

Monkey jack: underutilized edible medicinal plant, nutritional attributes and traditional foods of Western Ghats, Karnataka, India

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Monkey jack (*Artocarpus gomezianus* Wall.ex Trecul) an underutilized edible and medicinal plant of Central Western Ghats has been studied for their distribution, harvesting, morphology and juice yield, processing, preservation and powder yield at various regions of Central Western Ghats. The fruits showed variation with respect to morphology, juice yield, powder yield, proximates and nutritive value and also elemental components. The comparative study with RDA value confirms the food supplements properties of monkey jack. The uses of fruits in particular and other parts in general differ from region to region. The harvesting, processing, preservation and marketing are closely related with social and cultural conditions of the particular region. The fruits not only sources of nutrients supplements but also one of the important resources for income generation at middle regions of the Western Ghats. Further, the raw and processed products, is one of the important traditional ingredients for the preparation of local dishes. Among the different regions, the fruits are harvested, processed and used based on traditional methods and knowledge. The study confirmed that conservation of monkey jack needs both *in vitro* and *in vivo* approaches. The awareness among the local people, encouragement from government organization, voluntary involvement of NGO and involvement of local young people and women for biodiversity conservation help to develop potential of monkey jack linkage of farmers/collectors to market. The importance of monkey jack for the future potential uses is also discussed for the middle regions of the Western Ghats.

Keywords: Biodiversity conservation, Monkey jack, Nutritional attributes, Traditional uses, Underutilized fruits, Western Ghats

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Monkey jack (*Artocarpus gomezianus* Wall. ex Trecul) is an underutilized wild edible and medicinal plant of Central Western Ghats. The fruits are the sources of proximates, nutritive value and elemental sources for the people of the mountain regions of Central Western Ghats of Karnataka. In addition, the fruit diversity also has a cultural and social value and contributes to the stability of ecosystem¹. The monkey jack fruit satisfies the conditions of underutilized species². Chandrasekhar Reddy³ reported that 500 species of tropical fruits which are edible and they are differed in their cultivation and also availability. The majority of the fruits are found in tropical region. The fruits are not only sources of food supplements but also potential resources for income generation. During last 2-3 decades, they have attracted attention of academicians, planners, administrators and also Pharmaceutics and pharamalogical companies. A few studies have been initiated not only in India

but also in other countries on their various aspects. However, there are no published reports with respect to nutritional attributes, utility, harvesting and traditional uses and also medicinal importance of fruits in the Central Western Ghats of Karnataka. The present paper deals with occurrence, harvesting, processing and preservation, utility and marketing of monkey jack at various regions of Western Ghats of Karnataka.

Methodology

Study area

The Western Ghats is one of the hotspots of biodiversity. The forest of Western Ghats is known for edible plants which include underutilized fruits. The monkey jack (*Artocarpus gomezinaus* Wall.ex Trecul), a well known underutilized fruits are found throughout the Western Ghats. The fruit samples are sampled at different regions of the Western Ghats of Karnataka for the year 2009 and 2010. The

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number of field visits was made at different places of Central Western Ghats to document the protocol of morphological of fruits, fruit juice and powder yield. The utility and market value of fruits were gathered from the local people based on the questionnaire and personal discussions. The fruits are subjected for determination of proximates, nutritive value, elemental components and the harvesting, processing, preservation and utility are documented.

Analytical method

The morphology and fruit yield were studied^{4,5}. The fruit material were prepared for analysis⁶. The components of proximates (percentage of ash, moisture, fat, fibre, protein and carbohydrates), and nutritive value are determined⁶⁻¹¹. The mineral components (macro, micro and heavy metals) have been determined^{6,7,10,11} using AAS and flame photometer in the laboratory of department of Applied Botany, Kuvempu University, Shankaraghatta and at the Central Coffee Research Institute (CCRI) Balehonnur, Chikamagalure district of Karnataka, India. The values of proximates and macronutrients are expressed in percentage and micro and also heavy metals are expressed in ppm and the nutritive values are expressed in Cal/100 gm. The average values are compared with RDA values.

Statically analysis

The mean, standard deviation, standard error and statistical significant are made with correlation analysis by using the minitab and SPSS software and the P values have been calculated^{12,13}.

