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Morphological and biochemical traits of some selected underutilised wild edible fruits used by the Sahariya – A PVTGs of Rajasthan

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The purpose of the study is to document the wild edible fruits consumed by the Sahariya tribe through open ended questionnaire and morphological and biochemical analysis of four underutilised fruits *viz.*, *Buchanania lanzan* Spreng., *Diospyros melanoxylon* Roxb., *Flacourtia indica* (Burm. f.) Merr. and *Miliusa tomentosa* (Roxb.) Finet & Gagnep. The study had been carried out in and around villages of Shahabad and Kishanganj blocks of Baran district under South Eastern Rajasthan. A total of 39 wild edible fruits from 22 plant families were recorded and documented. *Diospyros melanoxylon* Roxb. with higher fruit weight and diameter of 23.55 g and 34 mm respectively and high pulp percentage (>50%) in fruits indicate that wild fruits have a significantly higher amount of consumable portion with a good shelf life (3-7 days at room temperature and 6-15 days in refrigerator). *Buchanania lanzan* Spreng., *Diospyros melanoxylon* Roxb. and *Flacourtia indica* (Burm. f.) Merr. with total soluble solids 26, 22 and 22 (^{o}Brix) respectively and total sugar content 28, 27 and 23% respectively. *Buchanania lanzan* Spreng. contained the ascorbic acid/vitamin C of 120 mg/100 g which is usually higher than commercially cultivated fruits. The species with the highest pH was *Miliusa tomentosa* (Roxb.) Finet & Gagnep. (5.4), resulting in the lowest titratable acidity content (0.25%), while *Buchanania lanzan* Spreng. had the lowest pH (3.9), resulting in the highest titratable acidity content (1.3%). The study shows that wild edible fruits are nutrient rich and well comparable with various commercial fruits.

Keywords: Food security, Nutrition, Rajasthan, Sahariya, Wild edible fruits

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People all around the world, from remote tribes to urban dwellers, rely heavily on wild fruits. Agrahar-Murugkar and Subbulakshmi[1] pointed out that wild plants can withstand harsher climates and that their edible components can be gathered year-round, making them a potentially vital source of nutrition. The economic potentiality of wild fruit plants has been underutilised, relegating them to mostly traditional and local usage, hence these species are classified as underutilised or neglected crops. Millions of people in many developing countries rely on wild edible fruits to supplement their diets, especially during times of food crisis, but this varies greatly depending on factors like availability, tradition, culture, socioeconomic conditions, and taste[2].

Tribes are particularly susceptible to starvation; therefore, wild fruits are typically ingested fresh or processed to meet the daily calorie requirement. Wild edible plants exhibited high concentration of nutrients especially carbohydrates, vitamins, proteins, and minerals[3,4], which supports health status of rural poor communities in many parts of world[5]. Many neglected and underutilised wild edible plants are nutritionally dense and valuable additions to a well-balanced diet[5]. In the form of ingredients, vegetables, and beverages in general, they offer nutritionally beneficial supplements. They are resistant to a variety of diseases and are frequently used in numerous Indian folk medicine formulations[6]. These underutilised wild edible plants can play an important role in poverty reduction, agricultural diversification, and income generation by enhancing household food security[7], and knowledge about the plants will be crucial in the near future to feed an ever-growing population[8]. The extinction of these species could have immediate effects on the nutrition and food security of the impoverished[9]. Therefore, forests are essential sources of income for tribes. Numerous studies have been

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conducted to ascertain the nutritional composition of various wild edible plants used in India[10,11]. The database on the nutrient content of these native edibles is still insufficient, and additional research is required. Rajasthan is home to 8.9% of the total tribal population in the country. About 3% of the tribal population of Rajasthan resides in Baran, of which 29% are Sahariya. The Government of India has designated the Sahariya as a Particularly Vulnerable Tribal Groups (PVTGs) because they are a primitive and one of the specified backward tribes located primarily in the Kishanganj and Shahbad blocks of Baran district. About 90% Sahariya reside in Kishanganj and Shahbad tehsils[12]. A recent study revealed that infants and adults of the Sahariya tribe are more likely to be undernourished[13]. The majority of Sahariya rely on forests for their livelihood and economic structure[14]. The present study is to document the wild edible fruits collected by the Sahariya tribe and to analyse the morphological traits and biochemical characteristics of four underutilized fruits *viz., Buchanania lanzan* Spreng., *Diospyros melanoxylon* Roxb., *Flacourtia indica* (Burm. f.) Merr. and *Miliusa tomentosa* (Roxb.) Finet & Gagnep. used by these tribes.

