

RESEARCH ARTICLE

EFFECTS OF PROCESSING METHODS ON THE NUTRIENT AND PHYTOCHEMICAL CONTENTS OF BITTER LEAF (*VERNONIA AMYGDALINA*) MEAL AS A POTENTIAL FEEDSTUFF FOR LIVESTOCK

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ABSTRACT

This study investigated the effects of different drying methods on the nutrient and phytochemical contents of bitter leaf (*Vernonia amygdalina*) meal as a potential feedstuff for livestock. Fresh leaves of *Vernonia amygdalina* were subjected to three methods of processing: air drying, sun drying and oven drying. Samples included: fresh bitter leaf (BLF), fresh bitter leaf sundried for a day (BLS1D), fresh bitter leaf air dried for two days and sundried for a day (BLA2D) as well as fresh bitter leaf oven dried at 105°C for 24 hours (BLOV1D). The proximate composition, mineral content and phytochemical composition of the fresh and processed leaves were subsequently determined, using standard methods/procedures. The crude protein of BLF (29.10%) was significantly ($p < 0.05$) higher than the mean values of 26.70, 25.30 and 22.80%, obtained for BLS1D, BLA2D and BLOV1D, respectively. There was significant difference ($p < 0.05$) in the calcium, magnesium, potassium, sodium, copper, manganese and nickel content of the different processed bitter leaf. There was significant difference ($p < 0.05$) in the anti-nutrients content of different processed bitter leaves. Quantitative estimation showed significant lowering ($p < 0.05$) of all the contents of the phytochemicals in the processed leaves compared to fresh bitter leaf. This study concluded that processed *V. amygdalina* leaf meal can serve as good source of protein, fibre and minerals in animal feeding. Furthermore, the processing of the bitter leaf meal through drying reduced the composition of phytochemicals for better incorporation and utilization and incorporation in livestock feeds.

KEYWORDS

Bitter leaf, phytochemicals, mineral content, proximate composition, feedstuff

1. INTRODUCTION

Non availability of feed for all year round required for the maintenance and production of animals is one of the major challenges facing livestock production. Reduced supply of feeds, high demand for reduced supply of feeds, high demand for meat, and high cost of feeds and feedstuffs especially protein source are the major problem of development and expansion of livestock industries in developing countries (Solomon et al., 2007). Seasonal changes in the tropics, causes reduction in the palatability and nutritive value of the abounding grasses for animal feeding (Alokan, 1998). This problem necessitated interest and great concern to researchers because the availability of good quality grasses during the dry season is difficult (Onwuika, 1986; Huston et al., 1993). In the tropics in the tropics, ruminants are raised mainly on grasses, which are poor in nutrients and digestibility coupled with scarcity during the off season (Babayemi, 2007). Poor productivity and high mortality of stock, which characterize this industry is largely explained by the inadequacy of feeding the right quantity and quality of feeds to the various livestock species (Ayandiran et al., 2013). The rising trend in tree planting can be mutual and beneficial to both small ruminants and the environment at large. Leaf of trees can be used to feed goats and sheep as protein supplements all year round while the wastes accruing from the animals can as well be used as organic manure for the trees.

Many leguminous fodder trees and shrubs have high protein levels and are potentially promising supplements to overcome nutrient deficiencies provided anti-nutritional factors as tannins and other secondary compounds can be controlled (Mousa, 2011). They reported that on average the chemical composition of bitter leaf appeared to be suitable as a protein concentrate for ruminants, a suitable replacement for *Gliricidia* and *Leuceana* species (Ekeocha, 2011). It was concluded that some of the multipurpose leguminous trees (MPT) such as bitter leaf, may prove to be useful dietary supplements for ruminants receiving poor quality forages considering their chemical composition (El Hassan et al., 2000). Studies have shown that *V. amygdalina* is rich in nutritional composition and phytochemicals such as alkaloids, tannins, saponins and flavonoids (Alara et al., 2021; Oyeyemi et al., 2018). Bitter leaf is a good source of essential minerals and vitamins, a valuable contribution to nutritional security in regions where it is commonly consumed (Akpabio et al., 2021). The leaf contained 21.8% crude protein (Modupe and Babayemi, 2009). Different drying treatments are common practices used to extend the shelf life of bitter leaf and improve its palatability. These processes can have significant effects on the nutritional value and phytochemical contents of the vegetable (Iweala et al., 2020). Though bitter leaf meal is available during harsh weather for feeding animals, its nutritional and economic value as dry season feed source for ruminant animals is underutilized. Therefore, the present study is to investigate the effects of different drying methods on the nutrient and phytochemical contents of bitter leaf

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(*Vernonia amygdalina*) meal as a potential feedstuff for livestock.