Results

The result of the present study have been presented under following headings:

Harvesting, processing and preservation

The harvesting period is between April and May and it varies from region to region. The plants which are grown in the wild or private owned lands are harvested manually for fruits. Having harvested (Fig. 1, 1A), the fruits are made in to different categories (big, medium, small, regular and irregular shapes). The bigger and medium sized fruits are made in to thin half-moon shaped slices and they are dried under the direct sunlight (Figs. 1B - E). The slices are dried under sunlight for about 8-10 days (Fig. 1F). The seeds are separated and discarded. Simultaneously, slices are also dried for the analytic

purpose in the laboratory (Fig. 1G). The seed are separated and discarded (Fig. 1H). The remaining seeds of the dry slices are removed manually. The dried slices are treated with 3-5% common salt or mixed with 3% common salt and dried again. The processed product is known as *Huli seppe*. The contents are stored in earthen container for 2-3 yrs. The small sized irregular fruits are also made into small shaped slices and dried under direct sunlight for 8-10 days. The seeds are removed and it is pounded into powder along with 3-5% common salt. The content is known as powder or *wate pudi*. It is also stored in earthen container as detailed. The details of harvesting, processing and preservation are outlined in the flow chart (Fig. 2). The preserved slices or powder is filled into polythene bags of required quantity. Having labeled, the products are sold in local markets by retail traders (Fig. 1 I).

Morphology, juice and powder yield

The details of morphology, juice and powder yield of monkey jack (*Artocarpus gomezianus* Wall.ex.Trecul) are given (Table 1).

Morphological study of fruits is made with respect to weight, length, width and shape and also colour. The colour of the fruits varied from green, light green, yellow green depending on maturation. The shape of the fruit is in round, irregular ovate to elliptical with smooth are irregular surfaces. The weight of the fruit varied between 52.59 ± 10.85 and 245.50 ± 50.05 gm. The minimum weight of the fruit is recorded at Ashwatpura and maximum weight of the fruit is recorded at Banajalaya at costal and middle altitudes. The length of the fruit varied between 40.80 ± 0.30 and 70.90 ± 1.60 again at Ashwatpura and Banajalaya respectively. Whereas width of the fruit varied between 20.90 ± 0.09 and 60.00 ± 0.03 at Ashwatpura and Gubburu respectively. It's clear that the weight and length and also width of the fruit low at coastal regions and maximum weight and width are recorded at middle altitudes. Analysis of fruit juice yield reveals that the quantity of juice extracted from fruits 15 fruits is calculated to a maximum of 245.50 ± 50.05 ml for the fruits of Banajalaya, while a minimum of 52.59 ± 10.85 ml is calculated for the fruits of Ashwatpura. Analysis of fruit powder yield reveals that the quantity of powder is calculated to a maximum of 8.12 ± 0.78 gm and minimum of 6.03 ± 0.58 gm for the fruits of Banajalaya and Ashwatpura, respectively. Of the six different regions of Central Western Ghats, the maximum weight of



Figs. 1 A—H Details of harvesting, processing and preservation; A. Manually harvesting; B. Harvested fruits; C. Graded fruits; C. Halving of fruits; D. View of halved and half moon shape; E. View of slices drying; F. View of drying in laboratory; G. View of slices removed seeds drying in laboratory; H. Powder of monkey jack in polythene bags

the fruits is recorded at Banajalaya and minimum weight of the fruits is recorded at Ashwatpura respectively. In case of Banajalaya the weight of the fruit is high the powder yield is also high. But in case of Ashwatpura weight of fruit is low, but the powder yield is also low.

Value added products

In addition to above raw and processed products, the monkey jack is also used in the preparation of local dishes. The local dishes are specific for specific region. The dishes reflects social and cultural heritage of the region. The dishes are prepared on

traditional knowledge. The details of a few dishes are documented. The above protocols are documented by interviews and personal involvement during the preparation and consumption at Banajalaya, Navanagere and Gubburu which are located on the middle region of the Central Western Ghats

Preparation of powder

The processed or preserved slices are pounded for fine powder along with 2 - 3% of cooking salt. The product is known as *Vatte pudi* or *Esluli pudi*. The powder is used instead of tamarind (*Tamarindus indica* L.) to prepare curry and other dishes by the

local inhabitants of Banajalaya of Shimoga, Gubburu of Chikmagalur and Navanagere of Uttra Kannada districts, respectively (Fig. 1I).

