African Journal of Food Science and Technology (ISSN: 2141-5455) Vol. 13(6) pp. 01-05, June, 2022
DOI: http:/dx.doi.org/10.14303//ajfst.2022.026
Available online @https://www.interesjournals.org/food-science-technology.html

Research Article

Chemical composition and In- vitro crude protein digestibility of some parts of Sclerocarya birrea tree

Balgees A. Atta Elmnan*, FaiezAbdalla AbdElrahmanand and Fadel Elseed, A.M.A

Department of Animal Nutrition, Faculty of Animal Production, University of Khartoum, Khartoum North, Sudan

E-mail: balgeesatta@gmail.com

Abstract

The study was conducted to determine the nutritive value of leaves fruits and seeds of Sclerocarya birrea tree. Samples of leaves and fruits were collected during summer, 2017 from AL-Daein locality -East Darfur State-Sudan. Parameters measured were: chemical composition, some macro-minerals content, metabolizable energy, some anti-nutritional factors and in- vitro crude protein digestibility (IVCPD). Data obtained were subjected to analysis of variance (ANOVA) for Completely Randomize Design. The results showed that the leaves had the highest crude protein, ash, saponnin, calcium, magnesium, sodium, potassium contents and IVCPD. While the seeds showed the highest content of ether extract, crude fiber and metabolizable energy for ruminants, the fruits showed the highest content of nitrogen free extract, tannin and phytate. Phosphorus concentration in all parts of S. birrea was lower than the level required by the different kinds of animals. Anti-nutritional factors content in different parts were below recommended level to have adverse effects on animal performance. The results showed that the leaves, fruit and seeds of S. birrea have a great potential as source of important nutrients as animals feed during summer.

Keywords: *Sclerocarya Birrea*, Nutritive values, Leaves, Seed, Fruits

INTRODUCTION

Livestock are key components of Africa farming systems and are increasingly viewed as important pathways for rural households to escape poverty. Sudan is rich in biodiversity within diverse environmental systems making it endowed with flora and fauna, where many tree and other forest products are used in ethno veterinary treatments that support animal health and hence human food production (FAO et al*.,* 2012).

Browse leaves, fruits, seeds and pods have been traditionally used as sources of feed for livestock in Asia, Africa and the Pacific. Browse legumes are shrubs and trees that are of considerable nutritional importance as livestock feed during the dry season. The use of tree parts as alternative feed resources for ruminant livestock is becoming increasingly important in many parts of the tropics and sub-tropics (Atta Elmnan et al*.,* 2009).*Sclerocaya birrea* (Homied) is one of the savannahs browse tree in the Sudan, and it belongs to the family *Anacardiaceae.* The *S. birrea* trees are found in the areas of the state of East Darfur, which is the only tree that gives delicious fruit in the summer, which benefits the animals and human. Thus, it can be used to compensate the lack of nutritional value in the pastures during the dry season. Since the literature is lacking to the studies dealing with its nutritive value in the Sudan, the current study was designed to determine the nutritive value of the different part of *S. birrea* trees in term of chemical composition, some macro-minerals, anti-nutritional factors content and in –vitro crude protein digestibility (SabahelKhier et al., 2010).

MATERIAL AND METHODS

Sample collection and preparation

Samples of fruits and leaves of *S. birrea* were collected during May and June, 2017 from AL-Daein Locallity–East

Received: 13-May-2022, Manuscript No**.** AJFST-22-63773; **Editor assigned:** 14-May-2022, PreQC No. AJFST-22-63773 (PQ); **Reviewed:** 28-May-2022, QC No. AJFST-22-63773; **Revised:** 07-Jun-2022, Manuscript No. AJFST-22-63773 (R); **Published:** 14-June-2022.

Citation: Elmnan BAA et al,. (2022). Chemical Composition and In- vitro crude protein digestibility of some Parts of Sclerocarya birrea tree. AJFST. 13: 026.

Darfur State- Sudan. The samples of the leaves were picked by hand from the branches at top, middle and the bottom of the different trees. The samples of the fruits were picked by hand, and then the seeds were separated from fruits by a sterile blade. Samples of leaves, fruits (pulp) and seeds were separately air dried then ground and kept in paper bags for further analysis.

