

## Determination of nutritive value of *Ziziphus rugosa* Lamk.: A famine edible fruit and medicinal plant of Western Ghats

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An attempt has been made to determine proximates, nutritive value, elemental composition and heavy metal content of the ripe, unripe pulp and seeds of *Ziziphus rugosa* Lamk. for two years (2009 and 2010). The edible parts of the pulp and seeds were separately analyzed with reference to their unripe and ripe conditions. The macronutrients studies of pulp reveal that nitrogen was the highest which was followed by potassium, calcium, sodium, magnesium and Phosphorus in case of unripe pulp, whereas in case of ripe pulp nitrogen was followed by potassium, magnesium, sodium, calcium and Phosphorus. Among the micronutrients iron was the dominant element which was followed by manganese, zinc and copper both in ripe and unripe pulp, respectively. The heavy metals, lead and cadmium were recorded only during 2009 and the lead was highest and values of cadmium were low not only in ripe pulp but also in unripe pulp. Among the components of nutritive value the moisture was the highest which is followed by carbohydrates, ash, fat, fibre and proteins, in case of unripe pulp, whereas in case of ripe pulp, the moisture was followed by carbohydrates, protein, fibre, fat and ash contents. In seeds, among the macronutrients nitrogen, was again the dominant and which was followed by potassium, magnesium, phosphorus and calcium in case of ripe seeds and nitrogen was followed by potassium, phosphorus, magnesium, sodium and calcium in unripe seeds, respectively. In case of micronutrients, iron was the dominant metals which was followed by manganese, zinc and copper both in unripe and ripe seeds. The lead was the dominant heavy metal not only in ripe seeds but also in unripe seeds. Among the proximates, the carbohydrates was the dominate proximate which was followed by moisture, fat, fibre, ash and protein in case of ripe seed and carbohydrates was followed by moisture, protein, ash, fat and fibre in case of unripe seeds. Between the pulp and the seeds, the seeds have more nutritive value than that of pulp and again the unripe seeds are more nutritious than the ripe seeds. The variation of macronutrients and proximates between unripe and the ripe components in pulp and seeds is statistically significant ( $P=0.00032$  for pulp and  $P=0.00052$  for seeds and  $P=0.000158$  for pulp and  $P=0.0032$  for seeds, respectively). At the same time variation of micronutrients between pulp and seeds is not significant ( $P=1.426$  for pulp and  $4.227$  for seeds, respectively). The average values of proximate, nutritive values and elemental components of pulp of *Z. rugosa* are compared with Recommended Dietary Allowances (RDA) values and discussed. Further, the uses of pulp of fruits to establish cottage industries to improve economic and social condition of local people are appended.

**Keywords:** Elemental composition, Famine food, Medicinal, Nutritive, Seed, Western Ghats, Wild fruit, *Ziziphus rugosa*.

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### Introduction

The wild fruits are important sources of minerals, fibre and vitamins, which provide essential nutrition for the human health. Though a few wild fruits are anti-nutritional and with diminish nutrient bioavailability. The majority of them are good source of nutrients which include carbohydrates, oils, proteins, minerals and ascorbic acid. The protein malnutrition is a major public health problem and can be solved by edible wild fruits<sup>1-3</sup>. The plants of *Ziziphus* species are multipurpose plants with great potential for ethnomedicinal use all over the world. *Ziziphus rugosa* Lamk. is a large straggling armed

shrub and belongs to the family Rhamnaceae. It is grown widely in the dry deciduous forest of Central Western Ghats. The fruits are commonly known as *Mullanu*, *Kottimullu* and *Badara* and are the known famine, medicinal and edible fruits. Further, the bark of root and stem, leaves and flowers are used in the preparation of herbal formulations<sup>4-9</sup>. The fruit is described as demulcent and enter into the treatment of throat and broncho-pulmonic irritations and the dried powdered leaves and fruits are applied topically in the treatment of boils<sup>10</sup>. The phytochemical studies with reference to alkaloids, flavones, glycosides and saponins were made by Tripathi *et al*<sup>11</sup> and Pandey and Tripathi<sup>12</sup> and isolated rugosanine-A: N-formylcyclopeptide alkaloid and uncharacterized

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isoquinoline from the stem bark of *Z. rugosa*. The antibacterial, antifungal and  $\beta$ -glucuronidase inhibitory activity of the extract of leaves and bark of *Z. rugosa* and *Z. oenoplia* were studied by Shoeb *et al*<sup>13</sup>. The present study is aimed to determine the proximates, nutritive value and elemental composition of unripe and ripe pulp and seeds of *Z. rugosa*, respectively.