Preparation of juice

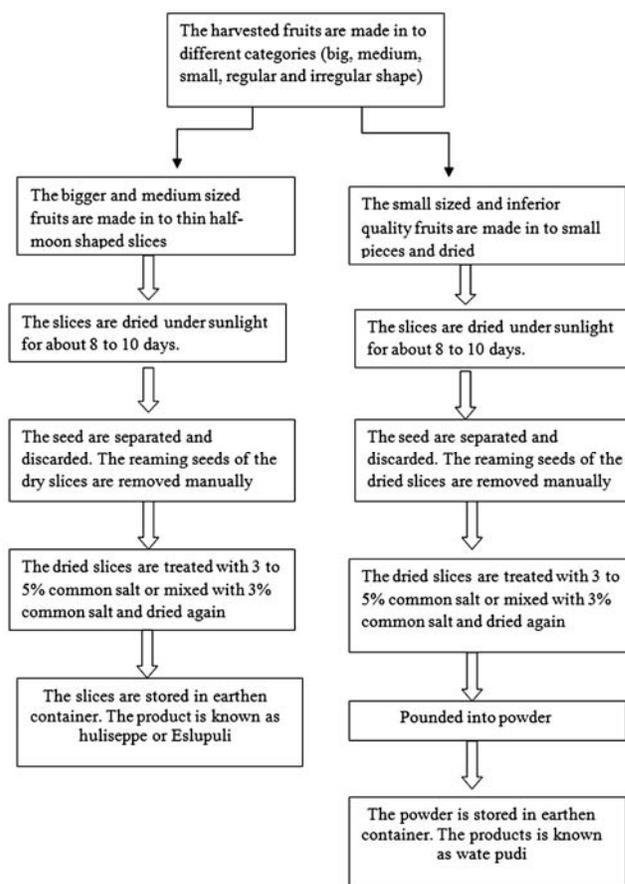
The known quantity of deseeded and epicarp removed pulp is mixed with equal amount of water and ground in a mixer along with a known quantity of sugar. The slurry is filter and a pinch of cardamom [*Elettaria cardamomum* (L.) Maton] and black pepper (*Piper nigrum* L.) are added. The preparation is used as juice (Figs. 3 A & C)

Preparation of papad

Prepare a paste with raw rice (*Oryza sativa* L.), green gram (*Phasleolus aureus* Zuccagni) black gram [(*Vigna mungo* (L) Hepper] along with small amount of jeera (*Cuminum cyminum* L.), pepper powder (*Piper nigrum* L.), chilli powder (*Capsicum annum* L.), salt and oil. Prepare an aqueous extract of fresh fruits of monkey jack (*Artocarpus gomezianus* Wall.ex Trecul) and mixed it with paste which is already prepared as above. The paste is pasted on banana leaf or thick plastic sheets and dried under direct sunlight. The product is known as *papad*. It is roasted on a direct fire or oil and it is eaten (Fig. 3 B).

Preparation of samber

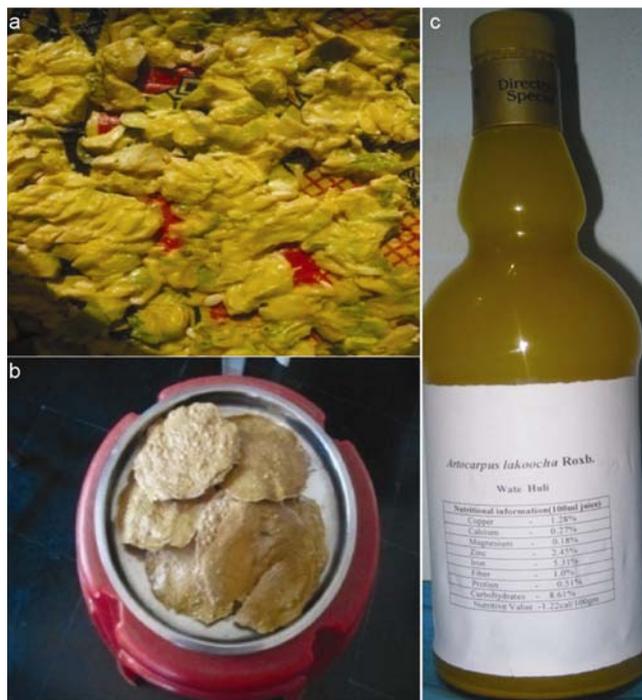
The required amount of vegetables are taken, washed, dried and made in to pieces. Boiled the vegetables along with dhal Pigeon pea



Figs. 2—Diagrammatic representation of harvesting, processing and preservation of slices and powder of monkey jack (*Artocarpus gomezians* Wall.ex Trecul) (at Banajalaya middle region of the Western Ghats).

Table 1—Morphological details of monkey jack at various places (width and length are expressed in mm and shape and colour by visual observation) juice yield is expressed in ml and weight of the fruit and powder yield are expressed in gm/15 fruits

