REPRODUCTIVE PERFORMANCE OF FEMALE GOATS FED LIFE-ENZYME (*ZYMOMONAS MOBILIS* TREATED SAWDUST) AS COMPONENT OF FORMULATED DIETS

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ABSTRACT

Direct-fed-microbes (DFM) (life-enzyme) was prepared in a traditional setting using *Zymomonas mobilis* (bacteria from palm sap) to ferment sawdust. The result revealed an improvement in the nutrient content of the sawdust and its feed values (protein, fibre etc.), and the feed usage efficiency. The reproductive performances of Red Sokoto (Maradi) goats fed direct-fed-microbes or life-enzyme (*Zymomonas mobilis* treated sawdust) were studied, using 18 goats (12 females and 6 males), aged 4 -5 months. They were free of helminth and trypanosome infections. The goats were divided into 3 groups (A, B and C) of 4 females and 2 males and were confined separately on concrete floored with wood shaven pens. Group A was maintained on 15% untreated sawdust diet with 12.04% crude protein (CP) day^{-1}, and group B and C were placed on 15% and 20% direct-fed-microbes (*Zymomonas mobilis* treated sawdust) with dietary protein of 12.79% and 13.04% day^{-1} throughout the growing period until the end of the study. The result showed that animals on the direct-fed-microbes gained significantly more weight (B= 99.0g, and C= 53.0g) ($P<0.05$) than those of the control (A= -20.0g) with untreated sawdust. The direct-fed-microbes does had significantly ($P<0.05$) higher body weight (B= 18.81kg and C= 12.67kg) than the control (5.20kg) with untreated sawdust. The final body condition score (B= 3.99 and C= 3.88) of the goats given the direct-fed-microbes were higher, and revealed significant ($P<0.05$) over those goats fed untreated sawdust diet (1.0). Equally, the does fed the direct-fed-microbes delivered and weaned kids of significant higher birth weight (B= 1.97kg and C= 1.41kg), and weaning weights (B= 3.99kg, C= 2.89kg) than those given untreated sawdust ($P<0.05$). The protein efficiency ratio followed the same trend (B= 2.36, and C= 0.77) showing the direct-fed-microbes (sawdust treated *Zymomonas mobilis*) goats with better performance ($P<0.05$) over the untreated sawdust (A= -0.94). It was concluded that sawdust treated *Z. mobilis* in rearing productivities when fed to Maradi goats enhanced foetal development, birth weight, mammary gland development and promoted lactation, all of which enhanced survivability of the neonates.

Keyword: Performance, life-enzyme, female goats and treated saw dust

INTRODUCTION

Red Sokoto goats, also known as Maradi goats are among the indigenous breeds of goat found mostly in the northern part of Nigeria and are characterized by medium size, early sexual maturity and is known as a good milker for tropical goats (Anigbogu 2007). These characteristics together with their able to bear extreme conditions enhance their performance with good productivities if properly reared. In the Southeast of Nigeria, goats are generally reared intensively with zero grazing as major source of feed, without feed supplements except in some occasions fed kitchen refuses. Nutrition is among the major constraints of goat production in zones, as the quality and quality of forages vary with season. Where extensive management is to be practiced, the pastures are usually of poor quality due to lack of proper range management and because of limited land resources due to competition with the industrial

and rural developments. There trait component of the Maradi goat is believed to be below zero influence for most of the production traits (birth and weaning weights, fecundity, size and weight at maturity, efficiency of gain, rate of gain, number of young weaned, and fertility) (Campell and Lasley 2000). Presently, there is no successful breeding programme based on selection for these traits in Nigeria, rather the situation is worsened by the practice of negative selection where by best performing animals are sold for cash while poor performers are retained for breeding (Nnadi *et al*. 2007). Also researchers have noted that improved dietary nutrition generally has significantly increased productivities in farm animals. Adamosun (1992) revealed poor nutrition as major limiting factor to small ruminant husbandry in African; which acknowledge the important of good nutrition in goat rearing, noting that higher producer could not prove well in the tropic, because of the low feed intake and availability.