### Materials and Methods

The fruit samples were collected from the Kuvempu University campus (Plate 1). The campus has an area of 230 ha and it is on the latitude of 13° 42' 20" N and longitude of 75° 13' 22" E. The area comes under Central Western Ghats<sup>5</sup>.

#### Collection of plant material and preparation of sample for analysis

The mature unripe and ripe fruits were collected during February and March of 2009 and 2010. The fruit samples were washed and shade dried. The pulp and seeds of both ripe and unripe fruits were continued for shade drying and powdered for further analysis.

The nutritive value is calculated on the basis of following parameters using the crushed seeds and pulp of unripe and ripe fruits, respectively.

#### Ash content

Ten gram of each sample was weighed in a silica crucible. The crucible was heated first over a low

flame till all the material was completely charred, followed by heating in a furnace for about 3-5 h at 600°C. It was cooled in a desiccator and weighed to ensure the completion of ashing. To ensure completion of ashing it was heated again in the furnace for half an hour, cooled and weighed. It was repeated till the weight become constant (ash become white or grayish white). Weight of the ash gave the ash content<sup>14</sup>. The ash content is expressed in percentage.

#### Moisture content

The samples materials were taken in a flat-bottom dish and kept overnight in a hot air oven at 100-110°C and weighed. The loss in weight was regarded as a measure of moisture content<sup>15</sup>. The moisture content is expressed in percentage.

#### Crude fat

The crude fat was determined by extracting 2 g moisture free samples with petroleum ether in a Soxhlet extractor, heating the flask on sand bath for about 6 h till a drop taken from the drippings left no greasy stain on the filter paper. After boiling with petroleum ether, the residual petroleum ether was filtered using Whatman No. 40 filter paper and the filtrate was evaporated in a pre-weighed beaker. Increase in weight of beaker gave the crude fat<sup>14,16</sup> and the percentage of crude fat is expressed.

#### Crude protein (Lowery's methods)

The protein is extracted from the samples by the enzyme assay, 500 mg of the sample is taken and grind by using pestle and mortar in 5-10 ml of the buffer. The mixture is centrifuged and used the supernatant for protein estimation. The protein is calculated from standard graph<sup>17</sup>. The value of protein is expressed in percentage.

#### Crude fibre

The crude fibre estimation was based on treating the moisture and fat free material with 1.25% dilute acid, then with 1.25% alkali, thus initiating the gastric and intestinal action in the process of digestion. 2 g of moisture and fat free material was treated with 200 ml of 1.25% H<sub>2</sub>SO<sub>4</sub>. After filtration and washing, the residue was treated with 1.25% NaOH. It was filtered, washed with hot water and then with 1% HNO<sub>3</sub> and again with hot water. The residue was ignited and the ash was weighed. Loss in weight gave the weight of crude fibre<sup>14</sup>. The percentage of fibre is expressed.



Plate 1 — *Ziziphus rugosa*: (a) Plant with ripe and unripe fruits; (b) Inflorescence with early development of fruits; (c) The separated unripe and ripe fruits (d) The powdered samples of unripe and ripe fruits for analysis.

**Carbohydrates**

The percentage of carbohydrates was calculated by the following formula:

$$\text{Carbohydrates} = 100 - [\text{percentage of ash} + \text{percentage of moisture} + \text{percentage of fat} + \text{percentage of protein}]^{14}.$$

**Nutritive value**

At the end the nutritive value was calculated by:

$$\text{Nutritive value} = 4 \times \text{percentage of protein} + 9 \times \text{percentage of fat} + 4 \times \text{percentage of carbohydrate}^{14}.$$

**Mineral analysis****Determination of macro elements***Samples Preparation*

One gram of powdered dried plant material was taken in 250 mL of conical flask, 25 to 35 ml of diacid mixture (900 ml HNO<sub>3</sub> + 400 ml perchloric acid) was added, and each conical flask was closed by using funnels. Then digestion was carried out by using hot plates at 1 h to get clear solution in 10 min then added 50 ml of distilled water and filtered by using Whatman filter paper. After completion of filtration, the content was transferred quantitatively to 100 ml of volumetric flask and final volume was adjusted to 100 ml by adding distilled water<sup>18</sup>.