Place	Altitude (meter)	Morphology of fruits				Colour	Juice yield		Powder yield		
		Weight of fruits Mean ± SE	Length Mean ± SE	Width Mean ± SE	Shape		Weight of fruits	Juice extracted	Weight of residue (seed and pulp)	Weight of fruit	Weight of powder
Ashwatpura/ Coastal region	22	52.59 ± 10.85	40.80 ± 0.30	20.90 ± 0.09	Round irregular	Green	52.59 ± 10.85	35.25 ± 0.25	14.99 ± 0.29	52.59 ± 10.85	6.03 ± 0.58
Padubidare/ Coastal region	147	62.34 ± 12.1	50.8 ± 1.15	40.10 ± 0.09	Round slightly irregular	Green	62.34 ± 12.14	45.56 ± 0.64	18.47 ± 0.45	62.34 ± 12.14	7.27 ± 0.71
Banajalaya/ Middle region	579	245.50 ± 50.05	70.9 ± 1.60	40.00 ± 0.05	Oval to elliptical	Light green	245.50 ± 50.05	98.67 ± 0.88	38.74 ± 0.44	245.50 ± 50.05	8.12 ± 0.78
Navanagere/ Middle region	590	59.94 ± 11.99	60.9 ± 0.78	50.00 ± 0.04	Round irregular	Green	59.94 ± 11.99	36.56 ± 0.28	14.97 ± 0.41	59.94 ± 11.99	6.08 ± 0.59
Gubburu/ Higher region	763	143.47 ± 29.35	70.00 ± 1.40	60.00 ± 0.03	Round smooth	Yellowish green	143.47 ± 29.35	56.35 ± 0.87	22.39 ± 0.48	143.47 ± 29.35	7.11 ± 0.69
Etinala/ Higher region	949	79.57 ± 16.03	70.9 ± 1.59	50.00 ± 0.05	Oval smooth	Yellowish green	79.57 ± 16.03	49.50 ± 0.55	19.18 ± 0.20	79.57 ± 16.03	6.28 ± 0.61



Figs. 3—A-C Preparation of juice and papad from the fruit sample of *monkey jack* A. a view of halved fruits, B. Papad, C. Juice

(*Cajanus cajan* (L.) Millsp. Having boiled vegetables and dhal, add sufficient quantities of salt. Simultaneously, fry the required amount of coriander (*Coriandrum sativum* L.) black gram [(*Vigna mungo* (L.) Hepper.] and fenugreek (*Trigonella foenum-graecum* L.) chilli (*Capsicum frutescens* L.) and curry leaves [(*Murraya koenigii* (L.) Spreng.)] on a low flame either with coconut oil or ground nut oil. Add sufficient quantity of preserved slices of monkey jack (*Artocarpus gomezianus* Wall.ex Trecul) or powder or fresh fruits along with required amount of copra (*Cocos nucifera* L.), grind them into fine past. Transfer the entire content into the boiling vegetables and dhal. Add 2-3 pieces of chilli, a little quantities of oil, turmeric powder (*Curcuma longa* L.) and fenugreek (*Trigonella foenum-graecum* L.), mustered [*Brassica juncea* (L.) Czern] and curry leaves [(*Murraya koenigii* (L.) Spreng.)]. Fry and transfer the entire content into the preparation. The prepared products are known as samber. It is used along with rice or other edible items (Figs. 4 A-D).

Preparation of fish curry

The clean and dried metallic container is taken sufficient amount of oil and mustard seeds (*Brassica juncea* (L.) Czern] are added. When mustard seeds



Figs. 4—A-D Preparation of Hulli from the fruit sample of *monkey jack* A. Ingredients of Hulli (samber), B. Mixing of ingredients, C. Squashing of sliced vate huli, D. Grinding of ingredients

are crackled, a pinch of fenugreek (*Trigonella foenum-graecum* L.) and garlic (*Allium sativum* L.) and curry leaves [(*Murraya koenigii* (L.) Spreng.)] are added. Simultaneously, sufficient quantities of chopped onion (*Allium ampeloprasum* L.) and fried are added, a medium flame until the content turn into golden yellow colour. The chopped tomatoes and salt are also added. The content is fried until the oil separated from the mixture. The sufficient amount of chili powder (*Capsicum annum* L.) coriander powder (*Coriandrum sativum* L.) and turmeric powder (*Curcuma longa* L.) are added and fried for few minutes. Then sufficient quantity of aqueous extract of fresh or preserved monkey jack (*Artocarpus gomezianus* Wall.ex Trecul) fruits are added under low flame and continued the cooking for 10 minutes. The milk of copra (*Cocos nucifera* L.) and the fish pieces are slowly added. The cooking is continued for another 10 minutes or required time or desired time. The container is removed from the flame and kept for five minutes. The product is known as fish curry (Figs. 5 A-D).

Preparation of chicken samber

Prepare a *masala* by grinding required amount of onion (*Allium ampeloprasum* L.), garlic (*Allium sativum* L.), clove [(*Syzygium aromaticum* (L.) Merr. et Perry], cardamomum [(*Elettaria cardamomum*



Figs. 5—A-D Preparation of fishA. Ingredients along with preserved slices of monkey, B. Frying of ingredients, C. Mixing of milk of copra and fish pices, D. Preparation fish curry

