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NUTRITIONAL ASSESSMENT OF DIFFERENT PARTS OF *ACACIA CATECHU* WILLD. COLLECTED FROM CENTRAL INDIA

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ABSTRACT: *Acacia catechu* is a multipurpose tree predominantly found in tropical and subtropical regions of India. The tree produces nitrogen rich fodder and green manure, high quality fuel wood and charcoal, strong durable poles and timber. The most useful products of this tree are Kutch or "Kattha" which is obtained from bark and heartwood of the tree. Commonly used plant part of *Acacia catechu* is bark which is a usual source of Kattha, is strong antioxidant, astringent, anti-inflammatory, antibacterial and antifungal in nature. The tree is also used as fodder for goat and cattle in many parts of India. However, the other plant parts of *Acacia catechu* especially from Central India have not been investigated for their nutritive value. The present study showcases a comprehensive investigation on different plant parts of *Acacia catechu* collected from Jabalpur. The results show that the young legumes of *Acacia catechu* can serve as a better source of nutrition for both human and animals.

INTRODUCTION: Plant based ingredients are commonly used as a food source, and mostly the plant based secondary metabolites are taken with the food, which perform therapeutic as well as medicinal role in the body.

Especially the Indian food; which is prepared according to the Ayurveda; advocate the inclusion of such plant based ingredients that provide therapeutic inputs to the body along with the nutrition.

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Therefore, estimation of nutritive value of plant or plant parts provides valuable data as it denotes the capability of any plant or plant part for being used as a food or drug [1]. The proximate analysis of nutritive ingredients gives a good insight especially when presented with additional data about their phytochemical contents as well as their biological activities. Hence, such analysis presents an overall view for the judgment of the data. The nutritional value describes mainly the percentage of major nutritional bio-molecules such as proteins, carbohydrates, lipids and fibre along with the presence of major minerals and their food value [1].

Acacia catechu also commonly called *Mimosa catechu* is a deciduous, thorny tree [2]. Common names for it include Catechu, Cachou and Black Cutch.

The *Acacia catechu* is called Khair in Hindi [3] and Kachu in Malay, and Catechu in Latin from which the extracts cutch and catechu are derived. It is found in Asia, China, India and the Indian Ocean area.

Balz [4] illustrated use of different parts of *A. catechu* as a traditional medicine in India and other countries. Bark of *A. catechu* tree is strong antioxidant, astringent, anti-inflammatory, anti-bacterial and anti-fungal in nature. It is useful in passive diarrhoea, high blood pressure, dysentery, colitis, gastric problems, bronchial asthma, cough, leucorrhoea and leprosy. It is used as a mouthwash for mouth, gum, sore throat, gingivitis, dental and oral infections. Similarly Sathya and Siddhuraju [5] investigated phenolics and antioxidant potential of legumes of *Acacia auriculiformis*. Such studies showed that different plant parts of acacias are rich source of active pharmacological ingredients.

According to world agro-forestry database, the tree's seeds are a good source of protein. Kattha (catechu), an extract of its heartwood, is used as an ingredient to give red color and typical flavor to "Paan". Branches of the tree are quite often cut for goat fodder and are sometimes fed to cattle. Though fresh pods of Acacia are used for culinary purposes in different parts of Latin America, not much information is available on their nutritive values.

Siddhuraju *et al* [6] investigated nutritional and anti nutritional characteristics and biological value of *Acacia nilotica* (L.) Del. seeds only. Velázquez *et al* [7] investigated the pods of *Acacia farnesiana* to be included as major diet source in lamb food. The mature seeds contained 234 g kg^{-1} crude protein, 126 g kg^{-1} crude fibre, 66.6 g kg^{-1} crude fat and 39.7 g kg^{-1} ash and 534 g kg^{-1} carbohydrates. Potassium, phosphorus, magnesium, iron and manganese occurred in high concentrations. Similarly, Vijayakumari et al.[8] investigated the seeds of *Acacia leucophloea* (Roxb.) Willd only. Ee and Yates [9] investigated for Nutritional and antinutritional values of evaluation of raw and processed Australian wattle (*Acacia saligna*) seeds. However, no comprehensive study could be found on *Acacia catechu* considering all edible plant parts.

