MINERAL AND ANTI-NUTRITIONAL COMPOSITION OF AFRICAN BLACK PLUM PLANT PARTS AS POTENTIAL SUPPLEMENT IN RUMINANT DIETS

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ABSTRACT

The study was conducted to assess the mineral and anti-nutritional concentration in the different plant parts of African black plum. Fresh leaves and ripe fruits of the plant were collected from trees within and around Federal University Dutse, Jigawa state, Nigeria. Mineral and anti-nutritional constituents were analyzed. Data collected were subjected to analysis of variance using SAS (1999) statistical package. The result revealed the nut had significantly ($p<0.05$) higher contents of calcium (2.62%), sodium (2.30%), potassium (1.41%), phosphorus (0.67%), zinc (50.18ppm) and copper (11.19ppm) whereas magnesium, manganese and iron were significantly ($p<0.05$) higher in the fruit (0.27 ppm, 121.60 ppm and 345.11 ppm, respectively). Phytate content (1.04%) was higher ($p<0.05$) in the leaf while the least tannin concentration (1.13%) was obtained in the fruit. Oxalate and saponins were significantly ($p<0.05$) lower in the nut whereas alkaloid content was similar ($p>0.05$) among the different plant parts. The different plant parts of African black plum examined had appreciable quantities of macro and trace minerals and the levels of anti-nutritional factors were within the limit tolerable by ruminants, as such, these plant could be a potential feed supplement for ruminants.

Keywords: Secondary metabolites, minerals, leaf, nut, fruit

INTRODUCTION

The presence of secondary plant compounds in feed is the major limitation to the quality of feeds. They have the ability to suppress feed intake and utilization by animals (Thi Mui *et al*., 2002) as well as inhibit nutrient and mineral availability and absorption (Omotoso *et al*., 2019) or reduce the utilization of one or more nutrients thereby altering the expected nutritional status of the animals (Atiku *et al*., 2016). Some of these anti-nutritional factors decrease or increase the requirement of certain vitamins and can also interfere with the optimum maximization of mineral elements (Akinyemi *et al*., 2022), however, they can have beneficial effects on organisms consuming them as anti-nutritional factors at tolerable levels, do not exert adverse effects in ruminants because they are degraded in the rumen (Omotoso *et al*., 2019). Thus, the level of anti-nutritional factors in plants play a major role in determining their safety in ruminant feeding (Atiku *et al*., 2016). Mineral elements are vital components of animals' metabolic processes and their deficiencies are usually manifested by reduced milk yield, reduced water intake, chewing bones, eating soils and increased straying in search of salty plants (Audu *et al*., 2021). Many minerals are essential for optimum production in ruminants, as such, knowledge of the level of mineral concentration present in trees may suggest mineral supplementation strategy to get better growth and reproductive efficiency of ruminants (Ghazanfar *et al*., 2011). The present study is therefore aimed at determining the mineral and anti-nutritional concentration in the different parts of African black plum plant.

MATERIALS AND METHODS

Fresh leaves of African black plum were collected from trees within and around Federal University Dutse and air-dried on concrete floor until they became crispy. The ripe fruits were harvested from trees within and around Federal University Dutse, dried and cracked using hammer mill. The cracked fruits were sieved to separate the dried fruit pulp from the nuts. The fruit pulp and nut obtained along with the dried leaf were milled separately using commercial maize milling machine and stored in polythene bags until required for analysis. The ground samples were analyzed in triplicates for minerals (macro and trace) and anti-nutritional factors using standard procedures. Phosphorus was determined using spectrophotometer, sodium and potassium were determined using flame photometer (AOAC, 2005), while zinc, iron, copper, manganese, calcium and magnesium were analyzed using atomic absorption spectrophotometer. Tannin was analyzed according to Makkar and Goodchild (1996), phytate was analyzed according to Maga (1982) and oxalate was analyzed according to AOAC (1995). Saponin was determined as reported by Babayemi *et al*. (2004). Data collected were subjected to analysis of variance using SAS (1999) statistical package and significant differences among means were compared using Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

