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Effects of Different Processing Methods on the Nutrient and Anti-Nutritional Factors of Tropical Sickle Pod (*Senna Obtusifolia*) Leaves

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Abstract
The study was conducted to evaluate the effects of different processing methods on the chemical composition of *Senna obtusifolia* leaves (SOLs). The leaves were divided into four batches. The first batch was sun-dried; second batch was boiled for 30 minutes; third batch was ensiled for 9 days and the fourth batch was boiled for 30 minutes and thereafter fermented for 7 days. The differently processed leaves were properly sun-dried, milled and analyzed in triplicates for their proximate composition, amino acid profile, vitamin contents and levels of anti-nutritional factors using standard laboratory procedures. The chemical composition of the processed SOLs was significantly ($P<0.05$) affected by the different processing methods. The lowest protein content, amino acid profile, vitamins and ash contents were recorded in the boiled SOLs. The fermented and ensiled SOLs however indicated the highest protein contents of 17.25 and 17.15%. The different processing methods were observed to reduce the levels of the anti-nutritional factors. However, the boiled and fermented SOLs indicated the lowest tannins (0.66 mg/100 g), alkaloids (0.64 mg/100 g) phytates (0.38 mg/100 g), oxalates (0.47 mg/100 g) and saponins (0.41 mg/100 g). In conclusion, the different processing methods were effective in reducing the levels of the anti-nutritional factors but boiling and fermentation was observed to be more effective in enhancing the nutritional qualities of the leaves and it is therefore, recommended for processing SOLs.

Keywords: Processing, Tropical Sickle Pod, Proximate, Anti-Nutritional Factors.

Introduction

The persistent increase in the high cost of feeding livestock in developing countries like Nigeria can be partly addressed through the utilization of cheaper alternative feed resources that are hitherto, underutilized as feed resources for domestic animals. Augustine *et al.* (2018) advocated the use of lesser-known legumes in feeding livestock so as to reduce the overall cost of raising livestock and enhance sustainable livestock production in a continent that is already battling with socio-economic problems.

The use of Senna obtusifolia leaf as feed material was well-documented (Ayssiwede et al. 2017). Yakubu et al. (2017) also reported that the leaves contain some anti-nutritional factors notably tannins, phytate and oxalates. This necessitates the need for processing before utilization as feedstuff for domestic animals. Some processing methods have been reported to cause nutrient losses (Jasray and Kiran, 2010; Smith et al. 2018) and therefore it is important to evaluate the best processing method(s) that can detoxify Senna obtusifolia leaves with appreciable increase in nutritional value and minimal nutrient losses. Much have not been done to evaluate the effects of different processing methods on the proximate composition, amino acid profile, mineral and vitamin contents and levels of anti-nutritional factors of Senna obtusifolia leaves. This study was conducted to investigate the effects of different processing methods on the chemical properties of SOLs with a view to determine the best processing method(s) that will detoxify the leaves. .

Materials and Methods

Collection and processing of Senna obtusiolfolia leaves

The leaves of Senna obtusifolia were harvested in bushes around Mubi area of Adamawa State, Nigeria. The area is located between latitudes 9^{o} 30' and 11^{o} north of the equator and longitudes 13º and 9º 45' east of Greenwich meridian (Adebayo, 2004). The harvested leaves were divided into four batches of 300 g each as follows:

1. The first batch was properly sun-dried for five days;
2. The second batch was boiled for 30 minutes. The boiling time was taken immediately the water started to boil;
3. The third batch was wilted and placed in an air-tight container (ensiled) and was allowed to naturally ferment for 9 days;
4. vi) The fourth batch was boiled for 30 minutes, cooled, drained placed in an air-tight container and was allowed to ferment for 7 days.

Chemical analysis

The proximate composition, amino acid profile, vitamin content and levels of the anti-nutritional factors were determined using the procedures of AOAC (2010).

Results and Discussion

The proximate composition of the differently processed SOLs is presented in Table 1. The result revealed significant (P<0.05) difference in the dry matter content of the Processed SOLs. The boiled and fermented SOLs, recorded the highest dry matter loss which was attributed to the combined effects of boiling and fermentation resulting in more dry matter loss. Fermentation was reported to cause dry matter loss (Smith *et al*., 2011). Microorganisms through series of metabolic activities can generate heat which in turn accelerates oxidation, moisture absorption hydrolysis, pyrolysis and other chemical processes resulting in dry matter loss (Richardson *et al*., 2002). This might be the reason for the dry matter losses observed in the boiled and fermented SOLs.

Table 1: Proximate Composition and Energy Content of *Senna obtusifolia* Leaf Meal Subjected to Different Processing Methods.