Material and Methods

Study area and climate

The study was concentrated in Shahbad and Kishanganj blocks of 'Baran' district in the State of Rajasthan where 90% population of the Sahariya tribe live[12]. The Baran district is located in the south-eastern portion of the Indian state of Rajasthan, between latitudes 24° 23' 35.85" and 25° 26' 39.94" north and longitudes 76° 11' 34.16" and 77° 25' 56.74" east. The forest area is 2239.69 sq. km and these forest covers are mainly concentrated in the south-western and central portion of the Mukundra hills having rich forest belt. The study site has subtropical climate, characterised by prolonged and intense hot summer, with minimal rainfall and short but severe winter[12].

Documentation of wild edible fruits used by the Saharia tribe

Two blocks namely Kishanganj and Shahbad, where Sahariya tribal population is concentrated were selected for the study during the period of 2018-20 in consultation with district officials. Primarily, the purposive sampling procedure was followed in case of selecting the study area. Eight villages were randomly selected from the fringes of forest area *viz.*, Moondiyar, Mamoni, Chak Lokya and Madanpura, Doondabar, Kaloni, Brijnagar and Sewani. The data collection in this study was through open ended questionnaire based on personal interviews and Focused Group Discussion[15,16]. Frequent field surveys were carried out in the study area. Wild edible fruit data (Local name, mode of consumption, habit of plants) was collected through interviews and discussion with the tribal in and around the study area. The wild edible fruits were identified with the help of Flora of India[17] and Digital Flora of Karnataka online[18]. The identified specimens were photographed and herbarium specimens were deposited in the Department of Forest Products and Utilization, College of Horticulture and Forestry, Jhalawar, Rajasthan. Plants of the World Online[19] was followed for the scientific nomenclature of species. The fruits of *Buchanania lanzan* Spreng., *Diospyros melanoxylon* Roxb., *Flacourtia indica* (Burm. f.) Merr. were collected during March - April and *Miliusa tomentosa* (Roxb.) Finet & Gagnep. fruits were collected in the month of July for the nutritional analysis.

Four underutilised wild edible fruits from four different species were selected for proximate analysis. Wild fruits used by Sahariya tribes were collected from Shahabad and Kishanganj area of Baran district in Rajasthan. Proximate analysis of fruits was done on two parameters *viz.*, physical parameters and biochemical parameters.

Physical parameters

Fruit weight was measured in digital balance with an accuracy of ± 0.001 g. Fruit diameter was measured with the help of vernier calliper in mm to an accuracy of 0.01 mm. Longitudinal and equatorial diameters were separately measured and mean diameter was calculated. Fruit was scrapped with peeling knife to remove out the peel from fruit. Fruit was cut and pulp was extracted with the help of knife. Pulp - peel ratio was determined by diving pulp weight with peel weight. Number of seeds per fruit was determined by counting the seeds.

Determination of pulp percentage

Pulp percentage of fruits was calculated using following equation[20].

$$\text{Pulp percentage} = \frac{\text{Pulp weight} \times 100}{\text{Fruit weight}}$$

Determination of Physiological Loss in Weight (PLW)

Physiological loss in weight was expressed in percentage. To measure physiological loss in weight Fruits were weighted during storage at regular intervals with the help of an electronic weighing balance. It was calculated by using the following formula.

$$PLW\ (\%) = \frac{(\text{Initial weight} - \text{Weight after known storage period}) \times 100}{\text{Initial weight}}$$

Determination of shelf life

It was measured by counting the number of days fruit showed 10% PLW.

Bio chemical parameters

Determination of Total Soluble Solids (TSS)

Total soluble solids (TSS) of fruits were determined with the help of hand refractometer and the values were presented in Brix after making corrections for difference in temperature[21].

Determination of titratable acidity

To determine titratable acidity fruit aliquot was titrated against standard Sodium hydroxide (0.1N) using phenolphthalein as an indicator[21]. For this 10 g of fruit pulp was taken and was titrated against 0.1 N NaOH by adding a drop of naphthalin until pink color. The result was calculated as per cent equivalent of citric acid.

$$\text{Titratable acidity}\ (\%) = \frac{\text{T. value} \times \text{N of NaOH} \times \text{Volume made up} \times \text{Eqt. Wt. of citric acid} \times 100}{\text{Weight of the sample} \times \text{Volume of sample taken} \times 1000}$$

pH

pH of fruit juice was determined by using glass electrode pH meter.

Determination of ascorbic acid (Vitamin C)

Ascorbic acid determined by volumetric method by using 2, 6-dicholorophenol-indophenol dye[21].

