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EFFECTS OF FERMENTATION ON CHEMICAL COMPOSITION AND IN VITRO GAS PRODUCTION OF *ALBIZIA LEBBECK* PODS

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Abstract
The study investigated the effect of fermentation on chemical composition and In vitro gas production of the pod, seed, and seed+husk of Albizia lebbeck. The study consisted of six (6) treatments, which were fermented seed, fermented empty pod, fermented seed+pod, unfermented seed, unfermented empty pod and unfermented seed+pod with each treatment replicated three times in completely randomized design. The fermented test materials were soaked for 3-days and fermented for 2-days with another set soaked for 3-days without fermentation. Dry matter for both fermented and unfermented test material were similar, ranging from 96.0% to 98.2%. Unfermented empty pod had the highest ash content of 8.5% with fermented seed, fermented seed+pod and unfermented seed being similar with mean values of 5.1, 4.6 and 5.1% respectively. Fermented empty pod recorded the highest percentage of NDF and ADF with mean value of 75.1 and 55.7% respectively while fermented seed recorded the least mean values of 25.0% and 10.0% respectively. Fermented seed recorded the highest percentage crude protein of 40.5% with fermented empty pod recording the least of 16.9%. Fermentation had no significant effect on in vitro gas production. Fermentation reduced Metabolizable energy (ME) in seed but did not affect seed+pod and empty pod. Fermentation did not have significant effect on short chain fatty acid in this study. In conclusion, fermentation caused an increase in CP and lower NDF and ADF in the seeds of Albizia lebbeck.

Keywords: Fermentation, Albizia Lebbeck, Short Chain Fatty Acid, Seed, Seed+pod

Introduction

Albizia lebbeck (L.) Benth, (Minosacaeae) is a multipurpose tree with potential to provide quality fodder for feeding different classes of livestock (Tope et al., 2018). It belongs to the family Fabaceae, a deciduous, perennial medium sized legume tree. The leaves have high concentration of crude protein (24.0%) with a moderate amount of NDF (46.9%) and ADF (33.7%) (Heuzé et al., 2015). During the dry season, it sheds off a lot its leaves whilst producing a large amount of seeds. The seeds are usually enclosed in a pod and often drop to the ground when dry and serve as feed for ruminants. The pods are rich in crude protein (21.0%) (Heuzé et al., 2015), but may contain high levels of cell wall fraction which may inhibit the digestibility of the nutrients in the pod.

Fermentation is a method of feed processing which could bring about increase in the levels of crude protein and digestibility. It is widely utilized within sub-humid, semi-arid tropics and sub-tropical areas where there is marked dry season and an unreliable rainfall pattern. It has been reported that Albizia lebbeck parts used as animal feed contain plant secondary metabolites that inhibit digestion and utilization to some extent (Muhammad et al., 2010). Fermentation of *Albizia lebbeck* seed has proven to reduce anti-nutrient composition of seeds and improved upon digestion of protein. Fermentation have also been reported to increase the ash contents, which could be due to the hydrolysis of some of the anti-nutrient contents which naturally bond to some of the mineral element (Ifesan et al., 2017). Despite being a source of rich plant protein for livestock, Albizia lebbeck pod is underutilized in the Guinea savannah agro-ecological zone of Ghana, where it is readily available for livestock production in dry seasons.

The study was therefore carried out to investigate the effects of fermentation on empty pod, seed+pod and seed only of Albizia lebbeck within the northern Guinea

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savannah agro-ecological zone.

Materials and Methods

Study Area
The test materials were collected from the Guinea savannah agro-ecological zone of Ghana. Chemical analysis and In vitro digestibility trial were carried out at the forage evaluation unit of Animal Science Department of the University for Development Studies. The study area has mean annual rainfall of 1043 mm distributed fairly from April to late November. Temperatures generally fluctuate between 15˚C (minimum) and 42˚C (maximum).

Sample Collection
Dried filled pod of Albizia lebbeck was harvested from trees within the environs of the Nyankpala campus of the University for Development Studies in the month of April. Filled pods were broken to separate the seed to obtain empty pod. Three test materials were prepared, and these were, Empty pod, Seed+pod and Seed only.

Experimental Treatments and Design
Six (6) treatments comprising fermented seed, fermented empty pod, fermented seed+pod, unfermented seed, unfermented empty pod and unfermented seed+pod with each treatment replicated three times in completely randomized design.

Soaking and Fermentation
Soaking and fermentation was done using the method of Tsado et al. (2018) with a little advancement. Three different samples each (28.0 g) empty pods, seed+pod and seeds only were soaked with about 4.0 L of water separately in buckets and covered with a lid for 72 h. The samples were drained, placed in doubled black polyethene bags and tied airtight to create an aerobic condition for fermentation. They were placed back into the plastic buckets and covered to prevent contamination for 48 h. Unfermented treatments, were only soaked for 72 h.