*Determination of Sodium and Potassium*

The concentration of sodium and potassium were determined with the help of flame photometer using separate standards of sodium and potassium. The yellow coloured solution was aspirated at the wave length of flame photometer to detect the concentration of sodium and potassium. Finally the percentage of sodium and potassium were calculated with the help of following formula:

$$\% \text{ of Na/ K} = \frac{\text{Graph ppm}}{10^6} \times \text{Dilution factor} \\ \times \frac{\text{Volume of plant digestion made}}{\text{Weight of the plant sample}} \times 100$$

*Determination of Phosphorus*

Orthophosphate (phosphorus) present in the plant material is determined by vanado molybdate yellow colour method<sup>18</sup>. The 5 ml of aliquot of plant digested was taken in 50 ml volumetric flask. The mixture is mixed with 10 ml vanado molybdate reagent. Having thoroughly mixed the final volume was adjusted to 50

ml by distilled water. After 30 min the developed yellow colour was measured on a spectrophotometer at 470 nm. The concentration of phosphorus was calculated with the help of standard graph. The percentage of phosphorus is calculated with the help of following formula:

$$\% \text{ of P} = \frac{\text{Graph ppm}}{10^6} \times \frac{\text{Volume of dilution made}}{\text{Aliquot}} \\ \times \frac{\text{Volume of Plant digest}}{\text{Weight of plant sample}} \times 100$$

*Determination of Calcium and Magnesium*

One ml of aliquot plant digested material was taken in 50 ml of volumetric flask final volume was adjusted to 50 ml by adding distilled water. The presence of calcium and magnesium were determined at the wave length 422.7 and 28.2 nm of AAS. The percentage of calcium and magnesium were calculated with the help of following formula<sup>18</sup>:

$$\% \text{ of Ca/Mg} = \frac{\text{Graph ppm}}{10^6} \times \text{Dilution factor} \\ \times \frac{\text{Volume of plant digestion made}}{\text{Weight of the plant sample}} \times 100$$

*Determination of Nitrogen*

One gram of powdered dried plant material was taken in Kjeldhal flask and 25 ml of diacid mixture was added. The digestion was carried out on low flame initial for 10 to 15 minutes until frothing stops. Then, digestion was carried out at temperature for 1 to 1½ h or till the content in Kjeldal flask become clear the flask was cooled and the contents was transferred quantitatively to the 100 ml volumetric flask and the final volume was adjusted to 100 ml by adding distilled water, 10 ml of diluted acid digested samples was taken in a micro Kjeldhal distillation assembly. The boric acid mixed indicator solution was kept ready at the receiving end to trap ammonia, 30 ml of 40% NaOH was added and distillation was carried out till the colour of the mixture changes and was further continued for some time to trap all the ammonia released. No changes in colour of the red litmus paper indicate the completion of distillation. The quantity of ammonia distilled was estimated by titrating against 0.01N H<sub>2</sub>SO<sub>4</sub> or HCl till the colour changes to purple<sup>18,19</sup>.

The percentage (%) of N was calculated with the help of following formula:

% of Nitrogen =

$$\frac{\text{Titrate value} \times \text{N.H}_2\text{SO}_4 \times 0.014 \times \text{dilution factor} \times 100}{\text{Weight of the plant sample}} \times 100$$

*Determination of Micronutrient (Zn, Fe, Cu and Mn)*

The 2 ml of digested samples were taken and diluted to 50 ml and the sample was aspirated at the wavelength of 213.9, 248.3, 324.75 and 279.5 of AAS to detect concentration of Zn, Fe, Cu and Mn. Finally, the values of micronutrients are expressed in ppm by the help of following formula<sup>18</sup>.

ppm of Fe/Mn/Cu/Zn =

$$\frac{\text{ppm}}{1000} \times \frac{\text{Vol. of plant digest}}{\text{Weight of the plant sample}} \times \text{Dilution factor} \times 1000$$

*Analysis of Lead and Cadmium*

The 2 ml of digested samples were taken and diluted to 100 ml. The presence of lead and cadmium were detected with help of AAS by aspirating the sample at the wave length of at 217 nm and 228 nm with appropriately lamps. The ppm of lead and cadmium were calculated by the help of following formula<sup>18</sup>.