The present study is an attempt to assess the nutritive value of *Acacia catechu* tree collected from the Central Indian region and to compare their nutritive values critically.

MATERIALS AND METHODS:

Identification of *Acacia catechu* in fields/forests: The plants (young plants and trees) were found in good quantity in the forest area of Dumna Nature Reserve, Jabalpur, India. The plants were identified using their morphological identification keys and confirmed by the local forest officers.

Collection of plant material: The young plants of *Acacia catechu* were obtained from the forest area of Dumna Forest Reserve, Jabalpur (MP). For this, roots were obtained from small plants having maximum length of 0.5 to 1 meter. The whole plants were dug from the soil during monsoon in 2011 with the help of the agricultural tools and the juvenile roots were obtained from the plants. The leaves and the stems were also used of the same plants from which the roots were collected.

Bark and the pods of *A. catechu* from fully grown trees were used. The bark was obtained by peeling off from the stem. The young pods were also collected from the trees.

Drying the plant material: All the parts were air dried under the shade for one week or longer till a constant weight was achieved. The care was taken to observe the fungal growth on wet parts especially of leaves.

Grinding and sieving of the plant material: Once dried up to constant weight, the plant materials were ground in a mixer grinder. The powder was passed through a test sieve having 100 µM pore size (Sonar, India) to obtain a particle size that is less than 100 µM. The remaining course powder was again grinded and sieved.

The process was continued four to five times or till the material could not be ground further. The fine powder of less than 100 µM was immediately stored in an air tight container for further use. The proximate analysis was done according to AOAC methods [10] unless stated otherwise.

Moisture Content: One gram of the powdered sample was weighed in a clean crucible/beaker of known weight. The sample was then dried in oven at 105°C for 8 h. The crucible/beaker was cooled and weighted to determine water loss in powdered sample.

Estimation of fat content: The apparatus used for estimation of fat is Soxhlet extractor. To determine the percentage of fat the dried sample of plant was extracted with petroleum ether. It was then distilled off completely and dried. The oil weight and percentage of oil was calculated.

Estimation of crude fiber: Briefly, 2 g of sample was subjected to acid and subsequent alkali treatment. Oxidative hydrolytic degradation of native cellulose and considerable degradation of lignin occurs. The residue obtain after final filtration was weighed, incinerated, cooled and weighed again. The loss in weight gives the crude fiber contents.

Estimation of ash Percentage: Weighed 2 g of each sample into the crucible and placed in to the Muffle furnace. Heating was stared gradually until temperature of 600˚C was reached. This temperature was maintained for 6 h. The crucible was then put inside desiccators and cooled. After cooling, the sample was reweighed and the percentage of ash was calculated.

Estimation of Nitrogen (protein) percentage [11, 12]: Nitrogen was estimated using micro Kjeldahl method. In this method, 50 mg sample was digested by boiling with concentrated sulfuric acid in the presence of catalyst copper sulfate till the formation of the clear solution. The ammonia was released by the addition of excess sodium hydroxide in presence of compressed water vapors and was removed by steam distillation. The distillate was collected in 4% boric acid solution and titrated with standard hydrochloric acid using methylene blue as an indicator. Total protein was calculated by multiplying nitrogen percentage by 6.25.

Estimation of carbohydrates [13]**:** The phenol and sulfuric acid method is general method for carbohydrate estimation. It is a modification to the Anthrone's method of carbohydrate estimation. For this, 100 mg of sample was digested for 3 h with 2.5 N HCl and all the carbohydrate was converted into glucose which is further dehydrated to hydroxyl methyl furfural. The solution was neutralized with sodium carbonate. To each test tube, 1 ml of 5% aqueous phenol was added. One milliliter concentrated sulfuric acid was then carefully dispensed to each tube. The solution was allowed to stand for 20 min before taking the readings at 490 nm. The absorbance was converted to glucose concentration using a standard curve of D-glucose prepared in the same manner.

