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Short communication

Storage stability of ready-to-serve beverage from *mahua* (*Madhuca indica*) flowers

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ABSTRACT

A technology to prepare ready-to-serve (RTS) beverage from the dried *mahua* (*Madhuca indica*) flowers was standardized. The developed RTS was stored in plastic bottles at ambient (25 ± 2°C) and refrigerated condition (4 ± 2°C) for estimation of shelf-life and biochemical changes during storage. The pH decreased from 5.36 to 3.40 in case of RTS blended with ginger extract @ 10 percent after five months of storage at ambient, while it decreased to 4.46 under refrigerated conditions. The total soluble solids decreased from 18.0 to 14.3°Brix at ambient and 16.16°Brix at refrigerated storage of RTS blended with ginger extract. Similarly, in case of *mahua* RTS blended with fennel extract @ 5 percent, pH decreased from 5.3 to 3.2 at ambient and 5.26 to 4.13 at refrigerated condition of storage. Total soluble solids decreased from 14.8 to 11.5°Brix at ambient and 14.8 to 13.0°Brix at refrigerated storage of *mahua* RTS blended with fennel. There was no microbial load detected till three months of storage at ambient and till five months at refrigerated conditions.

Key words: *Mahua* flower, ready-to-serve beverage, storage.

Mahua (*Madhuca indica*) is a common tree in deciduous forests of India, quite prominent in states of Andhra Pradesh, Bihar, Gujarat, Karnataka, M.P. Odisha, Rajasthan, U.P. and West Bengal. It belongs to family Sapotaceae and there are two common species namely *Madhuca indica* and *M. longifolia* in India., In addition to a number of minerals and vitamins it is rich in sugar (68-72%) (Patel and Naik, 9). One hundred gram dried *mahua* flowers, provide 110-calorie energy and contains 40 mg vitamins, 1.1 mg iron, 45 mg calcium, 22.7 mg carbohydrates, and 1.4 mg protein (Jayashree *et al.*, 5). The flowering season of *mahua* extends from February to April. The tribals of Udaipur, Banswara, Dungarpur and Chittoregarh districts of Rajasthan collect flowers and seeds of *mahua* which have medicinal and nutritional properties. The collected flowers are dried over 4 to 6 days in open sunlight and then used as food/ feed or used to make a local form of liquor called *Mahori*. Flowers not used for personal consumption are sold to local traders. Due to seasonal glut of *mahua* flowers, tribals do not realize the proper economic return it. For instance *mahua* flowers are sold @ Rs. 4 to 5 per kg during the season, while traders used to sell @ Rs. 20 to 25 per kg during off season in Udaipur region. Some experimental work has been done for decolorization and deodorization of dried *mahua* flower extract to produce sugar syrup (Shrivastava *et al.*, 11; Chand and Mahapatra, 2). However, in spite of being a rich source of nutrition, presently major portion of dried flowers is being used in the preparation of country liquor. The aim of present investigation was to develop RTS beverage from dried *mahua* flowers blended with powder of ginger rhizome and fennel seeds to harness the medicinal and nutritional properties of these as well to suppress the typical off flavour of *mahua* flower juice.

A ready-to-serve, non-alcoholic beverage was prepared from *mahua* flowers. About 500 g dried *mahua* flowers were soaked overnight in 1000 ml water containing KMS (100 ppm). The soaked flowers were ground in a mechanical grinder/juicer and then the juice was extracted through two layered muslin cloth. Then total volume was made to 1000 ml with water. In the extracted juice, ginger and fennel powder was added @ 2.5, 5 and 10 per cent along with sugar @ 5 per cent. The mixture was heated to boiling point for 15 min. and again filtered through one layered muslin cloth. Organoleptic evaluation of RTS beverage samples was performed by a panel of semi-trained persons on a 9-point Hedonic scale (Amerine *et al.*, 1) for selection of optimum blending combination. The prepared RTS with selected blending combinations was filled in plastic bottles of polyethylene terephthalate (PET) with screw-cap under aseptic conditions and used for study of storage stability.