Preparation of sample

10 g of fruit pulp was taken and crushed with mortar and pestle in 3% metaphosphoric acid. Final volume was made up to 100 mL with 3% HPO_3. Filtered the sample using Whatman No. 1 filter paper and took 10 mL of sample in a conical flask and titrated with dye. Mg of ascorbic acid per 100 g was worked out using the following formula[21].

$$\text{Mg of ascorbic acid per 100 g} = \frac{\text{Titer value} \times \text{Dye factor} \times \text{Volume made up} \times 100}{\text{Weight of the sample} \times \text{Aliquot volume of sample}}$$

Determination of total sugars

Total sugars, reducing sugars and non-reducing sugars of fruit samples were estimated[21]. 10 g fruit pulp was taken and crushed well in known volume of distilled water and transferred in to 250 mL conical flask and make up the volume 100 mL in conical flask. 2 mL lead acetate and 2 mL potassium oxalate was added and final volume was made up 250 mL by adding distilled water. Then 5 mL conc. HCl was added in it. This whole solution was kept for 24-48 h. and filtered through Whatman No. 1 filter paper into a conical flask. Each Fehling solution (A and B) measuring 5 mL was taken into a conical flask to which 50 mL distilled water was added. This was heated and 2-3 drops of methylene blue indicator were added into it. The Fehling solution was titrated by filtered fruit aliquot. The appearance of brick red colour determined the end point and percentage of total sugar was worked out using following formula.

$$\text{Total sugar}\ (\%) = \frac{\text{Factor} \times \text{volume made} \times 100}{\text{Titre value} \times \text{Wt. or volume of sample}}$$

Determination of reducing sugars

10 g fruit pulp was taken and crushed well in known volume of distilled water and transferred in to 250 mL conical flask and made the volume 100 mL in conical flask. 2 mL lead acetate and 2 mL potassium oxalate was also added and final volume was made up 250 mL by adding distilled water. This whole solution was kept for 24-48 h. and filtered through Whatman No. 1 filter paper into a conical flask. Each Fehling solution (A and B) measuring 5 mL was taken in a conical flask to which 50 mL distilled water was added. This was heated and 2-3 drops of methylene blue indicator were added into it. The Fehling solution was titrated by filtered fruit aliquot. The appearance of brick red colour determined the end point. Reducing sugar in sample was computed by the following formula[21]:

$$\text{Reducing sugar}\ (\%) = \frac{\text{Factor} \times \text{volume made} \times 100}{\text{Titre value} \times \text{Wt. or volume of sample}}$$

Determination of non-reducing sugars (%)

It was calculated by using formula:

Non reducing sugar (%) =
(Total sugar (%) - Reducing sugar (%)) × 0.95

Descriptive analysis was used to categorize family and habit. The proximate analysis was done using One-Way ANOVA and significant of each mean property value was determined with Duncans multiple range test using IBM SPSS ver.16 software

Results and Discussion

Documentation of wild edible fruits used by the Sahariya tribe

The Sahariya people live on the fringes of the forest in the Shahabad and Kishanganj blocks, and the use of 39 different wild edible fruits has been reported (Table 1). Majority of the wild fruit plants observed are trees (56.4%), followed by climbers (17.9%) and shrubs (17.9%) and herbs (7.6%) (Fig. 1). The families Annonaceae, Apocynaceae, and Euphorbiaceae each consists of 5% of the total, while the families Moraceae and Cucurbitaceae each consists of 16% (Fig. 2). Except for *Aristolochia indica* L., *Solanum nigrum* L., and *Lantana camara* L. var. *aculeata* (L.) Mold., nearly all of the other wild fruits recorded were seasonal. *Carissa carandas* L., *Ziziphus jujuba* Mill., *Limonia acidissima* L., *Phyllanthus emblica* L. and *Cordia dichotoma* G. Forst. are some of the unripe wild fruits used as pickle. *Coccinia grandis* (L.) Voigt, *Sphaeranthus indicus* L., *Ficus hispida* L.f., and *Solena amplexicaulis* Lam. are a few examples of plants whose fruits are utilised as cooked vegetables. These