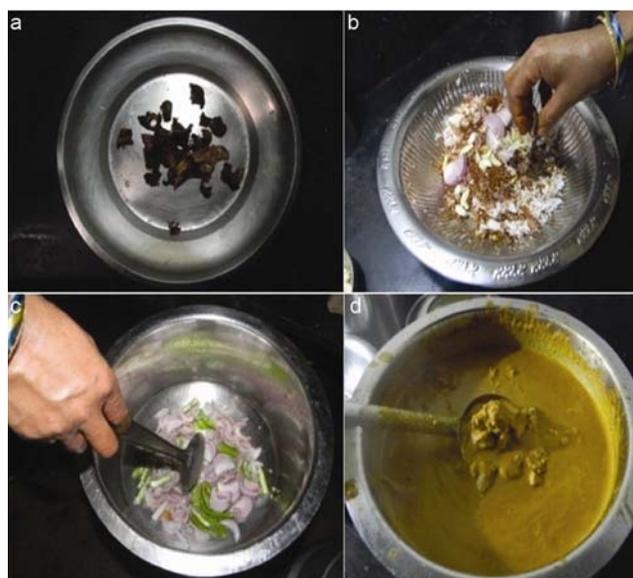
(L.) Maton] coconut (*Cocos nucifera*), salt, and preserved slices of monkey jack (*Artocarpus gomezianus* Wall.ex Trecul) At the same time, the clean and dried container is taken and sufficient quantity of oil and mustard seeds [*Brassica juncea* (L.) Czern] are added. And fried on a low flame. When mustard seeds crackled, sufficient quantity of curry leaves [*Murraya koenigii* (L.) Spreng.], chopped onions (*Cocos nucifera* L.) and chilli (*Capsicum frutescens* L.) are added. When the components turn in to golden yellow colour, transfer the *masala* into the container. Mix well under low flame and continue cooking for 10-15 minutes. The cleaned and washed pieces of chicken are added carefully. The mixture is boiled for another 20 minutes and the product is known as chicken samber (Figs. 6 A-D).

Proximates and nutritive value

The maximum, minimum and average value of proximates, nutritive value and elemental components are given: (Table 2):

The proximates values ranged in the following order at different regions

Place/region/ altitude in meter	Variation of proximate based on their concentration
Ashwatpura/ 22	Moisture>Fat>Fibre>Carbohydrates >Ash>Protien
Padubidare/ 147	Moisture > Fibre > Carbohydrates > Ash > Fat > Protien



Figs. 6—A-D Preparation of chicken A. Preserved slice of monkey jack, B. Mixing of slices and other ingredients, C. Frying of ingredients along with onion pieces, D. Boiling of mixture along with cleaned and washed pieces of chicken

Banajalaya/ 579	Moisture > Fat > Fibre > Carbohydrates > Ash > Protien
Navanagere/ 590	Moisture > Fat > Ash > Carbohydrates > Fibre > Protien
Gubburu/763	Moisture > Fat > Ash > Fibre > Carbohydrates > Protien
Etinala/ 949	Moisture > Fat > Fibre > Carbohydrates > Ash > Protien

Through, the moisture is the dominante proximate, its ranged value between maximum (81.32 %) and minimum (87.78 %) is very narrow. The protein is the lowest in their concentration. However, the range value between minimum (0.12 %) and maximum (0.51 %) is wider. The values of ash ranges between 1.50 % and 5.33 % , moisture 81.32 % and 87.78 % , fat 3.17% and 15.00 % , fibre 1.84 % and 10.21 % , protein 0.12 % and 0.51 % , and carbohydrates between 1.36 % and 8.62 % , respectively. Of the six proximate values, four proximates, fat, fiber, protein and carbohydrates are recorded highest in the fruits of costal region. The highest percentage of ash and moisture are recorded in the middle and higher altitude fruit samples. In addition the nutritional values of the fruits are highest in the fruits of costal samples and it is accompanied by high amount of proximates which included fat, fibre, protein and carbohydrates.

Table 2—Altitudinal variations in nutritive value and mineral components (Mean \pm S.D.; n = 4) of monkey jack (*Artocarpus gomezians* Wall.ex Trecul) in Western Ghats of Karnataka, India.