The elemental composition of the plant material was done at Central Coffee Research Institute (CCRI) Balehonnur, Chikamagalure district of Karnataka, India.

ppm of Pb/Cd =

$$\frac{\text{ppm}}{1000} \times \frac{\text{Vol. of plant digest}}{\text{Weight of the plant sample}} \times \text{Dilution of factor} \times 1000$$

#### Documentation of uses and product preparation

The uses of *Z. rugosa* with reference to medicinal and edible are made on the basis of literature survey and interviewing the local people. The details of making juice and dosa by us are given in results.

#### Statistical analysis

The mean, standard deviation and statistical significant were made by One way ANOVA analysis by using the PAST software and the P values have been calculated<sup>20</sup>.

#### Results

The fruit of *Z. rugosa* is eaten as raw fruit. The pulp of the fruit is used for the preparation of juice and dosa. For making juice of fruits known quantity of ripe deseeded pulp is mixed with water by adding saturated amount of sugar and a pinch of powder of cardamom seeds is used for flavour. For preparation of dosa, the ripe deseeded pulp is grinded with wet rice and the paste is prepared by adding a spoon full of salt. The mixture is kept for fermentation for about 10-12 hours and then is used for preparation of dosa (Plates 2 & 3). The values of proximate, nutritive value and elemental composition (macro, micro and toxic elemental) of pulp and seeds are given in Table 1.

Among the macronutrients nitrogen was dominant and calcium was the lowest with 21.02 and 0.049%, respectively. In general the concentration of nitrogen is followed by potassium in all the cases, whereas the concentration of sodium, calcium, magnesium and phosphorus varied abruptly (Fig. 1). The dominance of macronutrients with reference to their concentration are detailed below:



Plate 2 — a-Components of juice, b-Juice of *Ziziphus rugosa*



Plate 3 — a-Components of dosa, b-Preparation of dosa, c-Dosa of *Ziziphus rugosa*

Table 1 — Proximates, nutritive value, and mineral components of *Ziziphus rugosa* fruits

Factors	Unripe pulp			Ripe pulp			Unripe seed			Ripe seed		
	2009	2010	Mean ± SD	2009	2010	Mean ± SD	2009	2010	Mean ± SD	2009	2010	Mean ± SD
<b>I. Macro-nutrients in %</b>												
Sodium (Na)	0.14	09	0.52 ±6.26	0.11	0.26	0.185 ±0.11	0.14	013	0.108 ±9.090	0.086	0.39	0.238±0.21
Potassium (K)	2.27	2.56	2.41±0.21	1.58	1.78	1.68 ±0.14	2.27	1.9	1.665 ±0.26	0.95	1.075	1.012±0.09
Phosphorus (P)	0.17	0.18	0.175±0.01	0.15	0.18	0.165 ±0.02	0.17	0.24	0.235 ±0.05	0.21	0.19	0.2±0.01
Calcium (Ca)	0.62	0.386	0.503±0.17	0.20	0.143	0.171 ±0.04	0.62	0.083	0.0815 ± 0.38	0.05	0.049	0.049±0.00
Magnesium (Mg)	0.35	0.261	0.305±0.06	0.31	0.149	0.22 ±0.11	0.35	0.12	0.155 ±0.16	0.18	0.131	0.155±0.03
Nitrogen (N)	21.56	21.71	21.63±0.11	19.40	19.40	19.40 ±0.00	21.56	22.02	21.79 ±0.33	19.71	22.33	21.02±1.83
<b>II. Micro-nutrients in ppm</b>												
Zinc (Zn)	44.92	43.95	44.43±0.69	31.02	30.47	30.74±17.87	44.92	31.64	32.93±15.34	32.17	32.23	32.2±13.69
Copper (Cu)	34.40	29.37	31.88±3.56	8.60	3.88	6.24±14.78	34.40	19.16	20.80±12.95	13.66	11.56	12.61±11.17
Manganese (Mn)	561.94	56.07	309.00±357.70	65.20	56.62	60.91±230.98	561.94	10.65	50.9±230.46	35.26	29.84	32.55±209.80
Iron (Fe)	2232.56	19822107.28	±177.17	93.98	89.24	91.61±1092.57	2232.56	1705.26	1817.16±964.66	589.75	52.57	321.16±888.77
<b>III. Heavy metals in ppm</b>												
Lead (Pd)	50.92	0.00	50.92±36.01	51.69	0.00	51.69±26.07	50.92	0.00	50.92±23.97	56.91	0.00	56.91±23.78
Cadmium (Cd)	1.03	0.00	1.03±0.73	1.88	0.00	1.88±0.79	1.03	0.00	1.03±0.66	2.14	0.00	2.14±0.75
<b>IV. Proximates in %</b>												
Ash	2.033	1.70	1.866±2.35	5.00	5.00	5.00±8.13	2.033	2.00	2.51±7.91	2.00	2.23	2.115±7.34
Moisture	40.50	38	39.25±1.77	61.67	63.22	62.23±24.85	40.50	24.06	24.30±20.28	18.67	15.2	40.94±19.13
Fat	2.33	2.56	2.44±0.16	5.00	5.00	5.00±2.04	2.33	1.06	0.78±1.70	16.50	16.5	10.75±5.86
Fibre	2.20	2.20	2.20±0.00	3.65	4.10	4.08±1.60	2.20	0.35	0.35±1.42	2.39	2.70	3.24±1.23
Protein	0.29	0.73	0.51±0.31	1.13	1.41	1.128±0.50	0.29	0.24	3.24±0.44	0.61	0.91	1.01±0.39
Carbohydrates	36.55	41.68	39.11±3.63	27.12	25.35	26.34±14.63	36.55	72.62	72.66±20.56	60.22	65.12	42.78±21.77
<b>V. Nutritive value (cal/100g)</b>												
	147.82	193	170.41±31.94	158.00	152	155.5±61.14	147.82	301	300.86±81.55	391.83	412.6	271.91±127.27