Table 1 — Enumeration of the wild edible fruits used by the Sahariya tribe

S. No	Botanical names/ family name	Local name	Family	Habit	Seasons of availability	Mode of consumption
1.	*Aegle marmelos* (L.) Correa	*Bel*	Rutaceae	Tree	April – June	Ripen fruits are eaten as raw and used to make juice.
2.	*Alangium salviifolium* L.f.) Wangerin	*Ankula*	Cornaceae	Tree	March - July.	Ripen fruit pulp is eaten.
3.	*Ampelocissus latifolia* (Roxb.) Planch.	*Pani Bel*	Vitaceae	Climber	July – September	Blackish purple berries are sweet sour in taste and eaten as raw.
4.	*Annona squamosa* L.	*Saripha*	Annonaceae	Tree	November – December.	Fruit Pulp is eaten raw and made into juice.
5.	*Aristolochia indica* L.	*gwari/ gawarisal*	Aristolochiaceae	Climber	Throughout the year	Eaten after boiling.
6.	*Bridelia retusa* (L.) A. Juss.	*Panikasi*	Phyllanthaceae	Tree	August – January	Ripe fruits are eaten as raw.
7.	*Buchanania lanzan* Spreng.	*Chironji*	Anacardiaceae	Tree	April – May	Eaten as Raw and seed kernel used as dry fruit
8.	*Cardiospermum halicacabum* L.	*Chirputa*	Sapindaceae	Climber	August – October	Ripen fruits are eaten as raw
9.	*Carissa carandas* L.	*Karonda*	Apocynaceae	Shrub	June – October	Ripe fruits are consumed as raw and unripe fruits are made into pickle.
10.	*Carissa spinarum* L.	*Sana Karenda*	Apocynaceae	Shrub	March – December	Ripe fruits are consumed as raw and unripe fruits are made into pickle.
11.	*Coccinia grandis* (L.) Voigt	*Kundru*	Cucurbitaceae	Climber	Most part of the year	Green fruits are eaten after cooking.
12.	*Corchorus aestuans* L.	*Jute*	Malvaceae	Herb	July – December	Unripe fruits are cooked and eaten.
13.	*Cordia dichotoma* G. Forst.	*Lehsuaa*	Boraginaceae	Tree	March – September	Ripe fruits are eaten as raw and made into pickle
14.	*Cucumis melo*. L.	*Kachrio*	Cucurbitaceae	Climber	September – October	Ripen fruits are used as vegetable and made into pickle.
15.	*Diospyros melanoxylon* Roxb.	*Tendu*	Ebenaceae	Tree	April – May	Ripen fruits are eaten as raw.
16.	*Ficus benghalensis* L.	*Bargad*	Moraceae	Tree	April – February	Ripen fruits are eaten as raw.
17.	*Ficus carica* L.	*Anjir*	Moraceae	Tree	November – January	Ripen fruits are eaten as raw. After drying used in laddu making.
18.	*Ficus hispida* L.f.	*Phaglu*	Moraceae	Tree	November – July	Unripe fruit and receptacle are cooked as curry

… Contd.

Table 1 — Enumeration of the wild edible fruits used by the Sahariya tribe (Contd.)

S. No	Botanical names/ family name	Local name	Family	Habit	Seasons of availability	Mode of consumption
19.	*Ficus racemosa* L.	*Gular*	Moraceae	Tree	March – June	Ripen fruits are eaten as raw. After drying used in laddu making as an alternate of *Anjir*.
20.	*Ficus religiosa* L.	*Peepal*	Moraceae	Tree	March – June	Ripen fruits are eaten as raw.
21.	*Flacourtia indica* (Burm.f.) Merr.	*Kakoni*	Salicaceae	Shrub	April – June	Ripen fruits are eaten as raw immediately after collection and it becomes acidic after few hours
22.	*Gmelina arborea* Roxb. ex Sm.	*Gamar*	Lamiaceae	Tree	May-June	Ripen fruits are edible.
23.	*Lantana camara* L. var. *aculeata* (L.) Mold.	*Raimuniya*	Verbenaceae	Shrub	Throughout the year	Ripe fruit consumed as raw
24.	*Limonia acidissima* L.	*Kainth*	Rutaceae	Tree	November – April	Pulp of ripen fruit is dried and made into fine powder and added in various sweet recipes.
25.	*Miliusa tomentosa* (Roxb.) Finet & Gagnep.	*Kari*	Annonaceae	Tree	June – August	Ripe fruit eaten as raw.
26.	*Momordica dioica* Roxb. ex Willd.	*Jungli Karela*	Cucurbitaceae	Climber	March – June	Fruit is used as vegetable.
27.	*Morus alba* L.	*Sahtoot*	Moraceae	Tree	April – May	Ripe fruit eaten as raw.
28.	*Phoenix sylvestris* (L.) Roxb.	*Khajoor*	Arecaceae	Tree	April – June	Ripe fruits are sweet and eaten as raw.
29.	*Phyllanthus emblica* L.	*Anola*	Euphorbiaceae	Tree	November – Feberuary	Matured fruits eaten as raw; made into pickle.
30	*Solanum nigrum* L.	*Mukko*	Solanaceae	Herb	Throughout the year	Ripen and raw fruits are edible.
31	*Solena amplexicaulis* Lam.	*Amantamul*	Cucurbitaceae	Climber	April – November	Unripe fruits are cooked as vegetable
32.	*Sphaeranthus indicus* L.	*Gurudai*	Asteraceae	Herb	November – January	Fruits are cooked as vegetable
33.	*Syzygium cumini* (L.) Skeels	*Jamun*	Myrtaceae	Tree	June -August	Seeds from ripened fruit are powdered and is mixed with maize flour.
34.	*Tamarindus indicus* L.	*Imli*	Caesalpiniaceae	Tree	December – March	Pulp of unripe fruit is made into pickle and chutney. Juice is made after soaking the dried fruits in water for overnight.
35.	*Ziziphus jujuba* Mill.	*Ber*	Rhamnaceae	Shrub	January – March	Ripen fruits are eaten as raw.
36.	*Ziziphus mauritiana* Lam.	*Jungli Bor*	Rhamnaceae	Tree	November – February	Ripen fruits are eaten as raw.
37.	*Ziziphus nummularia* (Burm.f.) Wight & Arn.	*Jhar Ber*	Rhamnaceae	Shrub	October – February	Seeds of ripened fruits dried and powdered and is used as flour in case of famine.
38.	*Ziziphus oenoplia* (L.) Mill.	*Makora*	Rhamnaceae	Shrub	December – January.	Ripen fruits are eaten as raw.
39.	*Ziziphus xylocarpa* (Retz.) Willd.	*Gat Bor*	Rhamnaceae	Tree	March – January	Ripen fruits are consumed as raw.