2. MATERIALS AND METHODS

The *Vernonia amygdalina* leaves used were harvested from the cut branches of the planted shrub on the Teaching and Research Farm, Obafemi Awolowo University, Ile-Ife. Samples were subjected to different processing methods as follows: fresh bitter leaf (BLF), fresh bitter leaf sundried for a day (BLS1D), fresh bitter leaf air dried for two days and sundried for a day (BLA2D) and fresh bitter leaf oven dried at 105°C for 24 hours (BLOV1D). All the samples were milled and kept in cellophane bags pending laboratory analysis. The proximate and mineral composition and phytochemicals of the samples were determined according to the standard methods (AOAC, 2000). Data obtained were statistically analyzed with the General Linear Model of SAS (2008) and the Duncan New Multiple Range Test option of SAS (2008) was used to detect significant differences among means.

3. RESULTS

There were significant differences ($p < 0.05$) in the dry matter, organic matter, crude protein, crude fibre, ether extract, ash and nitrogen free extract content of processed bitter leaf (Table 1). Method of processing had effect on the proximate composition of the bitter leaf meal. The dry matter was 18.71, 83.93, 86.84 and 89.12%; organic matter, 80.37, 88.05, 85.35 and 85.44%; crude protein, 29.12, 26.67, 25.25 and 22.80%; crude fibre, 36.12, 12.94, 11.37 and 11.35%; ether extract, 7.71, 20.51, 19.49 and 17.74%; ash, 19.63, 11.96 and 14.57%; nitrogen free extract, 7.43, 27.93, 29.25 and 33.56% for BLF, BLS1D, BLA2D and BLOV1D respectively. The dry matter and nitrogen free extract content of BLOV1D was significantly ($p < 0.05$) higher than the mean values of others while the organic matter and ether extract content of BLS1D was significantly ($p < 0.05$) higher than the mean values of others. This can be due to the different processing method used. The crude protein content of BLF was higher than those obtained for BLS1D, BLA2D and BLOV1D.

Table 1: Proximate composition of the processed bitter Leaf

Parameter (%)	BLF	BLS1D	BLA2D	BLOV1D	SEM	Probability
Dry Matter (DM)	18.71 ^d	83.93 ^c	86.84 ^b	89.12 ^a	0.06	<0.0001
Analysis % of DM						
Organic Matter	80.37 ^d	88.05 ^a	85.35 ^c	85.44 ^b	0.02	<0.0001
Crude Protein	29.12 ^a	26.67 ^b	25.25 ^c	22.80 ^d	0.19	0.004
Crude fibre	36.12 ^a	12.94 ^b	11.37 ^c	11.35 ^c	0.12	<0.0001
Ether Extract	7.71 ^c	20.51 ^a	19.49 ^a	17.74 ^b	0.27	0.001
Ash	19.63 ^a	11.96 ^d	14.65 ^b	14.57 ^c	0.02	<0.0001
Nitrogen free extract	7.43 ^c	27.93 ^b	29.25 ^b	33.56 ^a	0.47	<0.0001

a, b, c, d: Means within each row with different superscripts are significantly different ($p < 0.05$)

BLF - Fresh bitter leaf; BLS1D - Fresh bitter leaf sundried for a day; BLA2D - Fresh bitter leaf air dried for two days and sundried for a day; BLOV1D - Fresh bitter leaf oven dried at 105°C for 24 hours; SEM - Standard error of mean

Table 2 shows the mineral composition of the processed bitter leaf. There was no significant difference ($p > 0.05$) in the phosphorus and iron content of the differently processed bitter leaf. There was significant difference

($p < 0.05$) in the calcium, magnesium, potassium, sodium, zinc, copper, nickel and chromium content of the different processed bitter leaf. The calcium, magnesium, potassium, sodium and zinc content of BLF was significantly ($p < 0.05$) higher than the mean values of others while BLA2D was significantly ($p < 0.05$) higher in copper and manganese content. The nickel content of BLS1D and BLA2D was significantly ($p < 0.05$) higher than that of others.