Laboratory analysis

Laboratory analysis was carried out at the Animal Nutrition laboratory, Department of Animals Nutrition, Faculty of Animal Production - University of Khartoum.

Proximate analyses

Dry matter (DM), crude proteins (CP), ash, ether extract (EE) and crude fiber (CF) were determined according to (AOAC, 2019), while nitrogen free extract (NFE) was calculated by difference:

NFE (DM%) = DM% – (CP% DM + EE% DM + CF% DM + ash% DM)

Metabolisable energy (ME)

Metabolziable energy for ruminant (MER) and poultry (MEP) were estimated according to Ellis, (1981) using the following equations:

MER=0.012*CP+0.031*EE+0.005*CF+0.014NFE

MEP=1.549+0.102*CP+0.275*EE+0.148*NFE-0.034 * CF

Determination of some macro-minerals

Samples to determine minerals were extracted according to the method by Each sample was burnt in muffle furnace at 550°C, then 10 ml of NH_4CL was added, after that solution was carefully filtered in a 100ml/volumetric flask and finally distilled water was added to make up to the mark. Potassium (K) and Sodium (Na) were determined by (AOAC, 2019). Method using flame photometer Calcium (Ca) and Magnesium (Mg) levels were carried out according to (Chapman & Pratt 1982) by titration method. Phosphorus (P) level was carried out according to the method described by atomic absorption spectrophotometer.

Determination of Anti- nutritional factors

Quantitative estimation of tannin was carried out using the modified Vanilin HCl methanol according to (Price et al., 1978). Phytic acid and Saponin content were determined according to the method of (Wheeler & Ferrel, 1971) and (AOAC, 2019) respectively.

Statistical analysis

Data obtained from the experiment were subjected to analysis of variance (ANOVA) according to completely randomize design Means between treatments were compared using the least significant difference (LSD).

RESULTS AND DISCUSSION

Crude protein content (CP%)

Results of CP content for different parts of *S. birrea* are shown in Table 1. Among the different parts, leaves contained the highest CP (15.16%) compared to fruits (12.08%) and seeds (9.71%).

The leaves in the current study contained higher amount of CP than results 12.0% reported by (Mangara et al., 2017). Leaves considered as a good source of protein, and can be used as an important source of nitrogen for increased rumen microbial activity and by-pass protein (Atta Elmnan & Dawood, 2011). On the other hand, the fruits contained 12.08% CP, which was higher than the results (9.2%) recorded by (LeHouerou, 1980) in Senegal. In addition, seeds' protein content was 9.17%, which was lower than 11.62% reported by (Muhammad et al*.,* 2016). The values of CP for different parts in the present study were adequate for maintenance requirements for cattle. According to mature cattle require 7.8% CP for maintenance; therefore, all parts in the present study had CP content above the required amounts for maintenance.

Crude fiber content (CF%)

The results of CF content for different part of *S. birrea* were given in (Table 1). The content of CF was significantly ($P \leq 0.05$) higher for seeds (34.97%) than fruits (18.50%). CF content of seeds was 34.97% which was lower than results (36.0%) reported by (Maigandi & Abubakar 2004). The fiber content of the fruits was 18.50%, which was higher than (9.2%) value reported by (LeHouerou, 1980). On the other hand, the CF content of the leaves was 19.35%, which was

Table 1. Chemical composition (%) and metabolizable energy (MJ/Kg) for ruminants and poultry of *S. birrea* leaves, fruits and seeds.

Plant part	CP	CF	EE	Ash	NFE	MER	MEP
Leaves	15.16[a]	19.35[b]	1.81[c]	9.11[a]	46.75[a]	9.90[b]	9.85[a]
Fruits	12.08[b]	18.50[b]	2.68[b]	8.67[a]	47.69[a]	9.86[b]	9.61[a]
Seeds	9.71[c]	34.97[a]	9.15[a]	1.88[b]	38.82[b]	11.19[a]	9.94[a]
SEM	0.39	0.33	0.07	0.14	0.57	0.06	0.01

Means with different superscripts in the same column are statistically different at ($P \leq 0.05$). SEM= stander error of the mean. CP=crude protein, EE=ether extract, CF= crude fiber, NFE =nitrogen free extract, MER= metabolizable energy of ruminants and MEP= metabolizable energy of poultry.

lower than 22.4% that reported by CF content of browse shrubs and trees is usually lower than that for tropical grasses and it is a good source to activate fermentation in rumen (Dambe et al*.,* 2015).