wild edible fruits were frequently consumed during hungry times of the day, seasonally during times of scarcity or acute famine due to drought. The tribals used to sell the fruits of *Diospyros melanoxylon* Roxb., *Ziziphus jujuba* Mill., *Syzygium cumini* (L.) Skeels, *Phyllanthus emblica* L., and *Carissa carandas* L. in nearby market. A number of underutilised minor fruits are naturally growing in Shahabad and Kishanganj region of Rajasthan. *Buchanania lanzan* Spreng. (*Chironji*), a vulnerable dry deciduous forest tree belonging to the family Anacardiaceae, is extensively utilised by the Saharia tribe of Rajasthan. This species is underexploited, and not cultivated on a large scale, and is restricted to forest areas in that region. Usually during the months of April and May, fruits are available. Fresh fruits are taken directly from the naturally wild-growing tree and consumed by tribal people, as well as sold in the local market. The kernels of this fruits have a flavour similar to almonds and are ingested raw or roasted and mainly used as dry fruits in desserts. According to Vijay *et al*.[22] *chironji* seeds are nutritionally rich and an important source of income for the tribal people of Central India. Despite its immense potential for commercialization, *chironji* still remains a minor fruit crop. The Saharia tribe collects the ripe fruits of *Diospyros melanoxylon* Roxb. in the month of

April for their own sustenance as well as for sale in the market. The fruit is extremely nutrient rich in terms of minerals and vitamins[23]. The fruits of *Flacourtia indica* (Burm. f.) Merr. were harvested between April and June, and those of *Miliusa tomentosa* (Roxb.) Finet & Gagnep. were harvested between June and August. The Saharia tribe eat ripen fruits of these species. The nutritional value of these seasonal fruits is unknown to the tribal population. Thus morphological and biochemical analysis of these four underutilized edible wild fruits *viz.*, *Diospyros melanoxylon* Roxb., *Miliusa tomentosa* (Roxb.) Finet & Gagnep. *Flacourtia indica* (Burm. f.) Merr. and *Buchanania lanzan* Spreng. are discussed below.