Various biochemical parameters such as, total soluble solids (TSS), pH, total sugars and reducing sugar of RTS beverage of *mahua* flowers were estimated during the storage period at monthly interval. The total

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sugars were estimated by anthrone reagent method as described by Hedge *et al*. (4). Reducing sugars in samples were estimated by using dinitrosalicylic acid (DNS) reagent method as described by Miller (7). The total soluble solids in the samples were determined with the help of hand refractometer and expressed in terms of °Brix. The pH of the samples was measured by using hand held pH meter. Microbial load of stored samples was recorded as per the standard methods of microbial examination of food (Ranganna, 10). Standard plate count agar (SPCA) medium was used for total viable bacterial count and Rose Bengal agar medium for fungal count. All experiments were carried out in triplicates. The data recorded were subjected to statistical analysis under completely randomised block design using SPSS-13 O software (Gomez and Gomez, 3).

Physico-chemical properties were recorded for the different levels of blending in *mahua* flower juice based RTS (Table 1). On the basis of organoleptic evaluation two blends, *viz.*, $Sugar_5$ + $Ginger_{10}$ and $Sugar_5$ + $Fennel_5$ were selected for storage studies (Table 1). Two conditions, *i.e.*, ambient and refrigerated (0-4°C) were used for storage of RTS bottles.

The total sugars content of *mahua* RTS blended with $Sugar_5$ + $Ginger_{10}$ decreased from 298.51 to 107.13 mg/ml at 5th month of storage at ambient conditions, while that of refrigerated condition it decreased from 298.51 to 271.15 mg/ml. This significant difference in total sugars of RTS beverage was due to storage at different temperatures (Table 2) and it may be also attributed to the microbial load in the RTS stored at ambient temperature. Similar trend was observed in case of reducing sugars as evident form Table 2. It decreased form 195.3 to 96.47 mg/ml and to 164.46 mg/ml in the RTS beverages stored at ambient and refrigerated conditions, respectively. There was gradual decrease in pH as well as total soluble solids content of the RTS during the storage period in refrigerated conditions as compared to ambient conditions. The pH decreased from 5.36 to 3.4 in case of RTS blended with ginger @ 10 per cent after five months of storage at ambient, while it decreased to 4.46 in case of refrigerated conditions. The TSS decreased from 18.0 to 14.33°Brix at ambient and to 16.16°Brix at refrigerated storage of *mahua* RTS blended with ginger (Table 2).

The total sugar content of *mahua* RTS blended with $Sugar_5$ + $Fennel_5$, decreased from 301.38 to 245.87 mg/ml at 5th month of storage at ambient conditions, while that of refrigerated condition it decreased from 301.38 to 290.66 mg/ml at 5th month of storage (Table 3). The reducing sugars decreased form 196.30 to 123.36 mg/ml and 182.10 mg/ml in the *mahua* RTS blended with $Sugar_5$ + $Fennel_5$ stored at ambient and refrigerated conditions, respectively (Table 3). The pH decreased from 5.26 to 3.16 at ambient and 5.26 to 4.13 at refrigerated storage conditions in case of *mahua* RTS blended with $Sugar_5$ + $Fennel_5$. Total soluble solids decreased from 14.80 to 11.36°Brix at ambient and 14.80 to 12.96°Brix at refrigerated storage of *mahua* RTS blended with fennel (Table 3).

Microbial load was detected in ginger blended RTS at 4th month of storage at ambient conditions. Total bacterial count of mahua RTS blended with $Sugar_5$ + $Ginger_{10}$ was found to be log 5.36 cfu / ml and total fungal count was found to be log 4.83 cfu / ml at 4th months of storage at ambient conditions. Samples of RTS blended with $Sugar_5$ + $Fennel_5$ were free from microbial contamination till 4th month of storage at ambient condition and total bacterial count was found to be log 5.54 cfu / ml and total fungal count was found to be 4.81 cfu / ml at 5th month of storage at ambient conditions. However, all the samples were free from microbial contamination till end of storage period at refrigerated condition.