Table 2: Mineral composition of the processed bitter leaf

Minerals	BLF	BLS1D	BLA2D	BLOV1D	SEM	Probability
Calcium (%)	0.05 ^a	0.01 ^b	0.01 ^b	0.01 ^b	0.35	<0.0001
Phosphorous (ppm)	0.23 ^a	0.20 ^a	0.25 ^a	0.20 ^a	0.03	0.74
Magnesium (%)	0.015 ^a	0.0040 ^b	0.0037 ^b	0.0037 ^b	0.02	<0.0001
Potassium (%)	0.12 ^a	0.038 ^b	0.046 ^b	0.040 ^b	0.003	0.0001
Sodium (%)	0.13 ^a	0.030 ^b	0.030 ^b	0.027 ^c	0.0003	<0.0001
Sulfate (ppm)	0.028 ^a	0.013 ^b	0.020 ^{ab}	0.014 ^b	0.003	0.08
Iron (ppm)	9.82 ^a	10.02 ^a	10.08 ^a	7.47 ^a	0.29	0.69
Zinc (ppm)	4.59 ^a	2.24 ^b	2.94 ^{ab}	2.41 ^b	0.0001	0.09
Copper (ppm)	0.19 ^b	0.28 ^b	0.43 ^a	0.18 ^b	1.45	0.01
Manganese (ppm)	2.29 ^b	2.76 ^b	6.67 ^a	2.35 ^b	0.0004	0.01
Nickel (ppm)	0.032 ^c	0.23 ^a	0.20 ^a	0.11 ^c	0.01	0.0002
Chromium (ppm)	0.21 ^a	0.09 ^b	0.12 ^{ab}	0.11 ^b	0.02	0.10

a, b, c, d: Means within each row with different superscripts are significantly different ($p < 0.05$)

BLF - Fresh bitter leaf; BLS1D - Fresh bitter leaf sundried for a day; BLA2D - Fresh bitter leaf air dried for two days and sundried for a day; BLOV1D - Fresh bitter leaf oven dried at 105°C for 24 hours; SEM - Standard error of mean

Table 3 shows the phytochemical contents of the processed bitter leaf. There was a significant decrease in all the contents of the phytochemicals in processed bitter leaves compared with the fresh bitter leaf. Tannin

content (mg/100g), polyphenol content (mg/100g), oxalate content (mg/g), phytate content (mg/g) and saponin content (%) of the leaves decreased from BLF to BLOV1D. BLA2D had lowest flavonoid (0.24%) and cyanide (1.00 mg/kg) content compared to others. The alkaloid content of BLS1D and BLA2D was lower than that of BLF and BLOV1D. There was a reduction in the composition of phytochemicals in the leaves as a result of drying.

Table 3: Phytochemical contents of the processed bitter leaf

Parameter	BLF	BLS1D	BLA2D	BLOV1D	SEM	Probability
Saponin (%)	6.59 ^a	1.49 ^b	1.44 ^b	1.24 ^c	0.03	<0.0001
Alkaloids (%)	4.08 ^a	0.64 ^c	0.64 ^c	0.71 ^b	0.01	<0.0001

Table 3 (cont): Phytochemical contents of the processed bitter leaf

Flavonoid (%)	2.71 ^a	0.28 ^c	0.24 ^d	0.35 ^b	0.01	<0.0001
Tannin (mg/100g)	10.20 ^a	5.70 ^b	5.38 ^c	4.30 ^d	0.02	<0.0001
Polyphenol (mg/100g)	4.65 ^a	2.89 ^b	2.71 ^b	2.08 ^c	0.08	0.001
Cyanide (mg/kg)	3.64 ^a	1.23 ^b	1.00 ^c	1.26 ^b	0.01	<0.0001
Phytate (mg/g)	60.89 ^a	30.46 ^b	28.51 ^c	24.09 ^d	0.06	<0.0001
Oxalate (mg/g)	13.92 ^a	10.74 ^b	10.16 ^c	8.46 ^d	0.01	<0.0001

a, b, c, d: Means within each row with different superscript are significantly different ($p < 0.05$)

BLF - Fresh bitter leaf; BLS1D - Fresh bitter leaf sundried for a day; BLA2D - Fresh bitter leaf air dried for two days and sundried for a day; BLOV1D - Fresh bitter leaf oven dried at 105°C for 24 hours; SEM - Standard error of mean.

