IN VITRO GAS PRODUCTION CHARACTERISTICS OF TREATED SAWDUST DIETS FOR SMALL RUMINANTS

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ABSTRACT
Given the increase in demand for animal feed, this study evaluated the potentials of sawdust as animal feed through in vitro assays by determining gas production at different hours during incubation and evaluating the organic matter digestibility (OMD), and short-chain fatty acids (SCFA). Sawdust from the Gmelina arborea tree was sorted from the nearby wood industry and treated differently into four treatments, T1 (wood-ash treatment), T2 (hot water treatment), T3 (caustic soda treatment), and T4 (molasses treatment). Feed samples were mixed with rumen fluid obtained from fistulated animals and a buffer solution (pH 6.8) at a ratio of 1:4 (feed to fluid); gas production was then measured at various time points for 24 hours to assess fermentability, and dry matter digestibility was determined post-incubation. The organic matter digestibility (OMD) and metabolizable energy (ME) were estimated using standard equations. The study found that wood ash and hot water treatments significantly improved gas production, having 13.33 (ml/200mg DM) and 12.33 (ml/200mg DM) respectively at 24 hours, and short-chain fatty acid (SCFA) having 0.25 (µmol/g DM) and 0.22 (µmol/g DM) with organic matter digestibility (OMD) having no significant differences across all treatments (P>0.05), indicating enhanced fermentation and nutrient availability. The wood ash treatment exhibited the highest digestibility and gas production, highlighting its effectiveness in breaking down lignocellulosic bonds. These findings suggest that treated sawdust, particularly with wood ash and hot water, can serve as a viable feed supplement for ruminants, contributing to sustainable animal nutrition.

INTRODUCTION
Sawdust is a very plentiful and affordable lignocellulosic substance found in nature. It is a waste from industry and agriculture that occurs in enormous amounts and poses disposal challenges. However, recent research has explored its potential as a component in livestock feed, aiming to address feed shortages and reduce environmental waste. Sawdust primarily comprises lignocellulosic materials, which are indigestible for most livestock. Various treatments have been investigated to improve its nutritional value to enhance digestibility in livestock. Treated sawdust presents a viable option for livestock feed, offering economic and environmental advantages (El-Ladan, 2010). *In-vitro* studies are crucial in determining the digestibility, nutritional value, and safety of possible feed ingredients before they are used in live animals. These controlled laboratory trials mimic the digestive processes of livestock, allowing researchers to examine how efficiently nutrients in feed are broken down and absorbed. *In-vitro* gas generation techniques monitor fermentation activity, providing information about the fibre degradability of feedstuffs like treated agricultural leftovers. *In-vitro* approaches help to create cost-effective, sustainable, and nutritionally balanced meals for ruminants by finding feed components that promote optimal energy and nutrient release. The current study, therefore, aimed to determine the in vitro gas production characteristics of treated sawdust diets fed to small ruminants.

MATERIALS AND METHODS
Sawdust from the *Gmelina arborea* tree was gathered from wood industries within Ogbomoso, divided, and treated in four ways (wood ash, hot water, caustic soda, molasses). Wood ash was collected from the environment (bakery) and sieved to remove stones, dirt, and other dangerous chemicals for the wood ash treatment. 0.25kg of wood ash is combined with water and put into 1kg of sawdust, which is properly mixed before being sealed in an airtight container for 21 days. 1 litre of hot water (100°C) is combined with 1kg of sawdust. In the caustic soda treatment, 0.25kg of caustic soda is mixed with 1kg of sawdust, which is then airdried for 5 days. Feed samples were dried at 60°C for 48 hours and ground to a uniform size of 1 mm. For incubation, samples were mixed with rumen fluid obtained from fistulated animals and a buffer solution (pH 6.8) at a ratio of 1:4 (feed to fluid) and incubated at 39°C to simulate rumen conditions (Steingass 1988). to assess fermentability, Gas production was measured at 6, 9, 12, 15, 18, 21 and 24 hours. After incubation, the residual feed material was filtered, dried at 60°C for 24 hours, and weighed to determine dry matter digestibility.
Organic matter digestibility (OMD), and metabolizable energy (ME)contents of the feed were estimated using the following equations:
OMD (%) = 14.88 + (0.8893 × GP) + (0.448 × CP) + (0.651 × ash)
ME (MJ/kg DM) = 2.20 + (0.136 × GP) + (0.057 × CP) + (0.002859 × EE)
GP = 24-hour net gas production (ml/200 mg DM); CP = Crude protein (%); EE = Ether extract (%)