Sl. No.	Place\ altitude (in meter)	Ashwatpura (22)	Padubidare (147)	Banajalaya (579)	Navanagere (590)	Gubburu (763)	Etinala (949)
		Mean \pm SD	Mean \pm SD	Mean \pm SD	Mean \pm SD	Mean \pm SD	Mean \pm SD
Macronutrients (in percentage)							
1	Sodium (Na)	0.55 \pm 0.44	0.24 \pm 0.10	0.68 \pm 0.52	0.28 \pm 0.15	0.32 \pm 0.19	0.63 \pm 0.52
2	Potassium (K)	1.47 \pm 0.17	0.76 \pm 0.58	1.45 \pm 0.07	0.87 \pm 0.55	0.85 \pm 0.47	1.44 \pm 0.22
3	Phosphorus (P)	0.22 \pm 0.02	0.26 \pm 0.04	0.13 \pm 0.02	0.10 \pm 0.02	0.10 \pm 0.009	0.16 \pm 0.03
4	Calcium (Ca)	0.26 \pm 0.04	0.083 \pm 0.069	0.10 \pm 0.07	0.14 \pm 0.04	0.123 \pm 0.075	0.19 \pm 0.10
5	Magnesium (Mg)	0.15 \pm 0.055	0.098 \pm 0.066	0.11 \pm 0.04	0.15 \pm 0.03	0.18 \pm 0.01	0.12 \pm 0.02
6	Nitrogen (N)	19.24 \pm 0.046	21.48 \pm 0.69	23.48 \pm 1.00	21.25 \pm 0.00	21.86 \pm 2.31	21.18 \pm 2.69
Micronutrients (in ppm)							
7	Zinc (Zn)	24.52 \pm 5.37	24.92 \pm 10.24	19.82 \pm 8.89	20.86 \pm 9.61	20.29 \pm 7.83	24.01 \pm 11.15
8	Copper (Cu)	9.76 \pm 4.71	12.84 \pm 3.57	10.06 \pm 2.47	9.36 \pm 2.61	9.85 \pm 3.95	7.81 \pm 1.92
9	Iron (Fe)	531.74 \pm 240.77	802.01 \pm 375.28	355.30 \pm 145.84	622.98 \pm 368.86	321.66 \pm 6.46	284.95 \pm 48.39
	Manganese (Mn)	46.81 \pm 5.22	95.29 \pm 20.85	34.14 \pm 6.93	64.30 \pm 9.04	103.49 \pm 6.62	36.12 \pm 6.93
Heavy metals (in ppm)							
11	Lead (Pd)	29.76 \pm 42.78	40.95 \pm 29.90	39.88 \pm 27.34	43.56 \pm 29.85	44.48 \pm 30.90	43.25 \pm 25.24
12	Cadmium (Cd)	2.16 \pm 0.83	1.81 \pm 1.39	1.98 \pm 1.18	3.01 \pm 0.93	1.95 \pm 1.44	2.30 \pm 1.64
Proximates (in percentage)							
13	Ash	2.83 \pm 1.21	3.25 \pm 0.38	1.50 \pm 0.50	5.33 \pm 0.94	3.83 \pm 0.37	1.83 \pm 0.37
14	Moisture	86.95 \pm 2.56	84.33 \pm 1.43	81.32 \pm 4.47	85.22 \pm 2.74	87.78 \pm 1.44	86.38 \pm 3.81
15	Fat	15.00 \pm 5	3.17 \pm 1.49	10.58 \pm 0.34	11.50 \pm 2.08	9.00 \pm 0.50	7.92 \pm 0.73
16	Fibre	10.00 \pm 0.00	10.21 \pm 1.72	8.43 \pm 1.28	2.53 \pm 0.48	1.84 \pm 0.36	7.47 \pm 0.25
17	Protein	0.12 \pm 0.10	0.51 \pm 0.10	0.14 \pm 0.10	0.24 \pm 0.24	0.28 \pm 0.23	0.36 \pm 0.26
18	Carbohydrates	8.62 \pm 4.93	7.57 \pm 3.14	6.54 \pm 4.69	3.17 \pm 3.47	1.36 \pm 0.93	6.65 \pm 3.30
Nutritive Value (Cal/100 gm)							
19	Nutritive value	114.87 \pm 11.14	72.53 \pm 26.59	121.53 \pm 20.37	95.30 \pm 11.78	85.57 \pm 13.17	78.86 \pm 23.13

Elemental composition

The macronutrients can be arranged as detailed below on the basis of the concentration

Place/region/altitude in meter Variation of macro elements based on their concentration.

Ashwatpura/22	Nitrogen>Potassium>Sodium>Calcium>Phosphorus>Magnesium
Padubidare /147	Nitrogen > Potassium > Phosphorus > Sodium > Magnesium > Calcium
Banajalaya/ 579	Nitrogen > Potassium > Sodium > Phosphorus > Magnesium > Calcium
Navanagere /590	Nitrogen > Potassium > Sodium > Magnesium > Calcium > Phosphorus
Gubburu /763	Nitrogen > Potassium > Sodium > Magnesium > Calcium > Phosphorus
Etinala /949	Nitrogen > Potassium > Sodium > Calcium > Phosphorus > Magnesium

Nitrogen is the dominate element and phosphorus or calcium or magnesium is the lowest element in their concentration. The positions of the elements vary

at different regions except nitrogen and potassium. Of the six elements, potassium, phosphorus, calcium and magnesium are high in the costal region except nitrogen and sodium which are highest in the middle regions of Central Western Ghats. At the same time, the macronutrients are rich in the fruit samples of costal regions.

Similar to macronutrients, the micronutrients zinc, copper and iron are rich in fruit samples of costal regions, whereas manganese are rich in fruit samples of higher altitudes.