Ether Extract content (EE%)

Results indicated that there was a significant (P ≤ 0.05) variation among the different parts in EE content (Table 1). The highest value of EE was recorded by seed (9.15%) and the lowest was recorded by leaves (1.81%)(Mlambo et al*.,* 2011).Demonstrated that the lipid content of seed may indicate potential for supplying additional energy in fattening rations. The EE content of the leaves was 1.81% which was lower than 3.12% reported by (Mangara et al*.,* 2017). EE content is the most important factor that makes feed valuable for maintenance of body functions and its metabolizable energy content, especially in dry season because of reduced intake of low-quality pasture.

Ash content (%)

The result shows of ash content of the studied parts of *S. birrea.* Leaves and fruits (8.7) had the higher (P≤ 0.05) ash content than seeds (Table 1). Ash content of the leaves was higher than the results (8.05%) reported by (Mangara et al., 2017). Furthermore, ash content is an index of nutritionally important mineral elements that related to human, poultry and ruminants' nutrition (Mangara et al., 2017).

Nitrogen free Extract content (NFE%)

The NFE of different parts of *S. birrea* was illustrated in Table 1. The highest NFE value was acquired by fruits (47.69%) and the lowest value recorded by the seeds (38.82%). The results of NFE content in seeds were lower than result (44.17%) reported by NFE content of the fruits in the current study showed a good potential as source of carbohydrate for feed.

Metabolizable Energy for Ruminant (MJ/Kg)

Calculated metabolizable energy for ruminant (MER) (MJ\Kg DM) of *S. birrea* was presented in Table 1. The highest value obtained by seeds (11.185 MJ/Kg DM) followed by leaves (9.895 MJ\Kg DM) and fruits (9.857 MJ/Kg DM). This result was in the same line with the result obtained by (Mdziniso et al., 2016).Who reported that the MER of *S. birrea* seeds was 11.65 MJ\Kg DM. The high value of MER in seed may be attributed to the high EE content of the seeds. In terms of energy, the browse plants contain double the amount in dry grass (Le Houerou, 1980).

Metabolizable Energy for poultry (MJ/Kg)

Calculated metabolizable energy (MJ\Kg DM) of different parts of *S. birrea* for poultry (MEP) was presented in Table 1. There were no significant differences (P>0.05) among different parts of the tree. The seeds contained the highest content of MEP (9.94 MJ/Kg DM), which was lower than result (12.5 MJ/Kg DM) reported by (Mziwenkosi & Bhekumusa, 2001) (Table 1).

Mean concentration of some Macro-elements (%) of different part of *S. birrea*

The content of some macro-elements of different parts of *S.birrea,* which were significantly (P < 0.05) different among different parts of plant except for phosphorus (P). The leaves, fruits and seeds contained adequate amount of calcium (Ca), magnesium (Mg), potassium (K) and sodium (Na) (Table 2).

Ca content of the leaves was lower than the result (6.23%) reported by (Mangara et al., 2017). however, this result was similar to the values (3.62%(recorded by (Amarteifio & Mosase 2006). Leaves and fruits of *S. birrea* examined in the present study had high Ca content that exceeded the recommended level for animal requirement. The concentrations of Ca were higher compared to requirements suggested for growth (2.4 gkg^{-1}DM Ca), pregnancy (1.4 gkg^{-1}DM Ca) and lactation (2.8 gkg^{-1}DM Ca) (Meschy, 2000) for farm animals. Moreover, fodder tree species may provide a good source of Ca supply even in the dry season.