Kumar and Manimegalai (6) have reported that a decrease in pH, total sugars and ascorbic acid but TSS did not change during storage of whey-based papaya fruit juice blended ready-to-serve (RTS) beverage. A

Table 1. Physico-chemical and organoleptic evaluation of *mahua* RTS.

Treatment	TSS (°Brix)	pH	Taste	Colour	Flavour	Over all acceptability
$Sugar_0$ + $ginger_{2.5}$	14.60 ± 0.10	5.60 ± 0.10	6.06 ± 0.11	6.78 ± 0.18	5.60 ± 0.20	6.18 ± 0.05
$Sugar_5$ + $ginger_5$	17.63 ± 0.15	5.53 ± 0.05	8.10 ± 0.10	7.46 ± 0.32	6.80 ± 0.10	7.54 ± 0.16
$Sugar_5$ + $ginger_{10}$	18.00 ± 0.10	5.36 ± 0.05	8.34 ± 0.15	7.67 ± 0.13	8.10 ± 0.10	8.02 ± 0.02
$Sugar_{00}$ + $fennel_{2.5}$	12.43 ± 0.15	5.43 ± 0.05	5.50 ± 0.10	6.13 ± 0.11	5.60 ± 0.10	5.82 ± 0.08
$Sugar_5$ + $fennel_5$	14.80 ± 0.05	5.26 ± 0.05	8.15 ± 0.05	6.40 ± 0.10	7.79 ± 0.08	7.77 ± 0.10
$Sugar_5$ + $fennel_{10}$	19.46 ± 0.28	5.33 ± 0.11	8.17 ± 0.15	5.65 ± 0.05	6.33 ± 0.21	6.65 ± 0.17
Control	11.40 ± 0.17	5.66 ± 0.05	4.50 ± 0.30	4.36 ± 0.20	4.68 ± 0.16	4.37 ± 0.12
CD (P = 0.05)	0.02	0.10	0.22	0.31	0.25	0.20

Table 2. Quality changes during storage of *mahua* flower RTS blended with $Sugar_5$ + $Ginger_{10}$.

Storage period (month)	Total sugars (mg/ml)	Reducing sugars (mg/ml)	pH	TSS (°Brix)
Ambient conditions				
0	298.51 ± 0.24	195.30 ± 0.4	5.36 ± 0.05	18.00 ± 0.10
1	297.60 ± 0.20	192.49 ± 0.27	5.26 ± 0.05	17.43 ± 0.11
2	291.36 ± 0.15	185.05 ± 0.38	5.16 ± 0.05	17.20 ± 0.10
3	283.39 ± 0.36	181.39 ± 0.27	4.73 ± 0.05	16.46 ± 0.05
4	209.50 ± 0.20	125.58 ± 0.17	4.13 ± 0.05	16.16 ± 0.05
5	107.13 ± 0.05	96.47 ± 0.34	3.40 ± 0.1	14.33 ± 0.15
Refrigerated conditions				
0	298.51 ± 0.05	195.30 ± 0.36	5.36 ± 0.05	18.00 ± 0.11
1	297.68 ± 0.05	192.40 ± 0.40	5.23 ± 0.05	17.53 ± 0.05
2	291.47 ± 0.05	185.43 ± 0.20	5.16 ± 0.15	17.16 ± 0.05
3	286.13 ± 0.05	178.38 ± 0.18	5.03 ± 0.05	17.03 ± 0.05
4	279.51 ± 0.05	173.46 ± 0.30	4.73 ± 0.05	16.80 ± 0.10
5	271.15 ± 0.05	164.46 ± 0.25	4.46 ± 0.05	16.16 ± 0.05
CD (P = 0.05) and SEm±				
Month	0.617 (± 0.21)	0.383 (± 0.13)	0.087 (± 0.03)	0.113 (± 0.04)
Storage condition	0.390 (± 0.13)	0.242 (± 0.08)	0.055 (± 0.02)	0.071 (± 0.02)
Month × Storage condition	0.873 (± 0.30)	0.541 (± 0.18)	0.123 (± 0.04)	0.160 (± 0.05)

Table 3. Quality changes during storage of *mahua* flower RTS blended with $Sugar_5$ + $Fennel_5$.