In contrast to proximates, macro and microelements, the heavy metals lead and cadmium are more in fruit samples of middle and higher altitudes. However, their percentage values are very low.

Comparison with RDA value of proximate and elemental components

When the recorded values are compared with RDA values (Table 3) all the macronutrients are rich in

Table 3—Comparison of Recommended Dietary Allowances (RDA) with Proximate, nutritive value and elemental composition of *Artocarpus gomezians* Wall.ex Trecul

Place	Ashwatpura	Padubidare	Banajalaya	Navanagere	Gubburu	Etinala	Recommended Dietary Allowances						Ref.
							Females			Male			
							9-13 years	14-18 years	19-30 years	9-13 years	14-18 years	19-30 years	
Altitude in meter	22	147	579	590	763	949							
I. Macronutrients (mg/lgm)													
Sodium (Na)	55	24	68	28	32	63			250mg/d				Ref. ¹⁴
Potassium (K)	14.7	76	14.5	8.7	8.5	14.4			250mg/d				Ref. ¹⁴
Calcium (Ca)	26	83	10	14	12.3	19	1.250mg	1.250mg	700mg	1.250mg	1.250mg	700mg	Ref. ¹⁴
Magnesium (Mg)	15	9.8	11	15	18	12	1.300mg	1.300mg	1.00mg	1.300mg	1.300mg	1.00mg	Ref. ¹⁴
Nitrogen (N)	-	-	-	-	-	-	-	-	-	-	-	-	Ref. ¹⁴
II. Micronutrients(mg/lgm)													
Zinc(Zn)	0.24	0.24	0.19	0.20	0.20	0.24	8mg/d	8mg/d	8mg/d	8mg/d	8mg/d	11mg/d	Ref. ¹⁴
Copper(Cu)	0.9	0.12	0.10	0.93	0.98	0.78	700mg/d	890mg/d	900mg/d	700mg/d	890mg/d	900mg/d	Ref. ¹⁴
Manganese (Mn)	0.53	0.80	0.35	0.62	0.32	0.28	1.6mg/d	1.6mg/d	1.8mg/d	1.9mg/d	2.2mg/d	2.3mg/d	Ref. ¹⁴
Iron (Fe)	0.46	0.95	0.34	0.64	0.10	0.36	8mg/d	15mg/d	18mg/d	8mg/d	11mg/d	8mg/d	Ref. ¹⁴
III. Heavy metals(mg or %/lgm)													
Lead (pb)	0.29	0.40	0.39	0.43	0.44	0.43				5.4%			Ref. ¹⁴
Cadmium(cd)	0.21	0.18	0.19	0.30	0.19	0.20				2.9%			Ref. ¹⁴
IV. Proximate(mg or %/lgm)													
Ash	2.83	3.25	1.50	5.33	3.83	1.83				NA			Ref. ¹⁵
Moisture	86.95	84.33	81.32	85.22	87.78	86.38				NA			Ref. ¹⁵
Fat	15.00	3.17	10.58	11.50	9.00	7.92				NA			Ref. ¹⁵
Fibere	0.10	0.10	0.84	0.25	0.18	0.74				25 to 30gm			Ref. ¹⁵
Protien	0.12	0.51	0.14	0.24	0.28	0.36				44 to 58 gm.			Ref. ¹⁵
Carbohydrates	8.62	7.57	6.54	3.17	1.36	6.65				55 to 60%.			Ref. ¹⁵
Nutritive Value (Cal/100gm)	114.87	72.53	121.53	95.30	85.57	78.86				NA			Ref. ¹⁵
Conversion of percentage into mg = $\frac{\text{Graph ppm} \times \text{Dilution factor} \times \text{Volume of plant digestion made}}{10^6} \times 10000$ Weight of the plant sample													

fruits of monkey jack (*Artocarpus gomezianus* Wall.ex Trecul). Similar to macronutrients, micronutrients and two heavy metals which are also essential at low concentration are also found in fruits of monkey jack (*Artocarpus gomezianus* Wall.ex Trecul)^{14,15}. The components of proximate (percentage of ash, moisture, fibre, protein and carbohydrates) are also rich in fruit of monkey jack (*Artocarpus gomezianus* Wall.ex Trecul). Therefore, fruits of monkey jack are nutritionally rich underutilized.

Marketing value

Monkey jack is one of the important underutilized fruits of Central Western Ghats. The fruits are used as raw and also their products. The uses varied from different regions of Central Western Ghats. Of the six regions, the raw fruits are sold at Etinal of Hassan, Padubidari of Udupi and Ashwatpura of Dhakshin Kannada districts. Whereas the raw fruits consumed local people and the products are preserved and used and also marketed at Navanagere of Uttara Kannada, Banajalaya of Shimoga and Gubbure of Chickamagalur district. The maximum edible products are prepared at Navanagere which is followed by Banajalaya and Gubbur. The cost of raw fruit and processed products varies from region to region. The cost of the raw fruits ranged between Rs 500 and 600/100 Kg, whereas, the cost of the processed slice and powdered ranged between Rs.7000 and 8500/100 Kg. Therefore, monkey jack is one of the important forest products which generate employment and revenue at middle altitude of Western Ghats.