Fermentation characteristics were also analyzed for short-chain fatty acid (SCFA) production, which provided insights into the fermentation dynamics of the substrate. The gas production kinetics were characterized using the formula $y = a + b\,(1\text{-}exp^{-ct})$,
Where, y = volume of gas produced at time t, a = volume of gas produced from soluble fraction b = volume of gas produced from insoluble but degradable fraction, (a+b) = total volume of gas produced, c = rate of gas production t = incubation time, offering valuable information on the digestibility and fermentation characteristics of the feed samples (Menke and Steingass 1988)

RESULTS AND DISCUSSION

Wood ash-treated sawdust (T1) had the greatest SCFA levels (0.25µmol/g DM) and gas volume (13.33 ml/200mg DM) compared to other diets/samples. Hot water-treated sawdust (T2) also exhibited high SCFA levels and gas volume compared to wood ash treatment (0.22µmol/g DM and 12.33 ml/200mg DM, respectively). Sawdust treated with caustic soda (T3) has typical SCFA levels and gas volume, with molasses-treated diet (T4) having the lowest SCFA levels of 0.16µmol/g DM and Gas volume of 9.67 ml/ 200mg DM indicating delayed fermentability and decreased microbial activity. This contrasts with some studies that show molasses can improve fermentation efficiency, implying that in this case, the molasses treatment may have been less successful due to substrate properties or the microbial environment (Hossain *et al*., 2012). There's no significant change in ME levels or Organic Matter Digestibility (P>0.05) across all treatments. The high short-chain fatty acid (SCFA) synthesis in T1 and T2 indicates active microbial fermentation, which is consistent with the report of Murphy *et al*. (1982), who discovered that substrates with higher acetate production often suggest more efficient fibre breakdown.
The Gas Production characteristics following $y = a + b\,(1\text{-}exp^{-ct})$, where a, which is the volume of gas produced from soluble fraction, and b, the volume of gas produced from insoluble but degradable fraction is higher in wood ash treated sawdust (a=9.86 and b=46.89) compared to all other treatments,
Wood ash-treated and hot water-treated sawdust diets generated substantial gas during incubation at 6, 9, 12, 15, 18, 21, and 24 hours. Wood ash-treated sawdust produced 8.33ml/200mg DM of gas, while hot water-treated sawdust produced 10ml/200mg DM after 15 hours. At 24 hours, wood ash-treated sawdust had 13.33 ml/200mg DM of gas, whereas the hot water-treated diet had 12.33 ml/200mg DM. This suggests better microbial fermentation, supporting Blümmel and Ørskov's (1999) argument that increased gas generation improves feed digestibility.

CONCLUSION

The *in-vitro* evaluation of sawdust as an animal feed ingredient discovered that wood ash treatment (T1) and hot water treatment (T2) were the most effective in improving fermentation characteristics. These treatments had the highest gas production, short-chain fatty acid (SCFA) concentrations, and organic matter digestibility (OMD) compared to the other treatments.

Table 1 In-vitro Fermentation Parameters

Parameters	T1(wood ash treatment)	T2(hot water treatment)	T3 (caustic soda treatment)	T4 (treated with molasses)	SEM	P-value
SCFA µmol/g DM	0.25[a]	0.22[a]	0.19[ab]	0.16[b]	0.01	0.03
ME µmol/g DM	4.18	4.10	3.90	3.86	0.06	0.12
OMD	29.61	28.79	28.90	27.66	0.34	0.25
GV ml/200mg DM	13.33[a]	12.33[a]	11.00[ab]	9.67[b]	0.51	0.03

Means with different superscripts across the columns are significantly different (P<0.05); SCFA means Short-Chain Fatty Acids, ME= Metabolizable Energy, GV means Gas Volume, OMD = Organic Matter Digestibility SEM= Standard error of means