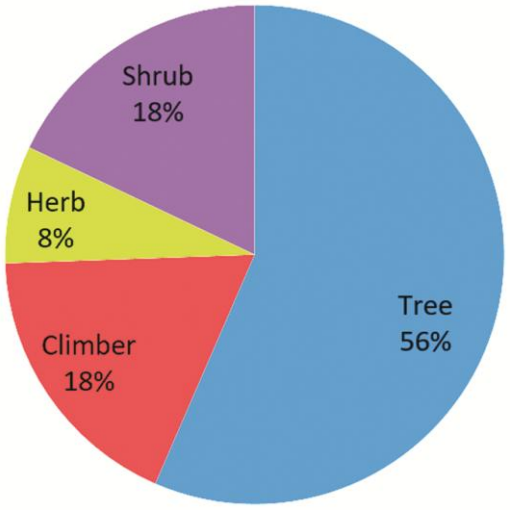

Fig. 1 — Habit wise distribution of wild edible fruits

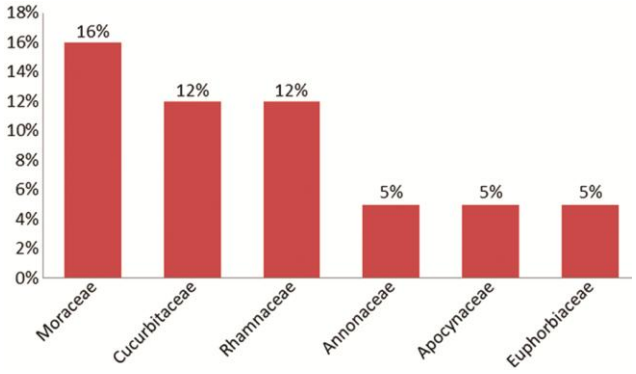

Fig. 2 — Families showing higher percentage sharing of wild edible fruits

Morphological traits of wild edible fruits

The physical characteristics of four underutilized edible wild fruits *viz.*, *Diospyros melanoxylon* Roxb., *Miliusa tomentosa* (Roxb.) Finet & Gagnep., *Flacourtia indica* (Burm. f.) Merr. and *Buchanania lanzan* Spreng. are depicted in Table 2. The fruit weight of the samples ranged from 23.55 g to 0.56 g, with *Diospyros melanoxylon* Roxb. producing the heaviest fruit and *Flacourtia indica* (Burm. f.) Merr. producing the smallest. Pulp and peel weight were maximum in *Diospyros melanoxylon* Roxb. (11.45 g) and lowest in *Flacourtia indica* (Burm. f.) Merr. (0.37 g) and (0.09 g), respectively. *Miliusa tomentosa* (Roxb.) Finet & Gagnep. (61.22%), *Buchanania lanzan* Spreng. (49.76%), and *Diospyros melanoxylon* Roxb. (48.55%) also contained appreciable quantities of pulp. Approximately, fifty percent of the total weight of each of the selected fruits consists of pulp, with a pulp-peel ratio that is economically viable and yields an adequate quantity of edible portion. The fruits' seed weight ranged from 4.7 g to 0.09 g, with *Diospyros melanoxylon* having the heaviest seeds and *Flacourtia indica* (Burm. f.) Merr. having the lightest. *Flacourtia indica* (Burm. f.) Merr. had the highest seed count per fruit (8.93). The number of seeds per fruit was 2.22 for *Diospyros melanoxylon* Roxb.and 2.53 for *Miliusa tomentosa* (Roxb.) Finet & Gagnep Each fruit of *Buchanania lanzan* Spreng. contains a single seed. The species with the highest pulp-to-peel ratio was *Flacourtia indica* (Burm. f.) Merr. (4.65), followed by *Buchanania lanzan* Spreng. (3.84) and *Miliusa tomentosa* (Roxb.) Finet & Gagnep. (3.2). For

Table 2 — Morphological parameters of wild edible fruits

Species	Fruit diameter (mm)	Fruit weight (g)	Peel weight (g)	Pulp weight (g)	Seed weight (g)	No. of seed /fruit	Pulp: Peel ratio	Pulp percentage
Buchanania lanzan Spreng.	13.04±1.07^{b}	1.24±0.16^{a}	0.17±0.09^{a}	0.62±0.15^{a}	0.44±0.04^{ab}	1±.00	3.84±1.2^{b}	49.76±7.8^{a}
Flacourtia indica (Burm. f.) Merr.	9.99±0.44^{a}	0.56±0.09^{a}	0.09±.02^{a}	0.37±0.07^{a}	0.09±0.01^{a}	8.93±1.03	4.65±2.2^{b}	66.48±5.3^{b}
Miliusa tomentosa (Roxb.) Finet & Gagnep.	20±5.15^{c}	6.27±4.21^{b}	1.09±0.33^{b}	4.21±3.33^{b}	0.95±.60^{b}	2.53±1.40	3.44±2.1^{b}	61.22±10.6^{b}
Diospyros melanoxylon Roxb.	34±1.87^{d}	23.55±3.79^{c}	5.95±0.93^{c}	11.45±2.22^{c}	4.7±1.92^{c}	2.22±0.77	1.98±0.2^{a}	48.55±5.0^{a}
F value	220.79**	215.03**	468.82**	99.44**	67.65**	209.91**	7.2**	20.29**

Means with same letter as superscript indicates homogeneous groups
******Significant at 1%

Diospyros melanoxylon Roxb. the lowest pulp-to-peel ratio (1.98) was recorded. All fruits experienced a progressive increase in physiologic weight loss over the course of storage. Physiological weight loss was lowest in *Diospyros melanoxylon* Roxb. on the 2nd, 3rd, and 4th day (4.19, 6.51, and 9.35%) at room temperature and 1.60, 2.23, 3.05, 3.90, 6.18, 8.54, and 10.04% on the 3rd, 4th, 5th, 6th, 9th, 12th, and 15th day in the refrigerator. *Buchanania lanzan* Spreng. exhibited a high physiological weight loss on the second and third day (9.89 and 21.28%, respectively) at room temperature, and on the fifth and sixth day (8.48 and 10.48%, respectively) in the refrigerator (Fig. 3). Lowest physiological loss of weight in *Diospyros melanoxylon* Roxb. lengthened its shelf life to 15 days in the refrigerator (70°C) and 4 days at ambient temperature. *Buchanania lanzan* Spreng. and *Flacourtia indica* (Burm. f.) Merr. both have a shelf life of two days at ambient temperature and six days in the refrigerator. The shelf life of *Miliusa tomentosa* (Roxb.) Finet & Gagnep. was three days at ambient temperature and seven days in the refrigerator. The physiological weight loss is inversely proportional to the fruit's expiration life. The fruit's thick rind may account for *Diospyros melanoxylon* Roxb. negligible weight loss. Additionally, PLW is dependent on the timing of produce harvest. High epidermis thickness and harvesting at the half-maturity stage reduce PLW and prolong the shelf life of fruits. The physiological process in fruits may be slowed at lower temperatures, resulting in a longer shelf life. Patil *et al*.[24] made comparable observations in Alphonso variety of ripen mango fruit.