Storage period (month)	Total sugars (mg/ml)	Reducing sugars (mg/ml)	pH	TSS (°Brix)
Ambient conditions				
0	301.38 ± 1.12	196.30 ± 0.46	5.26 ± 0.06	14.80 ± 0.10
1	298.40 ± 0.92	195.43 ± 0.32	5.16 ± 0.06	14.60 ± 0.10
2	290.93 ± 0.61	192.63 ± 0.15	4.76 ± 0.06	14.10 ± 0.10
3	288.18 ± 0.72	186.16 ± 0.15	4.46 ± 0.06	13.60 ± 0.10
4	286.03 ± 0.35	179.60 ± 0.35	4.13 ± 0.06	12.63 ± 0.15
5	245.87 ± 0.22	123.36 ± 0.45	3.16 ± 0.06	11.36 ± 0.15
Refrigerated conditions				
0	301.38 ± 0.62	196.30 ± 0.60	5.26 ± 0.06	14.80 ± 0.10
1	300.90 ± 0.36	195.00 ± 0.20	5.16 ± 0.06	14.63 ± 0.15
2	297.73 ± 0.31	192.05 ± 0.48	5.06 ± 0.06	14.40 ± 0.10
3	296.40 ± 0.53	187.80 ± 0.40	4.83 ± 0.06	13.63 ± 0.23
4	293.26 ± 0.40	184.39 ± 0.36	4.53 ± 0.06	13.26 ± 0.11
5	290.66 ± 0.58	182.10 ± 0.36	4.13 ± 0.15	12.96 ± 0.15
CD (P = 0.05) and SEm±				
Month	0.683 (± 0.23)	0.446 (± 0.15)	0.085 (± 0.03)	0.160 (± 0.05)
Storage condition	0.432 (± 0.15)	0.282 (± 0.09)	0.054 (± 0.02)	0.101 (± 0.03)
Month × Storage condition	0.966 (± 0.33)	0.630 (± 0.21)	0.121 (± 0.04)	0.226 (± 0.08)

slight increase in the microbial load was observed but the sensory quality attributes were highly acceptable even after storing for three months at refrigeration. The present findings are in accordance with Kumar and Manimegalai (6). There are some reports in which total sugars, and reducing sugars increased during the storage of ready-to serve-beverages prepared from different fruits (Singh *et al*.,12; Nidhi *et al.*, 8). Singh *et al.* (12) standardized guava and pineapple juice ratio for the preparation of RTS and nectar beverages. The RTS score prepared from 70% guava and 30% pineapple juice had highest acceptability with 82% score initially and 48% marks after four month of storage at ambient temperature. The total soluble solids and total sugars, and reducing sugars increased continuously during the storage period of 120 days, while ascorbic acid and non-reducing sugars decreased during storage. However, in case of ready-to-serve blends of *bael*-guava, total sugars, reducing sugars, acidity and browning increased, while pH, ascorbic acid and total phenols decreased in all the beverages with the increase in storage period at ambient temperature (30-35°C) (Nidhi *et al.*, 8). This variation in quality parameters of *mahua* flower juice based RTS may be attributed to the biochemical composition of mahua flower juice extract and the blending material (ginger and fennel) used in the present investigation.

Based on results, it may be concluded that the *mahua* flower juice based RTS blended with ginger and fennel significantly improved the organoleptic acceptance of the beverage. Higher level of blending was needed in case of ginger than that of fennel. *Mahua* RTS blended with $Sugar_5$ + $Fennel_5$ was observed to have better shelf-life than blended with $Sugar_5$ + $Ginger_{10}$. The shelf-life of *mahua* RTS was five months under refrigerated conditions.

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