Unripe pulp: N>K>Na>Ca>Mg>P; Ripe pulp: N>K>Na>Ca>P>Mg

Unripe seed: N>K>P>Ca>Mg>Na; Ripe seed: N>K>Na>Mg>P>Ca

Further, one way ANOVA analysis provides the significance of variance of macronutrients between unripe and ripe pulp and seeds, respectively. ( $P$  values =0.0003864 for pulp and  $P=0.0005267$  for seeds). The concentration of micronutrients did not vary and the dominance of micronutrients is same for the unripe and ripe pulp and seeds, respectively (Fig. 2), and it is in the order of iron, manganese, zinc and copper. The variations of micronutrients between seed and pulp is not significant and it is conformed from their  $P$  values ( $P=1.426$  for pulp and  $P=4.227$  for seeds, respectively). The heavy metals lead and cadmium were recorded only during 2009 and the values of lead were always higher than cadmium (Fig. 3). Among the proximate the moisture dominated in all the case of unripe seed where fibre is lowest with higher protein content (Fig. 4). The

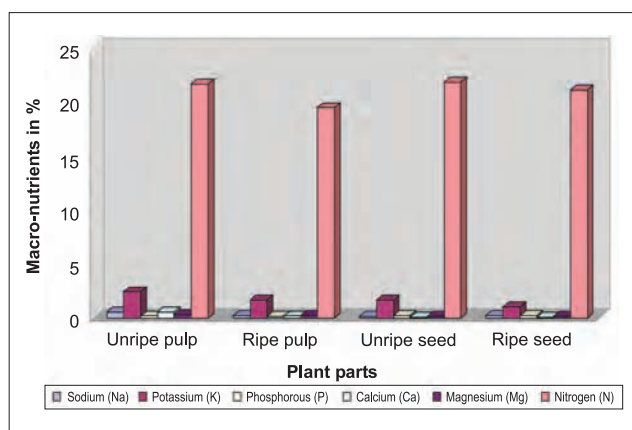


Fig. 1 — Variation of macro nutrients (%) in pulp and seeds of *Ziziphus rugosa*

variation of nutritive value was also significant between pulp and seeds with  $P$  values 0.00158 and 0.0032 for pulp and seeds, respectively. The nutritive values of seed are always higher (300.86 cal/100 g and 271.19 cal/100 g) of unripe and ripe seeds, respectively (Fig. 5).