Biochemical analysis of wild edible fruits

Table 3 shows the findings of a study on the approximate biochemical makeup of edible wild fruits. The TSS concentration was highest in *Buchanania lanzan* Spreng. (26 ^{o} Brix) and lowest in *Miliusa tomentosa* (Roxb.) Finet & Gagnep. (9 ^{o} Brix). Significant amounts of TSS are seen in *Flacourtia indica* (Burm. f.) Merr. and *Diospyros melanoxylon* Roxb. (22 ^{o} Brix and 22 ^{o} Brix, respectively) (Fig. 4). Total soluble solids (TSS) indicate sugar content (sucrose, glucose, and fructose) and are measured by the capacity of solutions to deflect or refract a light beam in proportion to the concentration of soluble solids, with the refraction serving as a measure of solution density[25]. TSS levels in selected wild fruits were found to be substantially higher than in popularly cultivated fruits like mango and guava[26,27]. The acidity of fruits is determined by

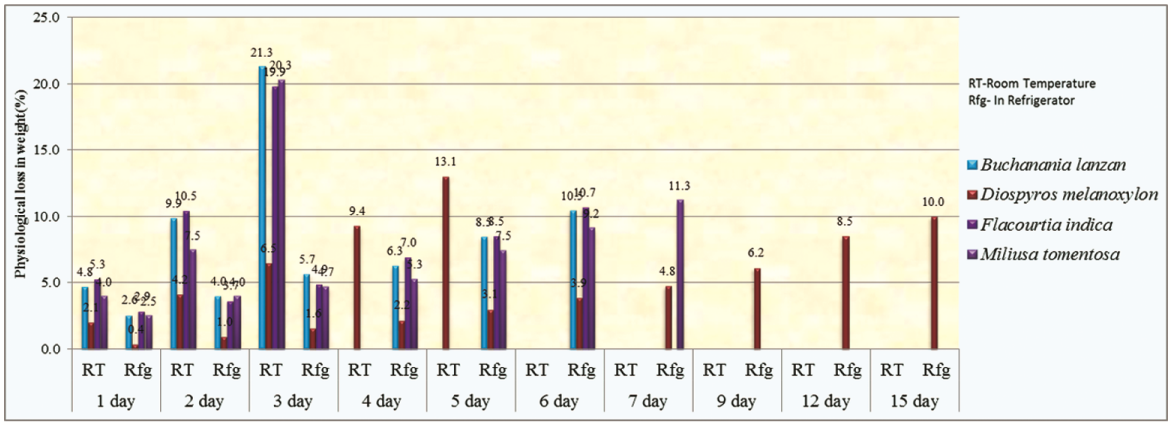

Fig. 3 — Physiological loss in weight (%) in four selected wild fruits at room temperature and in refrigerator

Table 3 — Biochemical parameters of wild edible fruits

Species	TSS ^{0}Brix	Ascorbic acid (mg/100 g)	Titratable acidity (%)	Total sugar (%)	Reducing sugar (%)	Non reducing sugar (%)	pH
Buchanania lanzan Spreng.	26±2.94^{c}	120±23^{b}	1.3±0.2^{c}	28±2.6^{d}	20±2.3^{d}	8±1.9^{b}	3.9±.18^{a}
Flacourtia indica (Burm. f.) Merr.	22±3.02^{b}	13.5±3^{a}	0.55±0.16^{b}	23±2.0^{b}	17±1.4^{c}	5±1.5^{a}	4.4±0.06^{b}
Miliusa tomentosa (Roxb.) Finet & Gagnep.	9±.90^{a}	5.6±1^{a}	0.25±.09^{a}	12.7±1.0^{a}	7.9±.8^{a}	5±1.0^{a}	5.4±0.24^{d}
Diospyros melanoxylon Roxb.	22±1.44^{b}	10.2±2^{a}	.32±0.07^{a}	27±2.0^{c}	14±1.2^{b}	11±1.6^{c}	5.2±0.27^{c}
F value	165.4**	317.8**	109.9**	193.1**	119.8**	60.3**	148.5**

Means with same letter as superscript indicates homogeneous groups
******Significant at 1%