The use of industrial waste and other by-products have been suggested by Anigbogu (2000) to help improve the dietary nutrient of farm animals. Sawdust is a wood based product that has high amount of crude fiber and has been used as roughage to feed ruminants. This by-product of the wood industries might serve as suitable feed for the Maradi goats for intensive animal production. In Nigeria, the disposal of this waste is among the major handicaps in the wood industries as noted by Anigbogu and Okocha (2003). Therefore, the recent microbial technology using efficient microorganisms and innovation solid-state fermentation (SSF) technology may be particularly appropriate for the biological conversion of sawdust (Lignocellulosic waste) to valuable feed, by making enzymic hydrolysis more accessible in the rumen (Anigobu and Ibe 2005, Anigbogu and Anigbogu 1999). Realizing the benefits that would accrue to the Maradi goats and the Nigerian farmers, the present study were carried out to examine the reproductive performance of Maradi does on direct-feed-microbes (*Zymomonas mobilis* treated sawdust).

MATERIALS AND METHODS

Animal and housing

Eighteen Red Sokoto (Maradi) goats (12 Females and 6 males, aged about 4.5 months were used for the study. The goats were obtained from Funtua main market, Funtua Local Government Area, Katsina State of Nigeria. On arrival, they were weighed to obtain their initial weights, and their faecal samples were collected for routine analysis of gastrointestinal (GI) parasite eggs. The goats were quarantined for a period of 3 weeks and were treated against ecto and endo parasites using Keporomec injection. During the acclimatization of 3 weeks, the experimental diets (Table 1) with chemical composition as in Table 2 were fed to the animals before the actual experiment growth study of 90 days. The animals were goat-housed and were partitioned in a floor space of 1.5 sq.m with feeding space of 10 linear in. animal^{-1} (PCARRD 1982, LDC- BAIP 2008). Faecal cultures were made for the recovery and identification of any infective larva (L_3) if present. Blood samples were also collected through the external jugular vein and screened for the presence of haemoparasites. At the end, the animals were transferred to the individual experimental pens for the study. All the animals were given the Pestes des Petits Ruminants (PPR) vaccine produced by National Veterinary Research Institute by (NVRI) Vom, Nigeria, as per manufacturer's recommendation.

Diets, experimental design, estrus, mating, doe and kid performance

The life-enzyme or direct-feed-microbe (DFM) was prepared in traditional setting using 40 kg sawdust obtained from the wood milling industry at Umuahia, Abia State, Nigeria. The sawdust was placed on the fermentation vat (Vol = 100 litres). Eighty litres of water was added on the vat with 4 kg previously fermented dough containing *Zymomonas mobilis* to act as starter innoculum. The samples were homogenously mixed at 48 hrs interval until 10 days period of fermentation, at the temperature of

about 23.95 ^{0}C. After which, the fermented product was sun-dried and stored as direct-fed-microbes (*Zymomonas mobilis* treated sawdust). Three diets were formulated comprising of diet A (0 % DFM but with untreated sawdust), diet B (15 % DFM) and diet (20 % DFM). Maize offal, palm kernel cake, bone meal, oyster shell, salt and vitamin premix were used to balance the diets as in Table 1, showing the composition and the chemical analysis of diets; and sawdust used (Table 2) (AOAC 2005).

Table 1: Experimental diets and their chemical composition

Ingredients	**A**	**B**	**C**
Maize offal	49.00	49.00	49.00
Untreated sawdust	15.0	-	-
Treated sawdust (Direct fed-microbes)	-	15.00	15.00
Palm kernel cake	33.00	33.00	33.00
Bone meal	1.25	1.25	1.25
Oyster shell	1.25	1.25	1.25
Salt	0.25	0.25	0.25
Vitamin premix	0.25	0.25	0.25
Total (Kg)	100.00	100.00	100.00
Chemical Composition (%):			
Crude protein	12.04	12.79	13.04
Ether extract	6,20	6.22	6.24
Crude fiber	18.35	17.86	21.35
Ash	5.35	5.52	5.59
Calcium	0.90	1.18	1.28
Phosphorus	0.65	0.68	0.69
Salt	0.63	0.64	0.72
Lysine	0.41	0.71	0.81
Methionine	0.30	0.44	0.49
MER (MJ/kg)*	11.24	11.29	11.74

*Metabolizable energy for ruminant (MJ/kg).