Nutritive value: After estimation of protein, fat and carbohydrate, the nutritive value was calculated as per the following formula.

Nutritive value (Kcal) = 4x Protein% + 9x Fat% + 4x Carbohydrate%

Estimation of Mineral contents: Acid digestion method was used to digest the dried plant powder for mineral analysis. Organic matter of dry plant powder was wet oxidized with the sequential combination of perchloric acid, nitric acid (HNO_3) and sulphuric acid (H_2SO_4) (1:2.5:1) at 125°C temperature. After complete digestion the sample was cooled, diluted with distilled water up to final volume of 50 ml. The estimation of nutritionally important minerals i.e. P, Na, K, Ca, Fe, Mg and Zn along with toxic heavy metals i.e. Hg, Pb, As and Se was done via Inductively Coupled Plasma-Atomic Emission Spectroscopy (ICP-AES) at Sophisticated Analytical Instrument Facility, Indian Institute of Technology, Mumbai (IIT, Bombay).

RESULTS: For the analysis, the tests were done with three independent replicates and the data are presented as mean ± standard deviation. **Table 1** shows the proximate analysis of different parts of *Acacia catechu.* Analysis revealed that there was not much difference in moisture content in different plant parts which ranged from 5.4 to 7.43%. However, the percentage of ash was found much lower in young pods (3.5± 0.4) to highest in leaf (18.6 ± 0.55).

The fiber percent was highest in root (38.33 ± 1.04) followed by stem (35.16 ± 1.55).

Young pods showed decent amount of fiber as 21.35 ± 0.55%. The protein content was found to be very high (34.3 ± 0.99) in young pods as compared to other parts which showed lesser amount of protein as 15.5 to 18.16% protein content.

Carbohydrate content was measured in terms of available glucose by comparing with the standard curve of D-glucose (R^2= 0.972). The carbohydrate percentage was again highest in young pods (42.23 ± 0.60) followed by leaf (35.87 ± 0.15). Root and bark of *Acacia catechu* showed least carbohydrate content.

Bark showed highest amount of total lipids (11.58 ± 0.53) while all other parts showed moderate lipid content as 4-5%.

Figure 1 represents the percent values of major nutrients in different plant parts of the *Acacia catechu.* The high percent of carbohydrates and protein in all plant parts is visible.

TABLE 1: PROXIMATE ANALYSIS OF DIFFERENT PLANT PARTS OF *A. CATECHU*. Values are presented as mean ± sd, n=3.

S. No.	Sample	Moisture	Ash	Fibre	Protein	Carbohydrate	Fat
1	**Root**	6.6 ± 0.26	16.43 ± 0.26	38.33 ±1.04	15.52 ± 1.39	18.6 ± 0.1	4.36 ±0.08
2	**Stem**	7.43 ± 0.32	12.26 ±0.06	35.16 ±1.55	18.16 ± 2.0	22.78 ± 0.53	4.29 ±0.06
3	**Leaf**	6.56 ± 0.25	18.6 ±0.55	20.23 ±0.49	13.84 ± 0.70	35.87 ± 0.15	5.87 ± 0.14
4	**Pods**	5.4 ±0.25	3.5 ±0.4	21.35 ±0.55	34.30 ± 0.99	42.23 ± 0.60	4.62 ±0.4
5	**Bark**	6.73 ±0.53	21.2 ±0.5	21.23 ±0.49	16.5 ± 0.75	22.8 ± 0.15	11.58 ±0.53