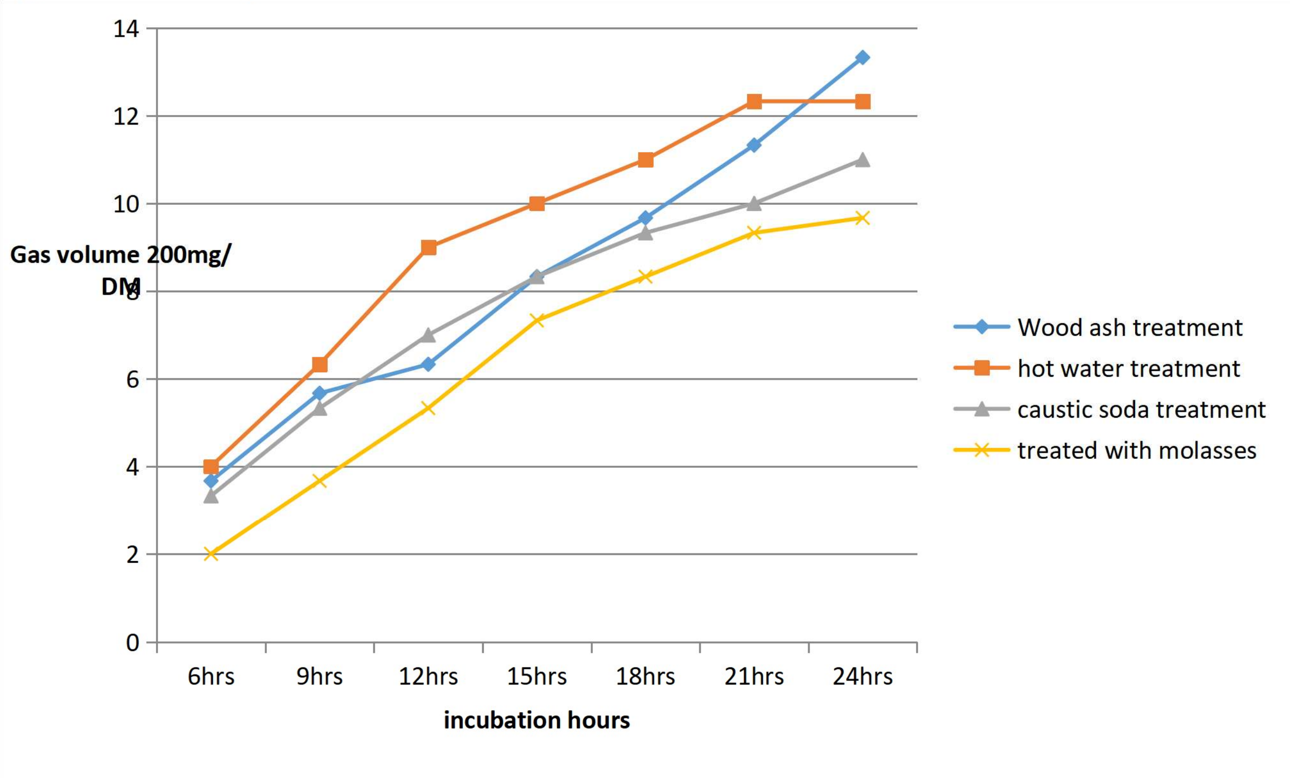
Table 2 Gas Production Characteristics

Parameters	T1(wood ash treatment)	T2(hot water treatment)	T3(caustic soda treatment)	T4(treated with molasses)	SEM	P-value
A	9.86[a]	3.33[b]	5.45[b]	5.44[b]	0.86	0.018
B	46.89[a]	11.33[b]	9.02[b]	18.87[b]	5.77	0.04
C	0.03[b]	0.10[a]	0.67[ab]	0.03[b]	0.01	0.02
T	5.95[b]	5.36[b]	9.17[ab]	12.10[a]	1.04	0.04
a+b	56.75[a]	14.67[b]	14.47[b]	24.31[b]	6.57	0.04

Y	9.37^{a}	5.85^{b}	6.49^{ab}	6.43^{ab}	0.58	0.016

y = a + b (1-exp^{-ct}). Where y= volume of gas produced at time t, a = volume of gas produced from soluble fraction b = volume of gas produced from insoluble but degradable fraction, (a+b) = total volume of gas produced, c = rate of gas production t = incubation time,

Figure 1 In-vitro Gas production at Time intervals



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