Table 1 presents the mineral content of parts of African Black plum plant. There were significant ($p<0.05$) differences in the macro and trace mineral concentration among the different plant parts. The nut had significantly ($p<0.05$) higher contents of calcium (2.62±0.01%), sodium (2.30±0.02%), potassium (1.41±0.02%), phosphorus (0.67±0.01%), zinc (50.18±0.64 ppm) and copper (11.19±0.30 ppm) whereas magnesium, manganese and iron were significantly ($p<0.05$) higher in the fruit (0.27±0.01, 121.60±0.42 and 345.11±1.29 ppm, respectively). The leaf had the least contents of sodium (0.51±0.01%), zinc (29.39±0.65 ppm), copper (6.67±0.16 ppm) and manganese (95.22±0.70 ppm). Mineral deficiency, excesses or imbalance of one or more minerals largely affect animals' performance (Audu *et al.*, 2021) by depressing their performance (Eyoh *et al.*, 2018). Calcium concentration disagrees with the report of Omoniyi *et al.* (2021) but compared favourably with that of Ghazanfar *et al.* (2011). The authors reported a deficiency of calcium could result in broken bones, convulsions and death. Sodium content recorded was higher than the report of Cheema *et al.* (2011) while the magnesium content was lower than the report of same authors. The sodium concentration obtained were sufficiently above 0.15% DM reported to meet the requirement of productive animals (Khan *et al.*, 2007). Magnesium content was slightly higher than 0.12 - 0.18% recommended by Anon (1985) but lower than 0.69-0.91% reported by Omoniyi *et al.* (2021). Trace minerals are needed in small quantities in the animal diets but are essential elements for supporting wide range of synthesis in animal body important for maintenance of health, fertility, growth and production (Habib *et al.*, 2013). Zinc concentration fell within 20-50 ppm recommended by NRC (1981) to meet the requirement of ruminants whereas copper level was lower than the report of Omoniyi *et al*. (2021).

Table 1: Some macro and trace minerals in the different parts of African Black plum plant

Parameters	**African Black plum plant parts**		
	Leaf	**Nut**	**Fruit**
Major minerals (%)			
Calcium	1.19 ± 0.12^{b}	2.62± 0.01^{a}	0.79± 0.00^{c}
Sodium	0.51 ± 0.01^{c}	2.30± 0.02^{a}	0.95± 0.02^{b}
Magnesium	0.19 ± 0.01^{b}	0.20± 0.01^{b}	0.27± 0.01^{a}
Potassium	0.98 ± 0.04^{b}	1.41± 0.02^{a}	0.99± 0.01^{b}
Phosphorus	0.49 ± 0.02^{b}	0.67± 0.01^{a}	0.54± 0.02^{b}
Trace minerals (ppm)			
Zinc	29.39 ±0.65^{c}	50.18±0.64^{a}	40.36±0.15^{b}
Copper	6.67 ±0.16^{c}	11.19±0.30^{a}	8.29±0.10^{b}
Manganese	95.22 ±0.70^{c}	110.99±0.35^{b}	121.60±0.42^{a}
Iron	336.08±3.51^{a}	310.80±0.20^{b}	345.11±1.29^{a}

$^{a, b, c,}$ means in the same row are significantly ($p<0.05$) different

Table 2 shows the result of anti-nutritional factors present in the different parts of African black plum plant. Saponin and phytate contents were statistically ($p<0.05$) higher in the leaf. Tannin content (1.13%) was significantly ($p<0.05$) lower in the fruit whereas oxalate content (0.96%) was lower in the nut. Alkaloid content was similar ($p>0.05$) among the plant parts. Tannin content (1.13 to 3.27%) obtained was higher than the reports of Udo *et al.* (2018) and Omotoso *et al.* (2019) but agrees with the report of Fadiyimu *et al.* (2011) for selected browse plants. The level of tannin reported to have an adverse effect on digestibility in sheep and cattle was in the range of 2 – 5 % while goats were reported to have a threshold capacity of about 9 % dietary tannin (Fadiyimu *et al.*, 2011). The tannin content of the different parts of African black plum is below the threshold tannin concentration of 5% beyond which there may be rejection of browses by goats and wild browsers (Okoli *et al.*, 2003). Moderate concentrations of tannins (2-4.5% DM) was reported to exert beneficial effects on protein metabolism in ruminants (Njidda *et al.*, 2012) by increasing the flow of amino acids to the intestine (Cheema *et al.*, 2011). Tannins have been reported to bind to proteins in the mouth thereby reducing the palatability of the feed and subsequently decreasing feed intake. They also have the ability to bind and inhibit the activities of digestive enzyme as well as affect microbial and enzyme activities (Cheema *et al.*, 2011). Saponin content fell within the range (3.15 - 5.72%) reported by Omotosho *et al.* (2019) while alkaloid content was lower than the report of same authors. Saponins have been attributed to a number of biological effects ranging from altering membrane permeability, hypocholesterolaemic to anti-carcinogenic properties. Saponins have been reported to have significant influence on growth, feed intake, protein digestion,