Proximate Components (%)	T1(SDSOLM)	T2(BSOLM)	T3(ESOLM)	T4(BFSOLM)	SEM
Dry matter	92.50^a	90.08^a	87.65^b	86.07^b	3.05
Crude Protein	16.25^b	14.75^b	17.25^a	17.15^a	0.001
Crude fibre	9.03^a	7.27^b	5.23^c	5.15^c	0.22
Ash	5.20^b	4.09^c	6.40^a	6.25^a	12.71
Ether extract	4.02	3.12	2.07	2.03	0.06
NFE	33.38	32.51	32.75	30.95	3.08
Energy Kcal/kg	2112.36^a	1952.58^b	1968.55^b	1897.51^c	11.07

SDSOLM = Sun-dried *Senna obtusifolia* leaf meal; BSOLM = Boiled *Senna obtusifolia* Leaf meal; ESOLM = Ensiled *Senna obtusifolia* leaf meal; BFSOLM = Boiled and fermented *Senna obtusifolia* leaf meal; NFE = Nitrogen-free extract.

The crude protein content was observed to be significantly (P<0.05) affected by the different processing methods. An increase in the protein content was observed in both the ESOLM and BFSOLM. This increase was attributed to the proteolytic activities of micro- organisms. This was buttressed by Pranoto *et al.* (2013) who reported that protein increase during fermentation is partly due to degradation of complex protein by micro-organism thereby releasing peptides and amino acid which is consistent with the findings of this study. Smith *et al*. (2018) reported that dry matter loss is always accompanied by increase protein content which is also another reason for the increase in the protein content observed in this study. Augustine *et al*. (2018) also observed an increase in the protein content of SOLs subjected to different fermentation periods.

The lowest fibre content was observed in the boiled, ensiled and boiled and fermented SOLs. However, the boiled and fermented SOLs recorded the lowest crude fibre. This decrease was connected to the combined effects of boiling and microbial activities during fermentation. Similar findings were reported by Augustine *et al*. (2018) for *Senna obtusifolia* seeds subjected to varying fermentation period. It was reported that fermenting microbes contains enzymes such as cellulases that can degrade fibre content (*www.fao.org/3/x0560e06*). Anthony and Babatunde (2014) further reported that microbes during fermentation can enzymatically break fibre and utilize them as carbon source which is beneficial to livestock especially monogastric animals.

The result indicated an increase in the ash content of the fresh fermented and the boiled/fermented SOLs when compared to the sun-dried and boiled SOLs. The boiled SOLs however, indicated the lowest ash content which might be due to leaching out of minerals into the boiling water which is in line with the finding of Jasraj and Kiran (2010) who similarly, observed a reduction in the ash content of boiled African leafy vegetables. The increase in the ash content of the fermented SOLs was linked to the activities of fermenting micro-organisms which is in agreement with the report of Pranoto *et al*. (2013) who reported that fermentation increases mineral such as iron, calcium and Zinc. Day and Morawicki (2018) further explained that, increase in mineral content during fermentation is due to loss of dry matter as microbes degrade carbohydrate and protein. Sripriya *et al*. (1997) buttressed that fermentation increases bioavailability of calcium, phosphates and iron likely due to degradation of oxalates and phytates that form complex compound with minerals.

The nitrogen-free extract and energy content of the leaves were significantly (P<0.05) different. The sun-dried however, recorded the highest nitrogen-free extract and energy content. This suggests that sun-drying only led to minimal loss of these components which is consistent with the findings of Umar *et al*. (2017). The lowest nitrogen-free extract and energy were recorded in the BFSOLM. This observed effect was due to the combined impact of boiling and fermentation which is consistent with the report of Osman *et al*. (2011) who reported that, fermentation activates starch-hydrolyzing enzymes such α-amylase and maltase which degrade starch into maltose, dextrin and simple sugars such as glucose which are utilized by the fermentation microbes resulting to a decrease in total carbohydrate.

The amino acid profile is presented in Table 2. The amino acid content of the SOL was significantly (P<0.05) different. The lowest amino acid content was observed in BSOLM which is similar to the finding of Augustine *et al*. (2018) for *Senna obtusitolia* leaves subjected to different boiling periods. The ensiled and boiled fermented SOLs indicated highest amino acid profile which might be due to metabolic activities of the fermenting microorganisms that synthesized new products during fermentation. Pranoto *et al*. (2013) buttressed that microbe degrade complex protein during fermentation thereby releasing peptides and amino acids resulting to an increase in amino acid content as observed in this study.

Table 2: Amino Acid Profile of Senna obtusifolia Leaf Meal as Affected by different Processing Methods.