Drying and Milling
After 48 h, fermented samples were air dried for 48 hours. Test materials were then milled using a hammer mill to pass through a 2.0 mm and 1.0 mm sieve for analysis.

Proximate Analysis and In Vitro Digestibility Set Up
Dry matter (DM), Ash, Ether extract (EE), and Crude protein (CP) were determined using the procedure of AOAC (2000). The method according to AOAC (2000) was employed in determining the crude fibre content of the sample in this experiment using the ANKOM 200 fiber analyser. NDF and ADF were determined limited of residual ash through sodium sulphite and α- amylase using the procedure of Van Soest et al. (1991) and this was done using Ankom200 fibre analyser (Method 5 and 6). The In vitro gas production technique of Theodorou et al. (1994) was adopted using a water bath. The samples were incubated in Eppendorf Tubes (50 ml) enriched with rumen fluid and McDoughal Buffer. The rumen fluid was obtained from slaughtered cattle at the Tamale abattoir following the procedure of Ansah et al. (2016). The incubated samples were placed in a water bath (39oC) and gas production recorded over a period of 96 h using a digital manometer. The IVOMD was calculated using the equation DOM (%) = 16.49 + 0.9042 GP + 0.0492 CP + 0.0387ash whiles SCFA and metabolizable energy were calculated using the equations SCFA = 0.0239*GP*0.0601 and ME (MJ/kg DM) = 14.30–(0.0134*ADF) respectively by Menke and steingass (1988).

Data Analysis
The one-way analysis of variance in GenStat, 11th edition was used to analyse the chemical composition and in vitro gas production data. Means that were significant were separated using Tukeys least significant differences (LSD) at 5%.

Results and Discussions
The result on the chemical composition is shown in Table 1. The indifferences in ash, ADF, NDF, CF between fermented seed and unfermented seed agrees with the finding of Adegbehinbhe et al. (2018). Fermentation is reported to increase some individual minerals like magnesium, zinc and calcium and may be due to loss in dry matter in the fermented sample (Pranoto et al., 2013) but in this study there was no loss in other components of the dry matter such as soluble carbohydrates in the fermented samples. The ash content of fermented seed+pod and empty pod showed a reduction as compared to their counterparts.

This is contrary to Adegbehinbhe et al, (2018) and Ogodo et al, (2017) who report ed an increase in ash content and suggested it may be due to the hydrolysis of some anti-nutrient contents which naturally bonds with the mineral contents. Decrement in ash content after fermenting food samples have been reported by Fakoya, (2013) while increment in ash content after fermentation have been reported (Osman, 2010; and Assohoun et al., 2013). The high fibre content (CF, ADF, NDF, and HM) of fermented seed+pod and empty pod as compared to unfermented seed+pod and

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Table1. Chemical Composition of Fermented and Unfermented Albizia Lebbeck Seed, Empty Pod and Seed+pod.

Parameter	Fermented			Unfermented			Sed	P Value
	Seed	Empty pod	Seed+pod	Seed	Empty pod	Seed+Pod		
DM	98.3	97.8	96.5	97.0	96.0	97.0	0.68	0.060
OM	94.9^{a}	96.7^{c}	95.3^{b}	94.8^{b}	91.1^{a}	91.5^{a}	0.27	0.001
CP	40.6^{e}	16.9^{a}	21.6^{b}	37.2^{d}	24.9^{c}	22.5^{b}	0.40	0.001
ASH	5.1^{b}	3.3^{a}	4.7^{b}	5.2^{b}	8.9^{c}	8.5^{c}	0.27	0.001
ADF	10.0^{a}	55.7^{d}	44.4^{c}	15.4^{a}	42.7^{bc}	37.2^{b}	1.77	0.001
NDF	25.0^{a}	75.1^{d}	61.8^{b}	27.2^{a}	61.0^{b}	52.7^{c}	1.80	0.001
HM	15.0^{ab}	19.4^{b}	17.4^{ab}	12.3^{a}	18.3^{ab}	15.5^{ab}	2.01	0.041
CF	5.9^{a}	45.2^{e}	31.5^{c}	5.9^{a}	38.0^{d}	24.43^{b}	0.40	0.001
EE	3.9f	1.0b	1.7^{c}	2.7^{d}	0.1^{a}	0.7^{b}	0.14	0.001

