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Chemical characterization, *in vitro* dry matter and ruminal crude protein degradability and microbial protein synthesis of some cowpea (*Vigna unguiculata* L. Walp) haulm varieties

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ABSTRACT

A study was carried out to evaluate the chemical composition, *in vitro* apparently and truly degraded dry matter (DM), utilizable crude protein at the duodenum (uCP) (total CP at the duodenum minus endogenous CP), methane production, and short chain fatty acid production of haulms of six cowpea varieties. The study was arranged in a 2 × 2 × 2 factorial design, with three replicates. Three improved (ITA2, ITA6 and ITA8) and three commercial (Oloyin, Peu and Sokoto) cowpea varieties harvested during wet and dry seasons were used for the study. After an initial gas test to evaluate 96 h gas production profiles of haulms with and without polyethylene glycol (PEG), the time to half maximal gas production was calculated and a second incubation conducted with fermentation stopped at substrate specific half time ($t_{1/2}$) and 24 h for each substrate. True DM degradability was measured from incubated residues and combined with gas volume to estimate the partitioning factor. Crude protein flow to the duodenum was estimated by combining gas volume with the measured ammonia nitrogen in the incubated fluid. Addition of PEG did not have any effect (P>0.05) on all the variables determined. Interaction between group (improved *vs.* commercial) and season was observed for CP (P=0.002), lignin (P=0.003) and hemicellulose (P=0.030) contents of the haulms. A group × season interaction was also observed for some of the variables at both substrate specific $t_{1/2}$ and 24 h. Commercial cowpea haulms had greater (P=0.002) microbial mass and produced less (P<0.05) methane than the improved cowpea haulms. The improved cowpea haulms were less (P<0.001) degraded in the rumen and as a result ensured greater (P<0.001) amount of uCP. The results validated that cowpea haulm is an important agro-based by-product that is adequate in protein and energy to sustain ruminant animal production in Nigeria and other Sub-Saharan African countries during the extended dry season.

Abbreviations: ADFom, acid detergent fibre expressed exclusive residual ash; Lignin(sa), lignin solubilized with sulphuric acid; CP, crude protein; DM, dry matter; EE, ether extract; ivADDM, *in vitro* apparently degraded dry matter; ivTDDM, *in vitro* truly degraded dry matter; MN, microbial nitrogen; NDFN, neutral detergent fibre bound nitrogen; NDFom, neutral detergent fibre expressed exclusive residual ash; NFC, non-fibre carbohydrates; PEG, polyethylene glycol; PF, partitioning factor; RDN, rumen degraded nitrogen; SCFA, short-chain fatty acids; uCP, utilizable crude protein at the duodenum; UDN, undegraded dietary nitrogen; UNAAB, University of Agriculture, Abeokuta.

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1. Introduction

Insufficient quantity and quality of traditional forage resources in many tropical regions, particularly those with acidic, low-fertility soils and prolonged annual dry season arising from fluctuations in environmental factors (which directly and indirectly limit the quantity of herbage available to animals either from natural grazing and/or crop residues) are major constraints for farmers to improve livestock productivity.

Agriculture in the Sub-Saharan African countries is intensifying in response to increasing populations of humans and livestock. Estimates have shown that ignoring crop residues as a feed resource will result in serious feed shortages. In these scenarios, crop farmers may own their own livestock for ready access to manure, while simultaneously selling some marginal land to livestock keepers who settle and begin crop farming using the manure from their animals (and possibly traction) as an input (Delgado et al., 1999). As a result, increased productivity demands are placed on integrated crop-livestock systems with more emphasis on legumes such as cowpea (*Vigna unguiculata* L. Walp). Cowpea has the potential to function as a key integrating factor in intensifying systems through supplying protein in human diets, and fodder for livestock, as well as bringing N into the farming system through fixation (FAO, 2000). Going beyond its importance for food and feed, cowpea can be regarded as a fulcrum of sustainable farming in regions characterized by systems for farming that make limited use of purchased inputs (Anele et al., 2010).

Cowpea is grown extensively in 16 African countries, with the continent producing two-thirds of the world total. Two countries–Nigeria and Niger–produce 850,000 and 271,000 tonnes annually or, together, 49% of the world crop (FAO, 2000). The bulk of this production comes from smallholder farmers in semiarid zones of the region.

The use of an *in vitro* gas technique in evaluating feedstuffs (through the measurement of variables like methane, microbial mass and short chain fatty acids (SCFA)) is a very effective and robust way of estimating energy loss from diets, microbial and feed nitrogen supply to ruminants.

The objective of this study was to estimate intervarietal differences of the nutritive value of some cowpea haulms. This was achieved by determination of *in vitro* apparent and true degraded dry matter (DM), utilizable crude protein at the duodenum (uCP; total CP at the duodenum minus endogenous CP), methane production, protozoa population, microbial mass and efficiency of three improved and three commercial varieties of cowpea haulms.

2. Materials and methods

2.1. Experimental site

The field experiment was conducted at the Teaching and Research Farm, University of Agriculture, Abeokuta (UNAAB), Ogun State, Nigeria. The site lies within the savanna agro-ecological zone of south-western Nigeria (latitude: 7°N, longitude 3.5°E, average annual rainfall: 1037 mm). Abeokuta has a bimodal rainfall pattern that typically peaks in July and September with a break of two to three weeks in August. Temperatures are fairly uniform with daytime values of 28–30 °C during the rainy season and 30–34 °C during the dry season with the lowest night temperature of around 24 °C during the harmattan period between December and February. Relative humidity is high during the rainy season with values between 63 and 96% as compared to dry season values of 55–84%. The temperature of the soil ranges from 24.5 to 31.0 °C (Source: Agrometeorology Department, UNAAB).

2.2. Forage establishment and management

The experimental area, measuring 2600 m^2, was ploughed twice and harrowed. The area was divided into eight blocks and each block was sub-divided into 10 plots each measuring 5 m × 4 m. Three improved (*i.e.*, IITA 97k-1069-6, IITA 98k-311-8-2, IITA 98k-476-8; hereafter designated ITA-6, ITA-2 and ITA-8) and three commercial (*i.e.*, “Oloyin”, “Peu”, “Sokoto”) dual-purpose cowpea varieties constituted the treatments. The dual-purpose cowpea varieties were semi-erect types and had 70–86 days to pod maturity. The improved varieties were modified for greater biomass and grain yields. Treatments were randomly allocated to plots within block. The inner six blocks (36 plots) were selected for sampling to avoid border effects. Samples collected from two blocks were bulked together to constitute one field replicate. As a result, three field replicates were obtained from the 6 blocks. The cowpea was planted in rows 0.4 m wide with a 0.3 m plant spacing in May, 2007. The experimental area was maintained weed-free throughout the first month to reduce competition. The cowpea formed a tight canopy within a short period after planting which smothered weeds. Grains were harvested approximately three months after planting to represent wet season. The second planting was carried out in August and harvested in November 2007 to represent dry season. The haulms, comprising of the vine, leaves and roots were later uprooted, manually rolled and chopped into particles of 2–4 cm lengths and milled with a hammer mill (Model DFZH-Bühler AG, Uzwil, Switzerland) using a 3 mm sieve.

2.3. Chemical analyses

Feed samples were successively ground in mills with 3 and 1 mm sieves. Prior to milling, samples were oven-dried at 60 °C for 96 h while DM was determined by oven-drying at 100 °C for 24 h. Total nitrogen (N) was estimated by combustion