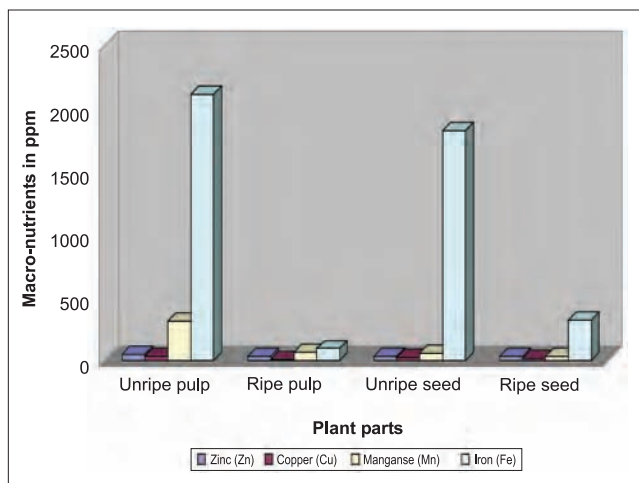


Fig. 2 — Variation of micro nutrients (ppm) in pulp and seeds of *Ziziphus rugosa*

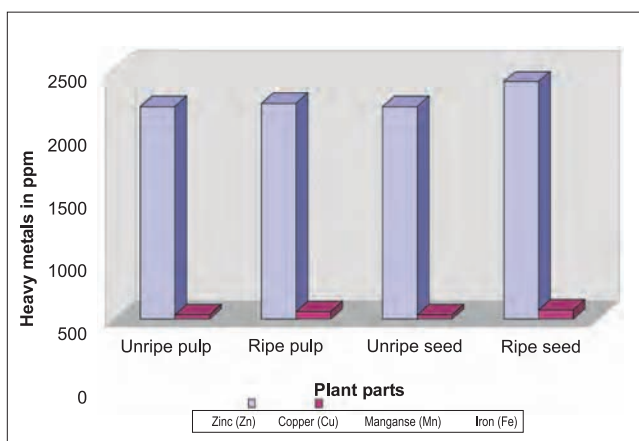


Fig. 3 — Variation of heavy metals (ppm) in pulp and seeds of *Ziziphus rugosa*

When compared the two yearly average values of proximate, nutritive values and elemental composition, both ripe and unripe pulp serve as a sources of proximate and elemental components and hence the fruits may be known as famine fruits when compared with available Recommended Dietary Allowances values (RDA) (Table 2)<sup>21,22</sup>.

### Discussion

The wild edible fruit of *Z. rugosa* is known as one of the famine fruits of the dry deciduous forest of Central Western Ghats. It is not only a medicinal plants but also a famine food both in India and neighboring country, the Bangladesh<sup>6,8,12,23,24</sup>. The observation of Chandrasekhar Reddy<sup>25</sup> reveals the edible fruit tree species of two vegetation types of Kodagu and emphasized the rich food resources. However, Uthaiiah<sup>26</sup> said that though there are several

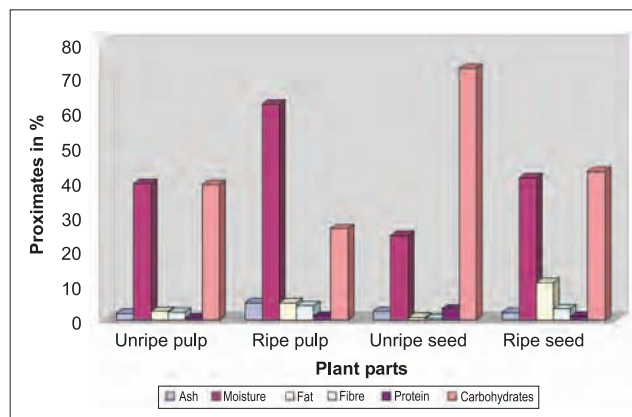


Fig. 4 — Variation of nutritional components (%) in pulp and seeds of *Ziziphus rugosa*

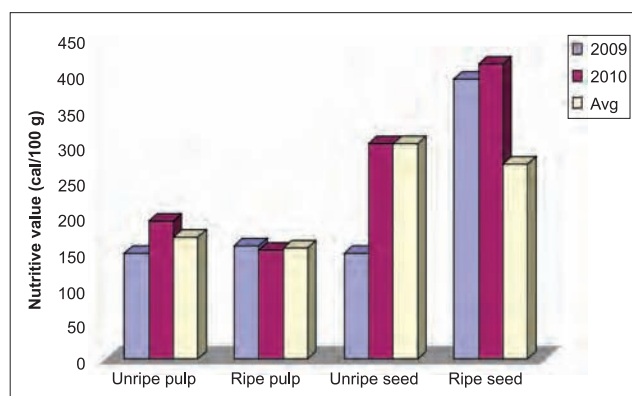


Fig. 5 — Variation of nutritive value (cal/100 g) in pulp and seeds of *Ziziphus rugosa*

