ABSTRACT

48 six weeks old crossbred weaner rabbits were randomly allocated to four treatments to determine the effect of enzyme and probiotic supplementation of maize processing waste-based diets on performance and nutrient digestibility of weaner rabbits. Four experimental diets were formulated such that diet 1 (T1) contained 0% MPW while diet 2 (T2) contained 50% MPW without supplementation. Diets 3 (T3) and 4 (T4) contained 50% MPW supplemented with 200mg of enzyme (grindazym) and probiotic (yeast) per kilogram of feed respectively. Results showed significant (P < 0.05) differences in body weight gain (BWG), feed conversion ratio (FCR), protein efficiency ratio (PER), crude protein, dry matter, crude fibre and ether extract digestibility among the rabbits. Rabbits fed enzyme (T3) and probiotic (T4) supplemented diets had significantly (P < 0.05) superior BWG, FCR and PER compared to other treatment groups. Rabbits fed 50% MPW diet without supplementation (T2) recorded higher BWG and better FCR than those fed 0% MPW diet (T1). There was no significant (P > 0.05) difference among the groups in daily feed intake (DFI), daily protein intake (DPI) and ash digestibility. Economic analysis favoured the inclusion of MPW, enzyme and probiotic in weaned rabbits diets. However, cost saving in percentage was higher for the supplemented diets. Results of this study suggest that up to 50% maize in rabbit diet could be replace with MPW and that enzyme and probiotic supplementation of MPW-based diet enhanced the performance of the rabbits.

Key words: Enzyme, Nutrient digestibility, Performance, Probiotic, Supplementation, Weaner rabbits

INTRODUCTION

One of the cheapest producers of meat that can easily fit into the wider segment of the populace but which has been neglected in Nigeria is the rabbit (Odoh and Ezekwe, 2005). The domestic rabbit has the potential to become one of the world’s major livestock species. As the human population exerts increasing pressure on the Nigeria food resources, it is very likely that rabbit will assume an increasingly important role not only in rural poverty alleviation but also serve as a possible solution to the acute protein insufficiency problem crippling the country. However, like other monogastric animals, commercial rabbit production is constrained by phenomenal rise in the cost of conventional feedstuffs especially energy sources (maize) which constitutes about 60% of formulated diets. Consequently, current research efforts in Nigeria are aimed at identifying and exploiting potential energy feed sources that are inedible to man, to replace certain proportion of maize in livestock diet (Onu et al., 2001; Onu et al., 2006). Their utilization in diet formulation will reduce or remove the competition between man and livestock for such feedstuffs and reduce the cost of feed with the ultimate aim of producing the needed animal protein at the lowest possible cost for human nutrition.

Maize processing waste (MPW) which is a fibrous material has the potential of replacing substantial amount of maize in rabbit diets. Okah (2004) reported that MPW is relatively available in large quantities in both rural and urban communities in Nigeria. However, despite the promising potential
of this waste, its use in monogastric animal diets may be hampered by its high fibre content. Since according to Anyaehie and Madubuike (2005) and Onu (2006), non-starch polysaccharides (NSPs) are highly indigestible in the gastro-intestinal tract of monogastric animals and therefore are of little nutritional value. NSPs have also been reported to have deleterious effect on feed intake, nutrient digestibility and utilization, thus adversely affecting the growth of these animals (Bhat, 2000; Bedford, 2000; Onu et al., 2006).

A promising method to accomplish enhanced nutrient digestibility and utilization especially with fibrous ingredients is the use of supplemental enzymes (Choct, 2004; Abdo Zeinab, 2004; Onu, 2006; Onu et al., 2006). Acamovic (2001) reported that enzyme increases the digestibility of feed ingredients and reduce the incidence of wet droppings, which may result from the presence of NSPs in the diets. EL-Nagmy et al. (2004) and Ghazalah et al. (2005) reported that enzyme supplementation improve monogastric animal performance and allowed a reduction in the energy formulation of the diets.

Recently, there is also a trend to use supplementary probiotics as a feed additive to enhance growth and nutrient digestibility with considerable success (Fioramonti et al., 2003; Lan et al., 2003; Ahmad, 2004). However, there is little information on the effect of enzyme and probiotic supplementation on the performance of weaned rabbits. Hence, this study attempts to investigate the effect of enzyme and probiotic supplementation of MPW-based diets on the performance and nutrient digestibility of weaner rabbits.