Discussion

The wild edible fruit of monkey jack (*Artocarpus gomezianus* Wall.ex Trecul) is well known multipurpose fruits of the moist deciduous forest of Central Western Ghats. It is not only a medicinal plant but also an underutilized fruit both in India and neighbouring country^{16,17}. The observation of Chandrashenkar Reddy³ reveals that edible fruit tree species of two vegetation types of Kodagu and emphasized the rich food resources. However, Uthaiiah (of Chandrashenkar Reddy)³ said that through there are several plant species of Western Ghats yield edible fruits and vegetables, there are no reported accounts exist at present to deal with status of wild edible species. Similarly to the earlier studies^{4,5,7,17} who have studied nutritive values and the mineral elements of medicinally valued plants from Uttaranchal,

nutritional attributes of *Elaeagnus rhamnoides* (Seabuckthorn) populations from Uttarakhand, and nutritive values of wild edible fruits, berries, nuts, roots and spices of *Khasi* tribes of India, the present study also reveals the importance of wild edible fruits. Further,^{4,5,7,17} they also mentioned the role of proximates, macro and micro elements and nutritive values. The investigation of Dhyani *et al.*⁴ explained the importance of wild bio resources to solve unemployment problem in the rural sector and to improve socio-economic and environmental balance. Agrahar-Murugkar *et al.*¹⁷ and Indrayan *et al.*⁷ discussed the nutritional profits of edible plant resources and classified the edible plants into food, fodder and medicinal uses respectively. The present study reveals that the monkey jack is one of the important underutilized fruits which not only generate income but also provide employment opportunities. Further, the maximum traditional foods which are being prepared contain monkey jack as one of the components. The harvesting, processing and preservation not only help to preserve the products but also increase remarkable income. The raw fruits earn Rs 500 - 600/100 kg and processed products Rs 7000-8000/100 Kg, respectively. In addition the awareness with reference to nutrients and elemental components of monkey jack, the voluntary organizations and institutes help in capacity buildings of local inhabitants. The programmers of Forest Department Government of Karnataka have initiated planting of wild edibles including monkey jack. The local people established home garden where they have cultivated majority of the wild edibles including monkey jack. The processed and preserved products are sold in the local market by collecting and labeling through the cooperative societies and voluntary organization. The processed and preserved products help for transportation and storage. The collection of local products through cooperatives societies and marketing facilities decreased the cost of transportation and storage. Simultaneously, the monkey jack increased their market value through processing, value addition and preservation by traditional knowledge. It is also interesting to note that the uses of tamarind (*Tamarindus indica* L.) which is one of the important components for the preparation of dishes is replaced by monkey jack (*Artocarpus gomezianus* Wall.ex Trecul) in the rural area of middle altitudinal region of Western Ghats. Therefore the holistic approaches for linkage from farmers to marketing is well established

in the middle region of Western Ghats, through it is partially or total absent in the costal and higher mountain regions. When model is compared with the model of kokum fruits,¹⁸ the model of monkey is well established in the middle region of Western Ghats.

Recommendations

Having studied, the following recommendations are made:

- 1 The conservation of monkey jack along with other wild edible needs priority as it is one of the multipurpose tree of Western Ghats.
- 2 The data reveal that fruits are edible and potential sources for food supplements. It also replaces uses of tamarind (*Tamarindus indica* L.) one of the important ingredients in the preparation of dishes in the mountain region of Western Ghats.
- 3 The proposed holistic model for conservation not only helps in conservation of biodiversity but also conservation of social, traditional and cultural heritage
- 4 The documented protocol for harvesting, preservation, grading and marketing may initiate establishment of cottage industries.
- 5 The entire tree is used not only for food and fodder but also other uses. Therefore the monkey jack needs study and conservation.

Conclusion

Wild edible are the important resources to provide nutrients supplements and to generate income. The majority of the NTFPs have come to near extension, because of unsustainable marketing and demand. The monkey jack an underutilized fruits of Western Ghats is a potential sources for proximates, nutrients and elemental components. The entire plant is used one or the other way, the plant is also a medicine not only in India but also in other tropical countries. The traditional systems of medicine reveal that all the parts of the plants have medicinal uses. The present investigation reveals that monkey jack is one of the important wild edible and medicinal plants. The traditional knowledge for processing, preservation and value added products are closely related with social and cultural status of the local people. The study is useful not only to known the various aspects of monkey jack but also useful in conservation of biodiversity and traditional knowledge.

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