Amino acid profile (mg/100g)	T1(SDSOLM)	T2(BSOLM)	T3(ESOLM)	T4(BFSOLM)	SEM
Lysine	2.19^b	1.26^c	2.95^a	2.75^a	0.007
Methionine	1.13^b	0.88^c	1.65^a	1.86^a	0.006
Threonine	2.07^b	1.79^c	2.75^a	2.66^a	0.005
Isoleucine	2.58	2.79	2.85	2.84	0.004
Leucine	1.65^c	1.24^c	1.85^b	2.77^a	0.001
Phenylalanine	1.61^a	0.65^c	1.70^a	1.73^a	0.012
Valine	1.48	1.54	1.58	1.52	0.006
Tryptophan	3.78^a	1.54^b	3.88^a	3.91^a	0.0011
Histidine	1.70	1.63	1.52	1.46	0.007
Alanine	2.61^b	1.96^c	2.93^b	3.51^a	0.003
Glutamic acid	1.54^b	1.56^b	2.99^a	2.50^b	0.005
Tyrosine	1.28	1.22	1.28	1.30	0.025
Serine	2.13^b	1.63^c	2.78^a	2.83^a	0.017

SDSOLM = Sun-dried *Senna obtusifolia* leaf meal; BSOLM = Boiled *Senna obtusifolia* Leaf meal; ESOLM = Fresh fermented *Senna obtusifolia* leaf meal; BFSOLM = Boiled and fermented *Senna obtusifolia* leaf meal.

The vitamin content of the processed SOLs is presented in Table 3. The vitamin content of the processed SOL were observed to be significantly (P<0.05) different. The lowest vitamin content was recorded in the boiled SOL which was possibly due to leaching out of the vitamins into the boiling water. The vitamins were observed to be higher in the fermented SOLs. It was documented that fermentation process can result to increase level of vitamins in the final products. *Saccharomyces cerevisiae* was reported to be able to concentrate large quantities of thiamine, nicotinic acid and biotin and thus form enrich products during fermentation (*www.fao.org/3/x0560e06*).

Table 3: Vitamin Composition of *Senna obtusifolia* Leaf Meal Subjected to Different Processing Methods.

Vitamin (mg/100g)	T1(SDSOLM)	T2(BSOLM)	T3(FFSOLM)	T4(BFSOLM)	SEM
A	48.66^b	24.32^c	65.18^a	66.09^a	0.37
D	0.56	0.53	0.56	0.54	0.004
E	0.23^b	0.17^c	0.22^b	0.32^a	0.033
K	0.06^b	0.03^c	0.17^a	0.19^a	0.01
B1	0.22^b	0.11^c	0.51^b	0.49^{ab}	0.003
B2	0.20^b	0.16^c	0.32^a	0.35^a	0.017

SDSOLM = Sun-dried Senna obtusifolia leaf meal; BSOLM = Boiled Senna obtusifolia Leaf meal; FFSOLM = Fresh fermented Senna obtusifolia leaf meal; BFSOLM = Boiled and fermented Senna obtusifolia leaf meal.

The effects of the processing methods on the levels of the ant-nutritional factors (Table 4) showed that, the different processing methods were effective in reducing the levels of the anti-nutritional factors. However, the BFSOLM recorded the lowest levels of the anti-nutritional factors, an indication that it is the safest for consumption by livestock which agreed with the findings of Nuha *et al*. (2010) for fermented *Senna obtusitolia* leaves. This outcome was possibly due to the impact of boiling and actions of micro-organisms during fermentation. Doudu *et al*. (2003) and El–hag *et al*. (2003) buttressed that, micro-organisms fermenting food can utilize anti-nutritional factors. Thus leading to their reduction. Emmambuse and Taylor (2003) reported that prolonged fermentation decreased tannin content due to microbial phenyl oxidase action.

Table 5: Levels of Anti-nutritional Factors of *Senna obtusifolia* Leaf Meal as Affected by Processing Methods'

Anti-nutritiona; factors (mg/100g)	T1(SDSOLM)	T2(BSOLM)	T3(ESOLM)	T4(BFSOLM)	SEM
Tannins	3.07^a	1.18^c	0.91^d	0.66^c	0.004
Alkaloids	3.68^a	1.21^b	0.63^c	0.64^c	0.016
Phytates	2.11^a	0.88^b	0.41^c	0.38^d	0.003
Oxalates	1.99^a	0.66^b	0.42^c	0.47^c	0.001
Saponins	1.80^a	0.61^b	0.6^b	0.41^c	0.002

SDSOLM = Sun-dried *Senna obtusifolia* leaf meal; BSOLM = Boiled *Senna obtusifolia* Leaf meal; ESOLM = Ensiled *Senna obtusifolia* leaf meal; BFSOLM = Fermented *Senna obtusifolia* leaf meal

Conclusion

It was concluded from the outcome of this investigation that sun-drying, boiling, ensiled and boiled and fermentation methods were effective in reducing the levels of the anti-nutritional factors of SOLS. However, boiling and fermentation methods were more effective in reducing the levels of the anti-nutritional factors and also in enhancing the nutritional properties of SOLs and is therefore recommended for processing SOLs.

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