Table 2: Chemical composition of untreated and *Z. mobilis*treated sawdust

Variable	**Untreated**	***Z. mobilis*treated**	**Significant[1]**
Crude protein	0.86	5.56	**
Ether extract	0.36	0.46	**
Crude fiber	62.10	58.85	Ns
Nitrogen free extract	36.26	34.81	Ns
Ash	0.42	1.52	**
Calcium	0.16	2.00	*
Phosphorus	0.04	0.22	**
Salt	0.05	0.50	**
Lysine	0.02	2.00	**
Methionine	0.04	0.95	**
Methionine + cysine	0.09	1.60	**
Energy value (100/g)	255.94	267.84	Ns
MER (MJ/kg)[2]	8,45	8.82	Ns

[1]Significant: ** = P<0.01; * = P<0.05; ns = P>0.05; [2]MER (MJ/kg) = Metabolizable energy for ruminant (MJ/kg).

The metabolizable energy for ruminant (MER) and protein supplied (PS) were determined using the AFRC system (AFRC 1993). During the period of study, the Treatment A, B and C with 0 %, 15 % and 20 % of DFM group goats received 12.04 %, 12.79 % and 13.04 % crude protein diets (Table 1), daily. In addition, water was provided at free choice.

The experimental design involved in the assignment of the goats into groups of 6 animals each. At the 90^{th} day growth study, the does were served either on coming on estrus naturally or after inducing heat in them by male-effect as described by Whitten (1956) and as applied by Nnadi *et al.* (2007). Briefly, these involved the introduction of the buck into the flock of does to allow physical contacts with them; withdrawing the buck after 6 hrs and reintroducing it 7 days later. Those on estrus were identified by their exhibition of classical estrus signs of incessant bleating, restlessness, chasing and mounting of pen mates, vulval swelling and reddening. Does standing to be mounted and mated upon the reintroduction of the buck confirmed estrus. Though, not all the females came on estrus the same day; this method helped in bringing about estrus synchronization and relative uniformity in the period of kidding. The feeding regime of 0 % DFM, 15 % DFM and 20 % DFM was maintained for each group throughout the study without any alterartion. The bucks were similarly provided adequate diets and water.

The animals were weighed throughout the experimental period, first at the beginning of the study and thereafter weekly; and the height was also measured. At birth, the kids were weighed within 12 hrs and thereafter at 6 weeks of age. The doe's milk yield was determined according to the method of Robinson *et al*. (1969). The body condition score (BCS) of the does were determined by lumbar palpation on a scale of 1 - 5 (Houdijk *et al.* 2000). While the feed conversion and protein efficiency ratios were determined as in Anigbogu (2000/2001). Water and diets were provided *ad libitum*, first at 9.00 am and later at 3.00 pm each day. Diet intake was measured by difference each time before the next feeding. All data gathered were recorded. The diets offered were on weekly intervals adjusted depending on the body weight, without altering the diets.

Statistical Analysis

The design of the experiment was complete randomized design, where the date collected were analyzed using analysis of variance procedure as described by Gomez and Gomez (2005). The difference between treatment means where found significant ($P<0.05$, $P<0.01$), were compared using Duncan's New Multiple Range Test as decided by Gomez and Gomez (2005).