DM: Dry matter, OM: Organic matter, ADF: Acid detergent fibre, NDF: Neutral detergent fibre, HM: Hemicellulose, CF: Crude fibre, CP: Crude protein,

empty pod is surprising. Laconi (1998) revealed that fermenting pod of cocoa increased crude protein content from 8.4 to 10.0% and decreased crude fiber from 55.7 to 45.6%. Wahyuni (2003) also stated that rice bran which was fermented by Aspergillus ficuum increased crude protein from 8.1 to 8.4% and decreased crude fiber from 18.4 to 11.0%. According to Ogodo et al. (2017), the use of artificial microbes causes greater decline in crude fibre content as compared to natural fermentation. Suleiman (2019) also recorded an increase in CF of C. cujete fermented with water of about 31.2%. Fakoya et al. (2018) also reported an increase in CF content after fermenting Albizia seeds. The increment in CF could be as a result of microbial activities where soluble sugars are metabolized and used by the microorganisms.

The increase in crude fibre content of the seed observed after fermentation in this study agrees with the report of Olufemi and Oyedeji (2015) while fermenting date fruits with Bacillus species. An increment in CF may infer that the feed will maintain the health of gastrointestinal tract when consumed (Audu and Aremu, 2011). The CP recorded in this study for unfermented seeds (37.2%) was higher than reported by Babayemi et al. (2009) (33.1%) and Fakoya et al. (2018) (28.4%). Other Albizia plants (samen and rhizonse) seeds also reported by Babayemi et al. (2009) had CP of 29.0 and 33.7% respectively which are lower as compared to this study. Difference in age of plant and location can create these differences. A High CP in fermented seed (40.6%) against unfermented seed (37.6%) in this study agrees with Fakoya et al. (2018) who recorded CP of 28.4% and 36.3% for unfermented and fermented Albizia lebbeck seed respectively. The CP recorded for fermented seed+pod (21.6%) and unfermented seed+pod (22.5%) is within the range reported by Heuze et al. (2015) to be 21.1%. The differences in CP among treatments in this study can be attributed to the effect of fermentation and level of chemical constituent in the Albizia lebbeck parts. The level of CP in diet affect animal performance and Norton (1994) recommended a CP of 8.0% (DM) to meet maintenance requirement of ruminants. The intake of forage is limited when CP content of forages is less than 10.0% (Raanjhman, 2001). In this study, fermented and unfermented Albizia lebbeck had CP higher than 8-10.0% which indicate they are good sources of protein for ruminant supplementation. All fermented samples had higher EE than their counterpart in this study and agrees with Fakoya et al. (2018) who recorded an increment in fat content after fermenting Albizia lebbeck but EE in this study was lower as compared to Fakoya et al. (2018). Neutral detergent fibre and ADF components in the fermented samples also showed a significant increase as compared to their unfermented samples. Fermented empty pod was observed to have more NDF and ADF even though fermented seed+pod was significantly increased. The increment recorded could be attributed to the unknown age of the plant harvested for the experiment. This could also be as a result of the soil nutrients composition of the study area. The findings agree with Rigueira et al. (2013) who also recorded high levels of ADF and NDF while ensilaging mombasa grass treated with nitrogen.

In vitro gas production trend is shown in figure 1.