MATERIAL AND METHODS
The research was carried out at the Teaching and Research Farm (Rabbitsry Unit of the Department of Animal Science, Ebonyi State University, Abakaliki with the approval of the Committee for Animal Experiments of the Institution.

Sources and processing of maize processing wastes
The maize processing waste was collected from pap producers at Abakaliki, and sun dried. The chemical composition of the maize processing waste was analyzed according to the methods of AOAC (1995) in order to determine the percentage crude protein, crude fibre, total ash, moisture contents, and ether extract. The nitrogen free extract was determined by difference. The metabolizable energy (M.E) of MPW was estimated using Pauzenga (1985) formula: ME = 35 x CP% + 81.8 x EE% + 35.5 x NFE

Experimental diets
The maize processing waste was used to formulate four experimental diets such that diet1 (T1) which served as the control contained 0.0% MPW (Maize-based) while diet 2 (T2) contained 50% MPW without supplementation. Diets 3 (T3) and 4 (T4) contained 50% MPW supplemented with 200mg of enzymes (Grindazym) and probiotics (yeast) per kilogram of feed respectively (Table 2). The ingredients were measured and mixed with a spade on a concrete floor; it was turned vigorously to ensure appropriate mixing of the ingredients and homogeneity. Samples of the experimental diets were analyzed for proximate composition according to the method of AOAC (1995).

Experimental animal and management
48 six-weeks old crossbred (Newzealand White and Californian) weaner rabbits of both sexes were used for the study. Twelve (12) rabbits were randomly allotted to each of the dietary treatments and each treatment replicated four times giving three rabbits per replicate. The experimental design was completely randomized arrangement. Each rabbit was housed in an individual pen. Before the commencement of the experiment, the hutches were thoroughly washed and disinfected with detol and allowed to dry. Each hutch was provided with feed and water troughs for daily provision of feed and fresh water ad libitum. Antibiotics and mange injection were administered before the commencement of the experiment as prophylactic treatment against bacteria and mange infections.

Digestibility study
Digestibility trial was conducted during the 53-56 days for all the rabbits. Polythene sheets were tied to the four legs of the hutches so that they were suspended. Total collection method was adopted. Each day fecal samples were pooled, ground, and then analyzed for dry matter, crude protein, ether extract and total ash (AOAC, 1995).
Economics of production
The market cost of the ingredients, enzyme and probiotics at the time of the study was used to calculate the total cost of feed per 100 kg of the diet, cost of feed per kg diets (₦), total cost of feed consumed (₦), cost of feed per kg weight (₦) and cost saving (%).

Data collection and Analysis
The rabbits were weighed at the beginning of the experiment to obtain their initial body weight and subsequently weekly. At the end of the experiment, the body weight gain was calculated by subtracting the initial body weight from the final body weight, while the daily weight was calculated by dividing the weight gain by the number of days the experiment lasted.

Feed intake was determined by weighing feed offered to each replicate. The left over per group was collected every morning, weighed and recorded. The daily feed intake of each replicate was determined by the difference between the amount served and the residual feed.

Feed conversion ratio was computed by dividing the daily feed intake by the daily weight gain while the protein efficiency ratio was evaluated by first calculating the protein intake. The values obtained were used to calculate the PER by dividing the weight gain by the protein intake.

Statistical analysis
Data generated from this study were subjected to analysis of variance and where significant differences were found, the means were compared using the Duncan’s New Multiple Range Test (DNMRT) as outline by Obi (2002).

RESULTS AND DISCUSSION
The chemical composition of MPW is presented in Table 1, while the ingredient and nutrient composition of the experimental diets is as presented in Table 2. Data on the performance, nutrients digestibility, and economics of production of weaner rabbits fed the experimental diets are shown in Tables 3, 4, and 5 respectively.

The results of the chemical composition indicated that MPW contains higher amount of crude protein (13.97%), crude fibre (7.20%) and ash (4.82%) than maize which contains 9.8% crude protein, 2.2% crude fibre and 1.3% ash. However, MPW was lower in ether extract (0.95%) than maize (4.4% EE).