Mg content of different parts of *S. birrea,* was significantly (P<0.05) different for leaves, fruits and seeds. The leaves contained less Mg than results (3.88%) reported by (Mangara et al., 2017). The quantity of Mg in the present study for different parts can be considered as acceptable quantity for small ruminants and poultry (Meschy, 2000).

Leaves contained more K (3.13%) than fruits and seeds (2.29%), (1.85%), respectively. In general, *S. birrea* seeds had adequate quantities of Ca, Mg and K to meet the requirements for beef, sheep and goat production (Mariod, 2000). The content of Na was below recommended levels required by ruminants for growth and productivity (Aganga

Table 2. Mean concentration of some Macro-elements (%) of different part of S. birrea.

Plant part	Ca	Mg	Na	K	P
Leaves	3.05[a]	1.68[a]	1.95[a]	3.13[a]	0.47 [a]
Fruits	2.63[a]	1.19[b]	1.05[ab]	2.29[b]	0.43 [a]
Seeds	1.85[b]	1.17[c]	0.95[b]	1.85[b]	0.40 [a]
SEM	0.09	0.01	0.08	0.03	0.02

Means with different superscription in the same column are statistically different (P≤0.05). Ca: calcium, Mg: magnesium, Na: sodium, K: potassium and P: phosphors

& Mosase, 2001). P content in Sudanese *S. birrea* was low compared with other countries, this difference in results, may be due to genetic factors, environment, and type of soil. Also, Mg, and K values in this study were acceptable compared to recommended requirements as suggested by (Mariod, 2000). The results on macro elements suggest that animals feeding on natural fodders in the area of study may not require mineral supplementation, except salt (NaCl) which should be provided to animals raised on pasture and browse. The difference in chemical composition results between this study and other studies could has been caused by some factors like age of tree, soil type and genetic factors (Abdu et al., 2013).

Anti-nutritional Factors

Tannin content

Tannin **(**mg/100g) content of different parts of *S.birrea* was significantly (P<0.05) different among different parts (Table 3). The highest content was found in fruits (0.33%) while the lowest value was in the seeds (0.27%). Fruits and seeds tannin in the present study was lower than results (2.04% in fruits) reported by (Umaru et al*.,* 2007) and (2.62% for seeds) (Aganga & Mosase 2001).

It may be noted that different parts of the tree had low levels (2–4%) of tannins and it was within the safe limits. The low level of tannin could have beneficial effects on ruminant animals that can suppress bloat in ruminants and reduce excess degradation of high-quality protein in the rumen. This helps in increasing the amount of rumen un-degradable protein, which is finally made available to the host animal for supplying essential amino acids. According to (McMahon et al*.,* 2012) low levels of tannins have two general traits that are relevant to grazing ruminants; they are prevention of bloat and increasing protein by- pass.

Saponnin

Saponnin content of different parts of *S.birrea* is presented in Table 3. There were significant (P<0.05) differences among different parts, while the leaves had the highest content (10.88 mg/100 g), the fruits had the lowest content (7.88 mg/100 g). Reported that the saponnin content of fruits was 7.35% which was slightly lower than the present study (7.80 mg/100 g). Saponins are bitter and reduce feed intake of livestock, including poultry and high levels of saponins in poultry diets result in decreased performance and growth rate. Moreover, in the ruminant, saponnin at high level can affect flora and bacterial density (Mosoni et al*.,* 2011).

Phytic acids

Phytic acids content of different parts of *S.birrea,* was significantly (P < 0.05) high in fruits (145.0 mg/100 g) than leaves (130.0 mg/100 g) and seeds (120.0 mg/100 g) (Table 3). Fruits in the present study contained less phytate than the results (214.72 mg/100 g ± 3.76) reported by (Muhammad et al*.,* 2015)(Poulsen et al*.,* 2001) reported that phyatic acid can bind to mineral elements such as calcium, zinc, manganese, iron and magnesium to form complexes that are un-degradable, thereby decreasing the bioavailability of these elements for absorption. Accordingly, the phytic acid content in the current study was below the level that can negatively affect animals' performance.