RESULTS AND DISCUSSION

All the in-kid does maintained their pregnancy throughout the in-kid period without any problem. Kidding was done without complication; except the does which were never in-kid [the treatment A fed 0 % direct-fed-microbes (*Z. mobilis* treated sawdust) which contributed about 0.13 % crude protein in the diet (Table 3) where never in-kid]. That is to say, all the does fed the *Zymomonas mobile* treated sawdust diets contributed 0.83 % (diet B) and 1.13 % (Diet C) as in the Table 3 kidded without any problem. The does delivered twins weighing about 3.70 kg (Diet B) and 3.89 g (Diet C); except for one doe on diet C group that kidded a single kid weighing 4.10 g. The Table 4 showed that, the body weight, daily weight gain and variation-in overall weight ($P<0.05$) was in favor of the direct-fed-microbes groups. There was a great improvement ($P<0.05$) in diet intakes among the direct-fed-microbes (*Z. mobilis* treated sawdust) over the untreated ones. The protein efficiency ratio value were generally better ($P<0.05$) among the direct-fed-microbe groups, but showed a negative value (-0.94) among the goats fed untreated sawdust. The direct-fed-microbes fed groups (diets B and C) does, generally had significant higher body condition score ($P<0.05$) than the untreated sawdust group.

Table 3: Nutrient contribution in percentage by untreated sawdust and *Z. mobilis* treated sawdust (TS) in the diets

	A (15% UTS)	B (15% TS)	C (20% TS)	Significant[1]
Crude protein	0.13	0.83	1.13	**
Ether extract	0.05	0.07	0.09	**
Crude fiber	9.32	8.83	11.77	*
Ash	0.06	0.23	0.30	**
Calcium	0.02	0.30	0.40	**
Phosphorus	0.006	0.03	0.04	**
Salt	0.01	0.08	0.10	**
Lysine	0.003	0.30	0.40	**
Methionine	0.006	0.14	0.19	**
MER (MJ/kg)[2]	1.27	1.32	1.77	**

[1]Significant: ** = P<0.01; * = P<0.05; ns = P>0.05; [2]MER (MJ/kg)= Metabolizable energy for ruminant (MJ/kg).

Table 4: Reproductive performance of does fed with *Z. mobilis*treated sawdust

Parameters	A	B	C	Significant
Initial weight (kg)	7.00	9.90	7.90	*
Final weight (kg)	5.20	18.81	12.67	**
Daily weight gain (g)	-20.00	99.00	53.00	**
Feed efficiency ratio	5.14	2.30	4.48	*
Daily feed intake (g)	400.00	525.00	631.00	**
Protein efficiency ratio	-0.94	2.36	0.77	**
Variation-over all in weight (kg)	-180	8.97	4.77	**
Initial body condition score	3.70	3.69	3.67	ns
Final body condition score	1.00	3.99	3.88	*
Birth weight of kids (kg)	0.00	1.97	1.41	*
Weaning weight of kids (kg)	0.00	3.99	2.89	*
Height of does (cm)	15.62	54.01	36.60	**
Height of kids at birth (cm)	0.0	5.69	4.03	**
Height of kids at weaning (cm)	0.0	11.03	8.31	**

[1]Significant: ** = P<0.01; * = P<0.05; ns = P>0.05.

Also, the *Z. mobilis* treated sawdust (direct-fed-microbe) diet groups kidded and weaned kids of significantly higher body weights, when compared to the untreated sawdust group (P<0.05). In addition, the higher weaning weights found among the direct-fed-microbe (*Z. mobilis* treated sawdust) kids may be an indication of better milk yield and composition in the does. Bath *et al.* (2000) concluded that, the most serious nutritional causes of reproductive failures are on insufficient supply of quality calories (energy) and protein; and that severe restriction of intake of these essential components of the ration results in infertile ovaries and delayed puberty in heifers. That for heifers on pasture feeding which do not exhibit estrous, the ration should be supplemented with grain for several weeks. Although, literature is controversial, for example, in one study reported (Bath *et al* 2000) of heifers reared on low medium and high nutritional levels, the percentages of heifers conceiving to a first service were 79, 68, and 58, respectively. Other previous reports indicate that, there is no effect of higher nutritional levels on fertility (Reid *et al.* 1964). That is to say, under-nutrition adversely affects some areas of productivity in ruminants (Robinson 1983, Smith and Akinbamijo 2000).