Fig. 4 — Underutilised wild edible fruits a.) *Buchanania lanzan* Spreng. b.) *Diospyros melanoxylon* Roxb. c.) *Flacourtia indica* (Burm. f.) Merr. and d.) *Miliusa tomentosa* (Roxb.) Finet & Gagnep

pH. The species with the highest pH was *Miliusa tomentosa* (Roxb.) Finet & Gagnep. (5.4), resulting in the lowest titratable acidity content (0.25%), while *Buchanania lanzan* Spreng. had the lowest pH (3.9), resulting in the highest titratable acidity content (1.3%). The titratable acidity of selected natural fruits was also in close agreement with the results of Mahapatra *et al*.[28]. Ascorbic acid/vitamin-C levels are higher in *Buchanania lanzan* Spreng., *Flacourtia indica* (Burm. f.) Merr. and *Diospyros melanoxylon* Roxb. (120 mg/100 g, 13.5 mg/100 g, and 10.2 mg/100 g, respectively) than in banana (8.7 mg/100 g), apple (4.6 mg/100 g), and pomegranate (6.1 mg/100 g)[26,27]. Vitamin C is an essential component of the diet because it plays a variety of functions in the processes of life. Pregnant women, nursing mothers, and children who are growing must consume a relatively high amount of vitamin C daily. Wild edible fruits are the primary source of vitamin C for indigenous populations. Vitamin C (ascorbic acid) is a crucial water-soluble vitamin that is already involved in the majority of life processes, but primarily serves as an antioxidant. Since ascorbic acid occurs more frequently in acidic mediums than in those with high pH values[29], the relatively high concentration of ascorbic acid in certain fruits may be attributable to the acidity caused by their bitter taste. Singh *et al*.[30] discovered similar observations. *Buchanania lanzan* Spreng. (28 2.6%), *Diospyros melanoxylon* Roxb. (27 2.0%), and *Flacourtia indica* (Burm. f.) Merr. (23 2.0%) had a greater sugar content than cultivated fruits such as sapota (21.4%), grapes (16.25%), and pomegranate (16.57%)[26,27]. *Miliusa tomentosa* (Roxb.) Finet & Gagnep. contained the least amount of total sugar (12%). *Buchanania lanzan* Spreng. contained the highest concentration of reducing sugar (20%), followed by *Flacourtia indica* (Burm. f.) Merr. (17%) and *Diospyros melanoxylon* Roxb. (14%). *Flacourtia indica* (Burm. f.) Merr. was found to contain the least amount of reducing sugar (7.9%). *Diospyros melanoxylon* Roxb. has a non-reducing sugar content of 11%, whereas *Miliusa tomentosa* (Roxb.) Finet & Gagnep. has 51%. Fruits' quality and sensory acceptability are largely determined by their sugar content. Reducing sugars play a significant role in determining the overall flavour and flavour of fruits[31,32]. In terms of total sugar, *Diospyros melanoxylon* Roxb. and *Flacourtia indica* (Burm. f.) Merr. exhibited a close correlation with the result of Vishwakarma and Dubey[33].

Conclusions

The result of the study revealed that knowledge about the edibility, habit, season of availability and uses of wild edible fruits are still maintained among the Sahariya tribal community. The preservation of this knowledge appears to be the result of continued reliance of local communities on the wild edible fruits. The study revealed that the community depends on wild fruits during scarcity and also sell some wild fruits in nearby market.

The morphological trait of *Diospyros melanoxylon* Roxb. is recorded superior with good shelf life. The biochemical make-up of the selected fruits shows their potential as a dietary supplement and as an alternative to conventional fruits, both of which can help people, especially those living in rural regions, overcome nutritional insufficiency. These findings indicate that natural fruits are a nutritious option for people generally living in rural and tribal areas. The nutritional profile of four native fruits was analysed to shed light on the richness of indigenous fruit diets and their potential utility as a replacement bio-nutrient source. In particular, species like *Buchanania lanzan*

Spreng. and *Diospyros melanoxylon* Roxb., which show promise as backyard plants and could be of tremendous use to farming systems suffering from crop loss, food scarcity, and chronic malnutrition. A value addition technique can be used to increase domestication of these wild fruit plants. Despite their understanding of local fruits, this primitive tribal community has not engaged in fruit tree growing, which would impoverish their nutritional profile and economic standing. In order to alleviate pressure on wild edible fruits in natural forest stands and generate economic benefits for the local tribal population. It is recommended that these underutilised wild fruit plant species be cultivated for commercial purposes and incorporated into traditional agroforestry systems.

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Conflict of Interest

The authors declare that they have no conflict of interest in the study undertaken.

Author Contributions

MKY- Conceptualization, field trips, data generation, data analysis, writing the manuscript, images; ASV- Suggestion, identification of plant specimen, Data analysis, editing/correcting manuscript; NKM- Editing/correcting manuscript, HC. Editing/correcting, AK- Editing/correcting, BK- Editing/correcting, AS- Editing/correcting.

Prior Informed Consent

All the respondents provided prior informed consent.

Data Availability

The author confirms that all data generated or analyzed during this study are included in this published article.

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