In -vitro crude protein digestibility

Shows the results of an *in-vitro* crude protein digestibility (IVCPD) for different parts of *S. birrea* tree*,* which was significantly (P≤0.05) different among the different parts of the plant. The highest value was detected in the leaves (80.98%), and the lowest value was in the seeds (73.79%). The IVCPD of the leaves was within the range obtained by (Atta Elmnan et al*.,* 2013) and (Dambe et al*.,* 2015) who reported that the IVCPD of generalist leaves browse was 49.5%- 84.6%.

Leaves containing high CP in the present study resulted increase in the digestibility; which agreed with (Atta Elmnan & Alamin 2015) who reported that the high CP content could increase ruminal ammonia N concentration which in turn enhances microbial activity and growth, resulting in greater digestibility (Atta Elmnan & Sharif 2020). More over reported that an *in vitro* protein digestibility improves by decreases in phytic acid, tannin content and with increase of CP content in the plants.

The seeds contained high EE% in the present study that may lead to decrease in digestibility. This result was similar with values reported by (Detmann et al*.,* 2014). Increasing EE content in seeds might have contributed to decreased intake of nutrients and digestibility (Muhammad et al*.,* 2016) observed that increased fat content of diets could depress the activities of rumen microbes.

Table 3. Tannin (%), saponnin, phytate (mg\100g) content and *in- vitro* crude protein digestibility (%) of different parts of *S.birrea.*

Plant part	Tannin	Saponnin	Phytate	IVCPD
Leaves	0.029[b]	108.8[a]	130.0[b]	80.98[a]
Fruits	0.033[a]	78.8[c]	145.0[a]	76.25[b]
Seeds	0.027[c]	92.0[b]	120.0[b]	73.79[c]
SEM	0.003	0.10	0.29	0.33

Means: with different superscription in the same column are statistically different (P≤0.05). IVCPD = *in vitro* CP digestibility, SEM= stander error of the means

CONCLUSION

The results obtained from the current study showed that the leaves, fruits, seeds of *S. birrea* have a great potential as source of important nutrients for animals. In view of the promising results of the present study, the fruit, leaves and seeds could be used as animals feed during summer period.

REFERENCES

Aganga AA, Mosase KW (2001).Tannin content, nutritive value and dry matter digestibility of Lonchocarpuscapassa, Zizphusmucronata, Sclerocaryabirrea, Kirkia acuminate and Rhuslancea seeds. Anim Feed Sci Techno. 91: 107-113.

Amarteifio JO, Mosase MO (2006).The Chemical Composition of Selected Indigenous Fruits of Botswana. J Appl Sci and Environ Management.10: 43 – 47.

AOAC (2019). Official methods of Chemical Analysis Association of Official Agricultural Chemists 21st edition Washington, DC.

Atta Elmnan AB, Dawood MH (2011). Nutritive evaluation of some pasture plants in early and late rainy season in Mosai (Southern Darfur State). Austr J Basic and Appl Sci. 5: 2065-2070.

AttaELmnan AB, FadalElseed AM, Salih AM (2009). Effect of Albizialebback or wheat bran supplement on intake, digestibility and rumen fermentation of ammoniated bagasse. J Appl Sci Res. 5:1002-1006.

Atta Elmnan AB, FadalElseed AMA, Mahala AG, Amasiab EO (2013). *In- situ* Degradability and in vitro Gas Production of Selected Multipurpose Tree Leaves and Alfalfa as Ruminant Feeds. World's Vet J. 3: 46-50.

Atta Elmnan AB, Sharaf MM (2020). In-vitro dry matter digestibility and in vitro gas production of some acacia seeds treated with sodium hydroxide and poly ethylene glycol. Pak J Nutr.19: 381-387.

Chapman HD, Pratt PF (1982). Methods of analysis for soil, Plant and water.University of California, Riverside, Division of Agric. Sciences.

Dambe LM, Mogotsi K, Odubeng M, & Kgosikoma OE (2015). Nutritive value of some important indigenous livestock browse species in semi-arid mixed Mopane bushveld, Botswana. Livest Res Rural Dev. 27: 1-10.

Detmann E, Valente E, Batista D, Huhtanen P (2014). Evaluation of the performance and efficiency of nitrogen utilization in cattle fed tropical grass pastures with supplementation. Livestock Sci. 162: 141-153.