Our results clearly show that, conceiving, ovulating and synchronizing of estrus were affected by the does on the direct-fed-microbe. Thus the does on direct-fed-microbe groups (Diets B and C) has successful gestation. However, untreated sawdust dietary fed goats appear to have imposed some constraints on some aspects of the reproductive effects in the does. The poor conception of the does on Diet A (with untreated sawdust); and the high birth weight as observed of the neonates in the direct-fed-microbe (*Z. mobilis* treated sawdust) groups with good survival threshold seem to be related to the nutrition of the does (Cole 2002, Nnadi 2007). Also, it has been established that during mid-gestation of the small ruminants, when the placenta is developing, under-nutrition can lead to reduced cotyledon and foetal weights (Sorensen 2001, McCrab *et al.* 1986), which leads to reduced birth weights and young ruminant viability in lambs (Cole and Cupps 2001, Genty and Rattray 1987, Vincent *et al.* 1985). The above references are in agreement with our results.

The *Zymomonas mobilis* treated sawdust (life-enzyme or direct-fed-microbe) fed products cause significant live weight increase among the does. This was more apparent during the growth period of the 90 days and at late gestation. The body condition of the supplemented groups was also significantly higher during this period. These were probably due to availability of adequate and quality protein for growth, reproduction and maintenance needs as noted among the sawdust treated does as in Tables 2 and 3. This was more apparent during growth and at late gestation period. The body condition of the supplemented groups was also significantly higher during this period (Table 4). These were probably due to the availability of adequate quality protein for growth, reproduction and a maintenance need, among the sawdust treated does (Etgen and Reaves 2002). In the untreated sawdust does it appears that, there was tissue protein withdrawal to supplement the growth and reproductive effects from the first week of our study, thus lower body conditions score. The reduction in the body condition, poor conception and no conception/birth among the untreated sawdust does, could be as a result of tissue losses of protein for attainment of breeding capability (puberty) and entire hormonal stimulus in the hypothalamus; which secretes releasing hormones (Gonadotropic Releasing Hormone {GNRH}, Follicle Stimulating Hormones Releasing Hormone {FSHRH}, and Luteinizing Hormone Releasing Hormone {LHRH}- in turn cause the releasing of follicle stimulating hormone {FSH} and Luteinizing hormone {LH} secreted by the adenohypophysis; which also stimulate the testes and ovaries to produce the germ cells for reproduction, and other hormones to prepare and maintain the reproductive system and activity for development a new life as revealed by Sorensen (2001) and Rhind (1992). The hypothalamus also releases other hypothamic hormones though not related to reproduction such as Thyrotropic Releasing Hormone (TRN), Corticotropic releasing Hormlone (CRH), Growth Hormone Releasing Hormone (GH-RH), and Melanocyte Stimulating Hormone Releasing Hormone (MRH); also the inhibitory hormones (Prolactin Inhibition Hormone {PIH} and Melanocyte Inhibiting Hormone {MIH}, though not related to reproduction; others are the Oxytocin and the Vasopressin. They are all protein nature and are produced do to the activities of hypothalamic nuclei-masses of cells with specific designations (Sorensen 2001, and Rhind 1992).

The observed significant higher birth and weaning weights noted among the treated sawdust kids indicated adequacy of dietary protein to fully support the reproduction effects of does including milk yield. As the diet of the untreated sawdust does in this study is similar to those used in traditional management setting of Nigerian goats in the humid ecological zone, this study shows among others things that such diets are deficient in their nutritional needs especially quality protein for adequate productivity. Experimenting on the nutritional limitation of sheep and goat production (Anigbogu 2000), attempts are to be made on the use of agro-industrial by-products as feed supplement (Kosaka 1990, Devedra 1990). The sawdust is cheap, available and acceptable to goats, and we suggest further definitive nutritional studies on it as a component of formulated caprine diet. The above observations

are based on the differences in dietary protein in the diets of the three groups alone. This is because the dietary energy level in the sawdust diet was high enough to have eliminated any effect due to energy deficit. In conclusion, dietary protein enrichment as adjunct to traditional goat nutrition enhances live body development. It also improves foetal development, survival, growth and lactation ability resulting in birth of viable kids and weaning of the kids of higher body weights.

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