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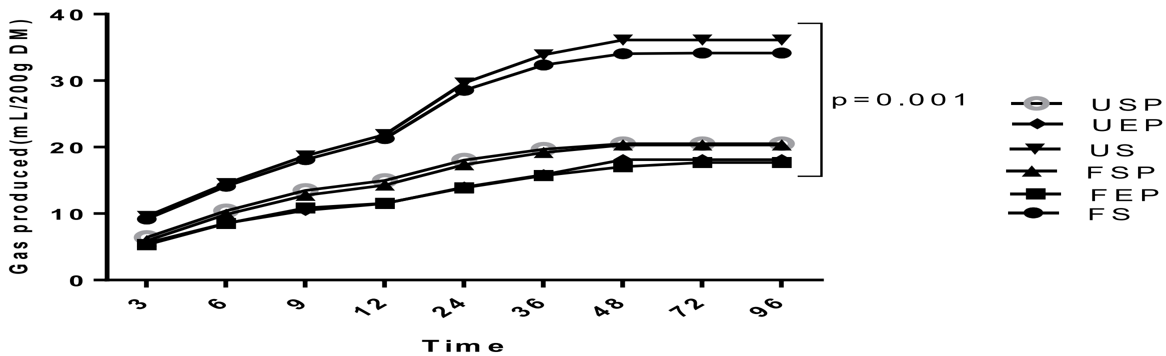
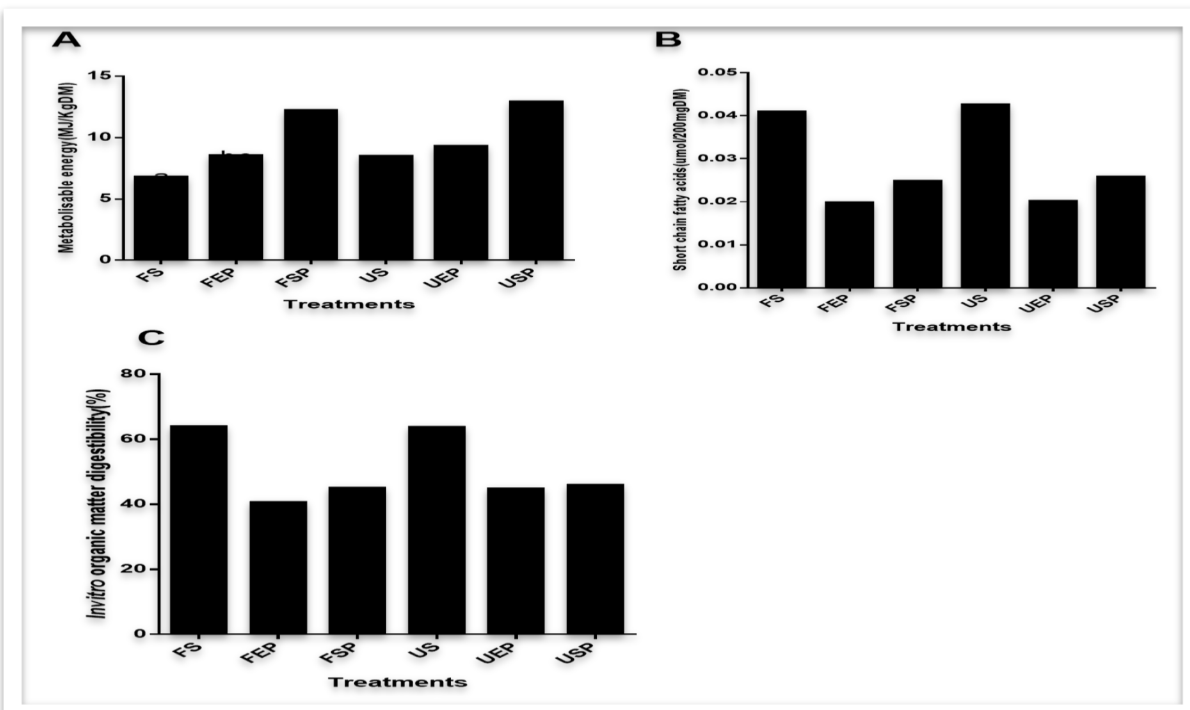


Figure 1. In vitro gas production (ml/200g DM) of fermented and unfermented Albizia lebbeck seeds, empty pod and seed+pod. USP-Unfermented seed+pod, UEP-Unfermented empty pod, US-Unfermented seed, FSP-Fermented seed+pod, FEP-Fermented empty pod, FS-Fermented seed

In vitro gas produced after fermentation is an indicator of the amount of available carbohydrate for rumen micro-organism. The extent of gas production depends on the amount of fermentable carbohydrate (Blümmel and Orskov, 1993). The pattern of in vitro gas production in this study is similar to that of Odeyinka et al. (2004) and Babayemi et al. (2009) who studied in vitro gas production of seeds of some legumes. The final total volume of in vitro gas produced in this study from fermented and unfermented seed (34.2 ml and 36.1ml) are comparable to Clitoria ternate, Caloppogium mucunoids, Pueraria phaseoloids, Stylosanthes guianensis and Leucaena leucocephala (30.3, 37.7, 36.8 and 29.8 and 40.7 ml) respectively of leguminous seeds recorded by Odeyinka et al. (2004). Additionally, in vitro gas produced at 24 h (29.7 ml) and ME (8.4 MJ/kg DM) of unfermented samples in



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The high IVOMD recorded for seeds in both fermented and unfermented can be due to high CP and low NDF and ADF of the seed. It has been reported by Omer et al. (2018) that there is a high negative significant correlation between IVOMD, ADF and NDF while there is a positive correlation between CP and IVOMD. Albizia seman, Albizia lebbeck and Albizia rhizonse seed were reported to have IVOMD of 54.7, 50.7 and 58.3% respectively which are low as compared to the current study (63.7%) for unfermented seed. Chemical composition differences in feeding materials are a major contributing factor in IVOMD of feeds.

Conclusion

In conclusion, fermentation caused an increase in CP and lowered NDF and ADF in the seeds of *Albizia lebbeck*. Both unfermented and fermented seeds had higher SCFA and IVOMD. However, the seed+pod fractions had higher metabolizable energy.

Conflict of Interest

No conflict of interest.

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