FAO, WFP, IFAD. (2012). The State of Food Insecurity in the World 2012. Economic growth is necessary but not sufficient to accelerate reduction of hunger and malnutrition. Rome, FAO.

Hassan MR, Abdu SB, Adamu HY, Yashim SM, Oketona GF (2013). Nutrient Intake and Digestibility of Red Sokoto Bucks Fed Varying Levels of Gmelina (Gmelina arborea) Leaf Meal. Niger J Anim Prod. 15: 125-133.

Le Houerou HN (1980). Chemical composition and nutritive value of browse in West Africa. 261-289.

Mangara JLI, Guliye AY, Migwi PK, Ondiek JO (2017). Nutrient composition of selected indigenous tree browses in Central Equatoria State of the Republic of South Sudan. Livest Res Rural Dev. 29.

Mariod AA (2000). Seeds of Sclerocarya birrea, oil and protein: quality and product development aspects (Aufl. 2012. 96 S) [Paperback].

McMahon LR, McAllister TA, Berg BP, Majak W, Acharya SN, Popp JD, Coulman BE, WangY, Cheng JK (2012). A review of the effects of forage condensed tannins on ruminal fermentation and bloat ingrazing cattle. Can J Plant Sci.80: 469-485.

Mdziniso PM, Dlamini AM, Khumalo GZ, Mupangwa, JF (2016). Nutritional evaluation of marula (Sclerocaryabirrea) seedcake as a protein supplement in dairy meal. J Appl Life Sci Int. 4: 1–11.

Meschy F (2000). Recent progress in the assessment of mineral requirements of goats. Livest Prod Sci. 64: 9-14.

Mlambo BJ, Dlamini MD, Ngwenya N, Mhazo ST, Beyeneand JL, Sikosana JLN (2011). In-sacco and in vivo evaluation of marula (Sclerocaryabirrea) seed cake as a protein source in commercial cattle fattening diet.Livest Res Rural Dev. 23: 1-10

Mosoni P, Martin C, Forano E, Morgavi DP (2011). Long-term definition increases the abundance of cellulolytic ruminococci and methanogens but does not affect the bacterial and methanogen diversity in the rumen of sheep. JAS. 89: 783-791.

Muhammad N, Omogbai IJ, Maigandi SA, Abubakar IA (2016). Utilization of Scelocaryabirrea kernel meal (SBKM) as proteinsupplement in the diets of fatteningUda sheep 46: 52-64.

Muhammad S, Umar KJ, Sani NA (2015). Evaluation of Nutritional and Anti-nutritional Profiles of Gingerbread Plum (NeocaryaMacrophylla) Seed Kernel from Sokoto State, Nigeria. Inte J Sci Techno. 4: 361–367.

Mziwenkosi NM, Bhekumusa S.M. (2001). The nutritive value of marula (Sclerocaryabirrea) seed cake for broiler chickens: nutritional composition, performance,carcass characteristics and oxidative and mycotoxin status. Trop Anim Health Prod. 49:835–842.

Price ML, VanScoyoc S, Butter LG (1978). A critical evaluation of theVallin reaction as an assay for tannin in sorghum grain. J. Agric. Food Chem. 26: 1214-1218.

Poulsen HD, Johansen KS, Hatzack F, Boise S, Rasmussen SK (2001). Nutritional value of low-phytate barley evaluated in rats. Acta Agric. Scand. A Anim Sci. 51: 53-58.

SabahelKhier KM, Hussain AS, Ishag KEA (2010). Effect of maturity stage on protein fractionation, in vitro protein digestibility and anti-nutrition factors in pineapple (Ananascomosis) fruit grown in Southern Sudan. Afr J Food Sci. 4: 550 – 552.

Umaru HA, Adamu R, Dahirum D, Nadro MS (2007). Levels of ant-nutritional factors in some wild edible fruits of Northern Nigeria. Afr J Biotechnol. 6: 1935-1938.

Wheeler EL & Ferrel RE (1971). A method for phytic acid determination in wheat and wheat fractions. Cereal Chem. 48: 312-320.