plant species of Western Ghats yield edible fruits and vegetables, there are no reported accounts exists at present to deal with status of wild edible species. The present investigation reveals that the pulp and seeds of the fruit are the source of proximates, macro and micro nutrients with negligible amount of toxic elements. The ripen pulp of the fruits have been being used in the preparation of juice and dosa, one of the South Indian dishes. Similarly to the earlier studies who studied nutritive values and the mineral elements of medicinally valued plants from Uttarakhand, nutritional attributes of *Hippophae rhamnoides* Linn. (Seabuckthorn) populations from Uttarakhand, and nutritive values of wild edible fruits, berries, nuts, roots and spices of the Khasi tribes of India, mentioned the role of proximates, macro and micro elements and nutritive values<sup>14,27,28</sup>, the present study also reveals the importance of wild edible fruits of *Z. rugosa* with reference to proximates, elemental composition and nutritive value. The investigation of Deepak Dhyani *et al*<sup>27</sup> explained the importance of

Table 2 — Comparison of Recommended Dietary Allowances (RDA) with proximate, nutritive value and elemental composition of *Ziziphus rugosa* fruits

Factors	Unripe pulp	Ripe pulp	Recommended Dietary Allowances						References
			Females			Males			
			9-13 years	14-18 years	19-30 years	9-13 years	14-18 years	19-30 years	
<b>I. Macronutrients (mg/1g)</b>									
Sodium (Na)	52	18.5				250mg/d			R-21
Potassium(K)	241	168				250mg/d			
Phosphorus (P)	17.5	16.5	1.250mg	1.250mg	700mg	1.250mg	1.250mg	700mg	
Calcium(Ca)	50.3	17.1	1.300mg	1.300mg	1.00mg	1.300mg	1.300mg	1.00mg	
Magnesium(Mg)	30.5	22	8 mg/d	15 mg/d	18 mg/d	8 mg/d	11 mg/d	8 mg/d	
Nitrogen(N)	216.3	194.0	-	-	-	-	-	-	
<b>II. Micronutrients (mg/1g)</b>									
Zinc (Zn)	4.443	3.074	8mg/d	9mg/d	8mg/d	8mg/d	8mg/d	11mg/d	R-21
Copper (Cu)	3.188	62.4	700mg/d	890mg/d	900mg/d	700mg/d	890mg/d	900mg/d	
Manganese (Mn)	30.900	609.1	1.6mg/d	1.6mg/d	1.8mg/d	1.9mg/d	2.2mg/d	2.3mg/d	
Iron (Fe)	210.728	916.1	8mg/d	15mg/d	18mg/d	8mg/d	11mg/d	8mg/d	
<b>III. Heavy metals (mg/1g)</b>									
Lead	5.092	5.169				5.4% 2.9%.			R-22
Cadmium	10.3	18.8							
<b>IV Proximate(mg or %/1g)</b>									
Ash	18.6mg	50.mg				NA			R-22
Moisture	39.25%	62.2%				NA			
Fat	2.44%	5.00%				NA			
Fibre	22.0g	40 g				25 to 30g			
Protein	51g	11g				44 to 58 g.			
Carbohydrates	39.1g	26g				55 to 60%.			
	170.41	155.5				NA			
<b>Nutritive value(cal/100g)</b>									

wild bio-resources to solve unemployment problem in the rural sector and to improve socio-economic and environmental balance. Agrahar-Murugkar *et al*<sup>28</sup> and Indrayan *et al*<sup>14</sup> discussed the nutritional profits of edible plant resources and classified the edible plants into food, fodder and medicinal uses, respectively. Therefore, the present study initiates the utilization of wild edible fruits for better uses and to establish plant based cottage industries to provide employment and to generate income by the rural people of Western Ghats of Karnataka.

### Conclusion

The seeds and pulp of *Z. rugosa* were analyzed to determined proximates, elemental compositions, and toxic elements and to calculate nutritive values. The pulps of the fruits are the source of macro and micro elements and proximates with negligible amount of toxic elements. The pulp of the fruit is the resources to prepare juice and dosa a popular South Indian dish. The steps for the preparation of juice and dosa are

appended. The pulp of the fruit can be used to establish cottage based industries to produce juice and to provide employment and to generate income by the local people. The dish which is prepared can be used as an additional food.

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