Table 1 : Percent composition of the experimental diets

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td>42.0</td>
<td>21.0</td>
<td>21.0</td>
<td>21.0</td>
</tr>
<tr>
<td>MPW</td>
<td>0.0</td>
<td>21.0</td>
<td>21.0</td>
<td>21.0</td>
</tr>
<tr>
<td>SBM</td>
<td>16.0</td>
<td>16.0</td>
<td>16.0</td>
<td>16.0</td>
</tr>
<tr>
<td>PKC</td>
<td>22.0</td>
<td>22.0</td>
<td>22.0</td>
<td>22.0</td>
</tr>
<tr>
<td>Wheat offal</td>
<td>15.0</td>
<td>15.0</td>
<td>15.0</td>
<td>15.0</td>
</tr>
<tr>
<td>Bone meal</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Lime stone</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Salt</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>Premix *</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>+E</td>
<td>+P</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Chemical composition

<table>
<thead>
<tr>
<th></th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry Matter</td>
<td>90.13</td>
<td>90.15</td>
<td>90.15</td>
<td>90.14</td>
</tr>
<tr>
<td>Crude Protein</td>
<td>17.26</td>
<td>17.87</td>
<td>17.87</td>
<td>17.87</td>
</tr>
<tr>
<td>Crude Fibre</td>
<td>6.79</td>
<td>8.03</td>
<td>8.03</td>
<td>8.03</td>
</tr>
<tr>
<td>Ether Extract</td>
<td>7.37</td>
<td>6.53</td>
<td>6.53</td>
<td>6.53</td>
</tr>
<tr>
<td>Ash</td>
<td>3.64</td>
<td>3.36</td>
<td>3.36</td>
<td>3.36</td>
</tr>
<tr>
<td>NFE</td>
<td>45.93</td>
<td>45.64</td>
<td>45.64</td>
<td>45.65</td>
</tr>
<tr>
<td>ME Kcal/kg</td>
<td>2836.74</td>
<td>2757.07</td>
<td>2757.07</td>
<td>2757.07</td>
</tr>
</tbody>
</table>

*To provide the following per kg of feed: Vit. A, 10, 000 IU, vit B₁, 075g, Biotin, 0.05g, Folic acid 1g, Chlorine chloride 250g Copper, 8g, Manganese, 64g, Iron 32g, Zn 40g Iodine 0.6g, Flavomycin 100g, Spiramycin 5g, 3-nitre 50g, DL-methionone, 50g, Selenium, 0.6g, Lysine 120g, BHT, 5g, E = Enzyme, P = Probiotic.
The maize-based diet (T1) compared favourably with MPW-based diets in relation to dry matter, crude protein and ash. However, T1 diet was lower in crude fibre but higher in ether extract value.

Performance characteristics: The results of this study showed that there were significant (P < 0.05) differences in BWG, FCR and PER of the rabbit. However, there was no significant difference (P > 0.05) among the groups in feed intake (F1) and protein intake (P1).

The comparable F1 and P1 of the rabbits on high fibre diets and the control is not surprising since rabbits are pseudoruminants with the capacity to handle high fibre diets. The presence of cellulolytic enzymes in the caecum of the rabbit together with cecotrophy have been reported to permit rabbit to obtain additional energy, amino acids and vitamins (Carabonô and Piquer, 1998) from the feed consumed. The result on F1 also signifies that the crude protein and metabolizable content of the diet met up the animals requirements. This observation disagrees with the reports of Taiwo et al. (2005) that high fibre increases the feed intake of rabbits. It should be noted that F1 was numerically higher for groups supplemented with enzyme and probiotics. This observation was in agreement with the reports of Balevi et al. (2001) and Ayasan et al. (2006).

