91	48.62
T3(80% Wood apple + 20% Pomegranate)	45.30	45.96	46.95	48.67
T4(70% Wood apple + 30% Pomegranate)	45.38	46.12	47.05	48.71
T5(60% Wood apple + 40% Pomegranate)	45.12	46.25	47.12	48.82
T6(90% Wood apple + 10% Dragon fruit)	45.15	45.88	46.83	48.58
T7(80% Wood apple + 20% Dragon fruit)	45.12	45.82	46.78	48.53
T8(70% Wood apple + 30% Dragon fruit)	45.08	45.78	46.72	48.50
T9(60% Wood apple + 40% Dragon fruit)	45.04	45.76	46.70	48.48
T10(50% Wood apple + 40% Pomegranate + 10% Dragon fruit)	45.28	46.28	47.22	48.92
T11(50% Wood apple + 30% Pomegranate + 20% Dragon fruit)	45.32	46.32	47.27	49.05
SE(m)	0.10	0.02	0.03	0.02
CD at 5%	0.03	0.06	0.07	0.06

3. Effect of storage periods (in days) on ascorbic acid

During the initial stage, the ascorbic acid content varied from 5.22 mg/100g in the fruit bar prepared from only wood apple to 10.58 mg/100g in the fruit bar prepared from wood apple, pomegranate and dragon fruit in a ratio 5:3:2. It was observed that there was a gradual decrease in the ascorbic content of wood apple fruit bars with advancement of storage period (Table 3).

The decrease in ascorbic acid content might be due to oxidation of ascorbic acid to de-hydroascorbic acid followed by further degradation to 2, 3-diketogluconic acid and finally to furfural compounds.

Mandal and Sahoo, 2014 also reported the reduction in ascorbic acid content in the products which might be due to the oxidation of ascorbic acid in to dehydrate ascorbic acid by oxygen.

Table 3: Effect of storage period (in days) on ascorbic acid content

Treatments	Initial	60	120	180
T1(100% Wood apple) Control	5.22	4.82	4.22	3.64
T2(90% Wood apple + 10% Pomegranate)	7.28	6.98	6.48	5.90
T3(80% Wood apple + 20% Pomegranate)	7.72	7.40	6.92	6.35
T4(70% Wood apple + 30% Pomegranate)	7.89	7.51	7.04	6.48
T5(60% Wood apple+ 40% Pomegranate)	8.90	8.55	8.12	7.55
T6(90% Wood apple+ 10% Dragon fruit)	7.22	6.83	6.28	5.72
T7(80% Wood apple+ 20% Dragon fruit)	7.58	7.20	6.68	6.10
T8(70% Wood apple+ 30% Dragon fruit)	7.72	7.36	6.92	6.36
T9(60% Wood apple+ 40% Dragon fruit)	8.38	8.12	7.72	7.28
T10(50% Wood apple + 40% Pomegranate + 10% Dragon fruit)	10.22	9.95	9.58	9.12
T11(50% Wood apple + 30% Pomegranate + 20% Dragon fruit)	10.58	10.23	9.82	9.33
SE(m)	0.01	0.02	0.02	0.01
CD at 5%	0.04	0.05	0.04	0.04

4. Effect of storage period (in days) on total sugar

It is observed that at initial stage, maximum sugar content (22.84%) was found in T5 followed by in the fruit bars of combination 70 per cent wood apple + 30 per cent pomegranate (22.50 per cent). Significantly less amount of total sugar was found in the fruit bars prepared with a combination of 60 per cent wood apple and 40 per cent dragon fruit. It has been observed that the sugar content of the bars is generally high, where pomegranate pulp was used as one of the components. There was a constant increase in sugar content of the fruit bars during the storage period under study.

The increase in total sugars during storage could be due to conversion of insoluble polysaccharides and other carbohydrate polymers to soluble sugars (Kuchi *et al.*, 2014) [8]. The same finding was also reported by Singh *et al.*, 2017 [14] while working on quality improvement in bael candy.

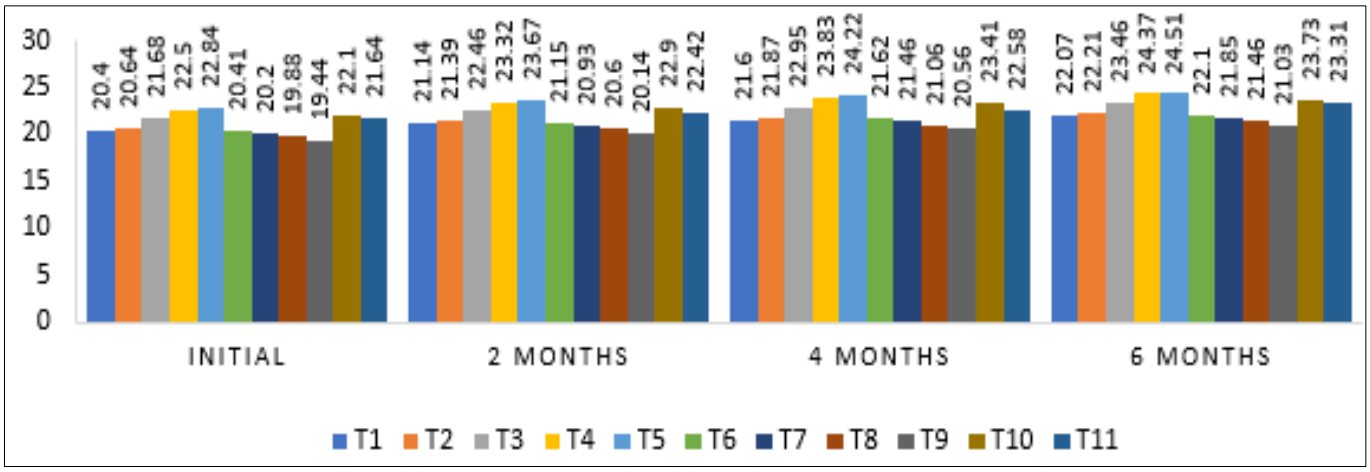

Fig 1: Change in total sugar % of fruit bar during the storage period

Conclusion

It was observed from the study that all the sensory attributes showed higher values in the fruit bars where wood apple was blended with pomegranate or dragon fruit or combination of three fruits. The wood apple blended fruit bars were qualitatively and organoleptically accepted and fit for consumption up to 6month of storage. The mix fruit bar has good potential both in domestic and export markets and there is great scope to earn foreign exchange. This technology not only improves the nutrient intake of consumers but also helps the women to start a small-scale production unit at home level to supplement their incomes by enabling self-employment in rural sector. This type of value addition by different nutritional fruit certainly helps in income generation of the entrepreneurs at large and promotes good nutrition. To maximize the beneficial effects and increase the consumption of fruit bars, future studies should emphasize on overcoming the possible uncertainties about their healthy image and consequently, develop and document a knowledge base on the uptake of such products.

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