nutrient uptake and reproduction in animals (Atiku *et al.*, 2016). Phytate content was lower than that reported by Fadiyimu *et al.* (2011) for browse plants but agrees with the report of Udo *et al.* (2018). Udo *et al.* (2018) reported oxalate content of 0.12 – 0.18% for differently processed rubber seed meal, however values obtained in this study were lower than the report of these authors. The authors reported rumen microbes have the ability to degrade oxalates into carbon dioxide and formic acid, and further stated ruminants are able to adapt to high oxalate diets with minimal problems.

Table 2: Anti-nutritional factors (%) of African Black Plum plant parts

	African Black plum plant parts		
Parameters (%)	**Leaf**	**Nut**	**Fruit**
Tannin	3.27 ± 0.01^{a}	3.29 ± 0.01^{a}	1.13 ± 0.05^{b}
Saponin	5.24 ± 0.01^{a}	2.52 ± 0.07^{c}	4.62 ± 0.03^{b}
Alkaloid	1.65 ± 0.05	1.96 ± 0.23	2.14 ± 0.01
Phytate	1.04 ± 0.05^{a}	0.22 ± 0.02^{b}	0.38 ± 0.05^{b}
Oxalate	2.01 ± 0.03^{a}	0.96 ± 0.08^{b}	2.33 ± 0.04^{a}

$^{a, b, c,}$ means in the same row are significantly ($p<0.05$) different

Conclusion and recommendation

The different plant parts of African black plum had appreciable quantities of macro and trace minerals and the levels of anti-nutritional factors were within the limit tolerable by ruminants, as such, these plant parts could be a potential feed supplement for ruminants.

REFERENCES

Akinyemi, B. T., Dele, P. A., Mozea, K. O., Okukenu, O.A. and Babatunde, M. O. (2022). Effect of drying methods on the anti-nutritional content of selected browse plants in rain forest zone of Nigeria. *Nigerian Journal of Animal Production,* 49(2):250-256

Anonymous (1985). National Research Council, Nutrient requirements of sheep: Sixth Revised Edition. National Academy Press, Washington, DC.

AOAC (2005). Official methods of analysis 15th Edition, Association of Official Analytical Chemists, Washington D.C., Arlington, V.A. pp 503-515

AOAC (1995). Official methods of analysis of the Association of Official Analytical Chemists. 16th ed. Arlington, Virginia, U.S.A.

Atiku, A., Oladipo, O.O. Forcados, G.E., Usman, A.S. and Mancha, M.D. (2016). Anti-nutritional and phytochemical profile of some plants grazed upon by ruminants in North Central Nigeria during the dry season (January to April). *International Journal of Livestock Production*, 7(4): 19-23.

Audu, R., Muhammad, I.R., Maigandi, S.A., Garba, Y., Tijjani, A. and Hanga, H.R. (2021). Nutrient content assessment of different varieties of soybean forage as supplemental animal feed in semi-arid Nigeria. 46th Annual Conference of the Nigerian Society of Animal Production held on 14th – 18th March at Federal University Dutsin-ma, Katsina state.