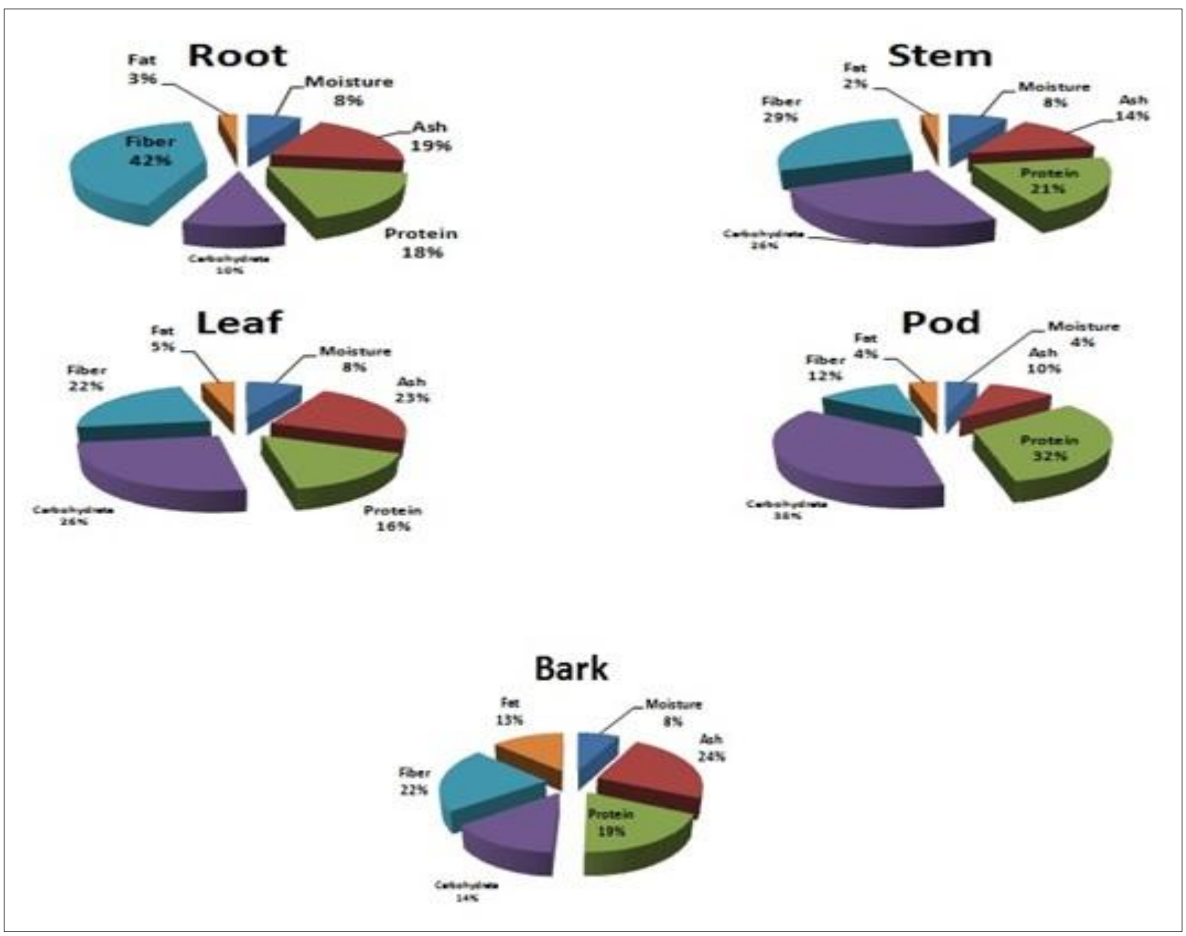

FIGURE 1: PROXIMATE PERCENTAGE OF MAJOR NUTRIENTS IN DIFFERENT PLANT PARTS OF *A. CATECHU*

Table 2 represent that when the nutrient value was calculated for all three replicates independently, pods showed highest calorific value as 433.9 ± 3.36 Kcal per 100 g dry weight followed by bark (220.6 ± 1.55 Kcal per 100 g dry weight). Other plant parts showed less calorific value with root showing the least.