4. DISCUSSION

The finding from the chemical composition of processed bitter leaf is in line who reported highest dry matter content of 91.40% in oven dried *Acacia angustissima* leaf meal and lowest, 89.80% in shade dried leaf meal (Sharai et al., 2015). The Crude Protein (CP) content of fresh and processed bitter leaves were higher compared to 21.50% and 19.70% reported (Owen, 2011; Ekeocha, 2011) respectively. The difference in CP value can be due to variation in processing methods, season and stage of cutting. BLA2D and BLOV1D had lower crude fibre content than others.

The calcium, magnesium, potassium and sodium content of BLF were higher than that of others while BLA2D had higher copper and manganese content. BLS1D and BLA2D had higher nickel content when compared with others. This showed that processing methods has effect on the mineral content of bitter leaf. The calcium, magnesium, potassium and sodium content of the fresh and processed bitter leaves were higher than the values reported by (Aliero and Addullahi, 2009). Higher reported higher iron, calcium and potassium contents in fresh bitter leaf than the processed vegetable except for sodium content were reported (Tsado et al., 2015). Processing of bitter leaf by air drying, sun drying and oven drying results in loss of calcium, magnesium, potassium, sodium, sulfate, zinc, nickel and Chromium. Relative to the suggested requirement range of 0.19-0.77% for calcium, 0.01-1.0% for potassium, 0.01-0.25% for sodium (Fettman et al., 1984), 0.17-0.21% for magnesium and 1.20-2.70% for phosphorus, the inorganic mineral contents of the bitter leaf meal could serve as good source of minerals for ruminant animal (McDowell, 1997; McDowell, 1992; Suttle, 1983; Akinsoyinu, 1986). The processed bitter leaf (BLA2D) with the required nutritive value and least antinutritional factors could be incorporated in the diets of ruminants. Oven drying method is expensive and less economical than BLA2D.

Tannin content (mg/100g), polyphenol content (mg/100g), oxalate content (mg/g), phytate content (mg/g) and saponin content (%) of the leaves decreased from BLF to BLOV1D. BLA2D had lowest flavonoid (0.24%) and cyanide (1.00 mg/kg) content compared to others. Authors also reported lowest tannin content in oven dried leaf meal and observed marked reduction in cyanide content of cassava leaves and their consequent toxicity at 105 °C drying temperature (Phuc et al., 2000; Sharai et al., 2015). The alkaloid content of BLS1D and BLA2D was lower than that of BLF and BLOV1D. There was a reduction in the composition of the phytochemicals in the leaves as a result of the drying process. The reduction in these compounds is consistent with research by (Ogbonna et al., 2023). They found that processing methods generally reduced bioactive compounds like flavonoids and phenols, but noted that this reduction might be offset by improved bioavailability of remaining compounds. The observed higher cyanide content in the fresh samples of the different vegetables studied compared to their corresponding processed samples, agrees with the submission that various food processing methods will reduce cyanide content in avocado (*Persea americana*) leaves, plants and cassava leaves, respectively (Oboh, 2005; Ojako and Igwe, 2008). The significant decrease in cyanide concentrations in the vegetable during sun drying and oven drying may be attributed to the volatile nature of cyanide and could have been dissipated during drying. This observation is in agreement with the finding to the effect that cyanides are volatile compounds and can be dissipated while drying (Aganga and Tshwenyane, 2003). Reduction in antinutrients like saponin, phytates, oxalates and tannins can improve palatability, mineral bioavailability and digestibility (Onigbinde et al., 2024).

5. CONCLUSION

The results obtained from this study showed that processed *V. amygdalina* could serve as good source of protein, fibre and minerals in animal feeding.

Furthermore, processing of the bitter leaf meal through drying reduced the composition of antinutritional factors for better utilization as feed for livestock.

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