Babayemi, O. J., Demeyer, D. and Fievez, V. (2004). Nutritional value of qualitative assessment of secondary compound in seeds of eight tropical browse, shrub and pulse legumes. *Communication in Applied Biological Science*. Ghent University, 69(1): 103-110

Cheema, U.B., Sultan, J.I., Javaid, A., Akhtar, P. and Shahid, M. (2011). Chemical Composition, mineral profile and in situ digestion kinetics of fodder leaves of four native trees. *Pakistan Journal of Botany*, 43(1): 397 - 404.

Eyoh, G. D., Ayuk, A. A., Anya, M. I. and Udo, M. D. (2018). Mineral and proximate composition of selected forages fed to West African dwarf bucks in Obio Akpa. *Nigerian Journal of Animal Production*, 45(5):129 – 135.

Fadiyimu, A. A., Fajemisin, A. N. and Alokan, J. A. (2011). Chemical composition of selected browse plants and their acceptability by West African Dwarf sheep. *Livestock Research for Rural Development. Volume 23, Article #256.* Retrieved January 27, 2023, from http://www.lrrd.org/lrrd23/12/fadi23256.htm

Ghazanfar, S., Latif, A., Mirza, I.H. and Nadeem, M.A. (2011). Macro-minerals concentrations of major fodder trees and shrubs of District Chakwal, Pakistan. *Pakistan Journal of Nutrition,* 10(5): 480-484.

Habib, G., Saleem, M. and Hameed, A. (2013). Mineral Composition of local tree leaves for feeding sheep and goats in Kohat District of Khyber Pakhtunkhwa. *Sarhad Journal of Agriculture,* 29(1): 97-103.

Khan, Z.I., Ashraf, M., Valeem, E.E., Ahmad, K. and Danish, M. (2007). Pasture concentration of minerals in relation to the nutrient requirements of farm livestock. *Pakistan Journal of Botany*, 39(6): 2183-2191.

Maga, J. A. (1982). Phytate, its chemistry, occurrence, food interaction, nutritional significance and methods of analysis. Journal of Agriculture Food and Chemistry, Volume 30, pp 1-5.

Makkar, A. O. S. and Goodchild, A. V. (1996). Qualification of tannins, a laboratory manual. International Centre for Agricultural Research in the dry areas (ICARDA), Aleppo, Syria

Njidda, A. A., Olatunji, E. A. and Raji, A. Y. (2012). Semi-arid browse forages: Their anti-nutritive substances and in sacco neutral detergent fibre and organic matter degradability. *Journal of Agriculture and Veterinary Science*, 1(6): 21-30.

Okoli, I. C., Anunobi, M.O., Obua, B. E. and Enemuo, V. (2003). Studies on selected browses of southeastern Nigeria with particular reference to their proximate and some endogenous anti - nutritional constituents. *Livestock Research for Rural Development. Volume 15, Article #62*. Retrieved January 16, 2023, from http://www.lrrd.org/lrrd15/9/okol159.htm

Omoniyi, L.A, Akinbode, R.M., Isah, O.A. and Onwuka, C.F.I. (2021). Mineral profile of four selected tree forage species consumed by small ruminants in the south-western Nigeria. 46th Annual Conference of the Nigerian Society of Animal Production held on 14th – 18th March at Federal University Dutsin-ma, Katsina state.

Omotoso, O.B., Arilekolasi, T.A. and Fajemisin, A.N. (2019). Study on mineral, antinutrient and blood parameters of goats fed molasses treated rice husk. *Journal of Food, Nutrition and Agriculture*, 2(1): 10-19.

SAS (1999). Statistical Analytical Systems. SAS/STAT User's Guide Statistical Analysis Institute Inc. ,Version 6, 3rd Edition, Cary, North Carolina, USA. 943 pp.

Thi Mui, N., Ledin, I., Uden, P. and Van Binh, D. (2002). Nitrogen balance in goats fed Flemingia (*Flemingia macrophylla*) and Jackfruit (*Artocapus heterophyllus*) foliage based diets and effect of a daily supplementation of polyethylene glycol (PEG) on intake and digestion in goats. *Asian-Aust. Journal Animal Science*, 15: 699-707

Udo, M.D., Ekpo, U. and Ahamefule, F.O. (2018). Effects of processing on the nutrient composition of rubber seed meal. *Journal of the Saudi Society of Agricultural Sciences*, 17: 297-301.