TABLE 2: ESTIMATION OF NUTRITIONAL VALUE IN TERMS OF KCAL PER 100 G DRY MATTER OF DIFFERENT PLANT PARTS OF *A. CATECHU*. Values are presented as mean ± sd, n=3

S. No.	Sample	Replicates			Mean	SD
		1	2	3		
1	**Root**	121.66	111.59	120.17	117.80	5.4
2	**Stem**	185.89	190.09	173.4	184.12	9.9
3	**Leaf**	170.69	167.03	171.01	169.57	2.21
4	**Pod**	430.25	434.68	436.85	433.9	3.36
5	**Bark**	219.0	220.1	220.7	220.6	1.55

SD= Standard deviation.

Table 3 represents the nutritionally important mineral content in different plant parts of *Acacia catechu* as analyzed through ICP AES. Among nutritionally important minerals, zinc was in the range of 12.39 ppm in pods to 70.22 ppm in root. In stem of *A. catechu* Zn was found 32.73 ppm while in the bark and leaf, Zn was found to be 34.28 and 28.86 ppm respectively**.**

Iron content was found different in all different plant parts. Highest iron content showed by leaf (62.94 ppm), somewhat lesser in bark of *A. catechu* that is 60.52 ppm, while lowest in young pods (10.71 ppm) of *A. catechu*. In stem and root, iron content was found moderate that were 33.16 and 30.85 respectively.

Higher amount of calcium was found in all five parts of *A. catechu* ranging from 214.53 ppm in pods to 1055.95 ppm in bark. In leaf it was found 495.98 ppm while in stem and root of the *A. catechu* calcium content found somewhat similar 519.42 and 517.62 ppm respectively.

As far as potassium is concerned, it was found in all five parts of *A. catechu*. In pods, potassium content was found highest (225.42 ppm) and lowest was found in bark (40.34 ppm), while in leaf , stem and root, potassium content was found to be in increasing order 82.44, 141.71 and 159.22 ppm respectively.

Sodium content also varied greatly among plant parts. Low sodium content was found in *A. catechu* stem (5.34 ppm), moderate in pods (9.49 ppm), bark (6.04 ppm) and leaf (7.69 ppm) and highest sodium content was found in root (16.20 ppm).

Magnesium content in all five plant parts of *A. catechu* were found ranging from 12.04 ppm (pods) to 63.04 ppm (root). In stem magnesium content was found 29.69 ppm, while in bark it was 30.31 ppm and in leaf it was found to be 26.44 ppm. The root showed phosphorous percent as 57.2 ppm. The stem showed phosphorous content as 73.1 ppm, in leaf it was 75.0 ppm, while in pods and bark, phosphorous percentage were found to be 94.6 and 58.9 ppm respectively.

TABLE 3: ESTIMATION OF NUTRITIONALLY IMPORTANT MINERALS IN DIFFERENT PLANT PARTS OF *A. CATECHU* USING ICP AES. Values are in ppm.

S. No.	Sample	Minerals						
		Zn	Fe	Ca	K	Na	Mg	P
1	**Root**	70.22	30.85	517.62	159.22	16.20	63.04	57.2
2	**Stem**	32.734	33.162	519.42	141.71	5.34	29.69	73.1
3	**Leaf**	28.86	62.94	495.98	82.64	7.69	26.44	75.0
4	**Pod**	12.39	10.71	214.53	225.42	9.49	12.04	94.6
5	**Bark**	34.28	60.52	1055.9	40.34	6.04	30.31	58.9

When heavy metal toxicity associated with *Acacia catechu* from Jabalpur region was assessed, only a small portion of lead (Pb) was found in all plant parts. Bark showed maximum lead content as 0.044 ppm while leaf showed minimum (0.147 ppm). Moderate amount of lead content were found in other part of *A. catechu;* in stem 0.096 ppm, in pods 0.058 ppm while in root lead content was found 0.129 ppm (**Table 4**). Some other heavy metals were also analyzed in different plant parts of *A. catechu* i.e. Selenium (Se), Mercury (Hg) and Arsenic (As) along with minerals of nutritive importance through ICP AES. ICP AES analysis showed the absence of Hg, Se and as. They were below the magnitude of 0.01 ppm and reported as not detected (**Table 4**).

TABLE 4: ESTIMATION OF TOXIC HEAVY METALS IN DIFFERENT PLANT PARTS OF *A. CATECHU* USING INDUCTIVELY COUPLED PLASMA ATOMIC EMISSION SPECTROSCOPY (ICP AES). Values are shown in ppm

S. No.	Sample	Heavy metals			
		Pb	Se	Hg	As
1	**Root**	0.129	ND	ND	ND
2	**Stem**	0.096	ND	ND	ND
3	**Leaf**	0.147	ND	ND	ND
4	**Pod**	0.058	ND	ND	ND
5	**Bark**	0.044	ND	ND	ND

ND= not detected, below 0.001 ppm

DISCUSSION: *Acacia catechu* is a tree of high economical value and is prevalent in most part of India and South Asia. Though all plant parts serve for medicinal or fodder use, the woody parts are used as timber. However, not many studies have evaluated the nutrient value of different plant parts of this tree, especially from the Central Indian region of Jabalpur, where this tree has a jungle of its own. The leaves are used a fodder for goats and cattle.

Mokoboki *et al* [14] showed that three species of Acacia i.e. *A. nilotica, A. sieberiana* and *A. tortolis* have potential as livestock fodder based on high crude protein content, low neutral detergent fibre, low tannins and high palatability indices. The young pods of *Acacia catechu* plant are eaten regularly in Latin American countries. Our study describes the nutrient value of all the plant parts of *Acacia catechu.*

Most of the research work done previously has been concentrated on proximate analysis of seeds of acacia plants. Vijayakumari et al.[8] analysed *Acacia leucophloea* (Roxb.) Willd seeds for their proximate composition, minerals, protein fractions, seed protein amino acid profiles, fatty acid composition of lipids and anti-nutritional substances. Crude protein value was 26·5 g 100 g^{-1} DM. The other major nutrient contents (g 100 g^{-1}) were crude lipid, 5·13; crude fibre, 6·78; ash, 4·12 and total crude carbohydrates, 57·5. The seeds were a rich source of minerals such as Ca, Mg, P, Fe and Mn. The predominant seed protein fractions were globulins and albumins.

They found that essential amino acids, cystine, methionine, tyrosine and phenylalanine, were low and threonine, valine, isoleucine and lysine were fairly high when compared with the FAO/WHO/UNO amino acid recommended pattern.

The lipids contained high amounts of unsaturated fatty acids in which linoleic acid (51·1%) was the major fatty acid. Nasri *et al* [15] concluded that seeds of the three species of Acacia i.e. *A. cyclops*, *A. ligulata* and *A. salicina* seem to be quite rich in lipids (from 6% to 12%). Since, our study used young pods of *Acacia catechu* the exact comparison is not possible. Though these young pods showed promising content of proteins and carbohydrates along with minerals.

Pailan et al.[16] investigated trees of Budelkhand region, India for nutritional values. The tree leaves of *Acacia catechu* and pods of *Acacia catechu* were higher in nutritive values as compared to other species under study. Rajaram and Janardan[17] explored three different tree pulses, *Acacia catechu*, *Parkinsonia aculeata* and *Prosopis chilensis,* for proximate composition. The seeds of all the three pulses analysed were rich in the minerals K, Ca, Mg and Fe. Our results show that all the plant parts of *Acacia catechu* contain moderate to high amounts of nutritionally important minerals. The presence of lead in the plant parts were also less than the maximum permissible limit of lead in the food source.

For example, FDA has set an action level of 0.5 ppm for lead [18]. Other toxic heavy metals could not be detected in any of the plant part assuring that these plant parts are safe for human consumption.

The present study shows that the different plant parts of *Acacia catechu* especially the young pods can be used for food as well as medicinal purposes. The young pods are not only capable of fulfilling the daily recommended dose of macro and micro nutrients, but are also loaded with secondary metabolites that perform pharmacological activities in the body i.e. antioxidant activity.

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