Data on weight gain showed that rabbits fed diets supplemented with enzyme (T3) and probiotics (T4) had significantly (P < 0.05) superior BWG compared with those of other treatment groups. Similarly, rabbits fed MPW-based diet (T2) gained significantly (P < 0.05) more weight over the control. The observed depression in weight gain of the group fed T1 diet could be due to the low level of crude fibre and higher energy levels of the diets. This is in line with the reports of Champe and Maurice (1983) and de Blas et al. (1986) that growth rate is reduced when rabbits are fed low fibre and high energy diets. This could also be as a result of longer feed retention time in the digestive tract emanating from lower fibre level (Laplace and Lebas, 1977).
The improved weight gain of rabbits fed unsupplemented MPW – based (T₂) diet over the control could be due to increased availability of nutrients and adequate crude fibre level. Crude fibre activates the intestine and more occurrences of peristaltic movement, more endogenous enzymes production resulting in efficient digestion of nutrients (Esonu et al., 2005). Colin et al. (1976) reported that the favourable effects of fibre termed a “ballast” effect are apparently due to the stimulation of cecal – colonic motility probably due to the scabrous effects of the larger particles and the increased bulk of the digesta. This is in line with the reports of Champe and Maurice (1983) that growth rate is reduced when rabbits are fed low-fibre and high energy diets.

Supplementation of diets with either enzymes or probiotics resulted in significant (P < 0.05) improvement in weight gain of rabbits fed the diets compared with other treatment groups. The enhanced weight gain of rabbits fed enzyme supplemented diets suggests that exogenous enzyme could improve growth in rabbits. This could be due to improved digestion and utilization of non-starch polysaccharides present in maize and maize processing waste. This finding agrees with the reports of Steenfeldt et al. (2003) who reported that enzyme supplementation improved the performance of monogastric animal for which, body weight increased but feed intake was not influence. While Officer (2000) reported that exogenous enzymes work in conjunction with digestive enzymes of animals to break up large molecules to smaller size that can be utilized by monogastric animals. However, this finding conflicts with the findings of Fernandez et al. (1996) who did not find any benefit from the inclusion of enzymes in rabbit diets.

The improved weight gain of rabbits fed probiotic-supplemented diet could be associated with improved health status of the animals, higher digestion and absorption of nutrients by the animals (Lan et al., 2003). Probiotics have been reported by Maertens and De Groote (1992) as feed supplement that contain beneficial live or revivable microorganisms capable of colonizing the gut and contributing to the maintenance of the flora equilibrium. Blecha (2000) and Soderhohm and Perdue (2001) reported that probiotic supplementation repairs the deficiencies in the gut flora and a balanced intestinal microbiota enhancing resistance to infection thereby improving performance of animals.

The feed conversion and protein efficiency ratios of rabbits fed T₃ and T₄ diets were significantly superior over the other groups. On the other hand rabbits fed T₂ diet had a better FCR than the control. The improvement in FCR achieved by either enzyme or probiotic supplementation indicates that the nutrients were more available, efficiently digested, absorbed and utilized by the rabbits (Fioramonti et al., 2003; El – Mandy et al., 2002). The PER result suggests the protein in T₃ and T₄ diets were efficiently metabolized for growth than the protein in T₁ and T₂ diets. This collaborates the report of Balogun et al. (2001).

**Nutrient Digestibility**

Results presented in Table 4 showed significant differences (p < 0.05) in crude protein, dry matter, crude fibre and ether extract digestibility. Rabbits fed probiotic and enzyme supplemented MPW diets recorded significant (p < 0.05) improvement in crude protein, ether extract and crude fibre digestibility. The higher crude protein digestibility observed in rabbits fed supplemented diets compared to those fed the control and unsupplemented diets may have been responsible for the higher weight gain of the rabbits fed these diets. It is clear from the result that there was no inhibition of nutrient digestion due to the presence of non-starch polysaccharides in the diet. It also appears that the utilization of MPW by rabbits is relatively high. The marginal improvement achieved by enzyme supplementation (2.16%) over the unsupplemented MPW diet may have resulted from partial degradation and solubilization of non-starch polysaccharides which allow for greater digestion and absorption of nutrients and hence improved performance of the rabbits (Chesson, 1993).
**Economics of production**

Rabbit production enterprise is a business and the goal of every business is to make profit. It is important therefore to consider cost effectiveness along with nutritional factors in recommending a particular feed ingredient for incorporation into feed formula. The economic analysis favoured the inclusion of MPW, enzyme and probiotic supplementation in weaner rabbit diets. MPW is comparatively cheaper than maize. Therefore, replacing a relatively expensive feedstuff (maize) with cheaper one (MPW) resulted not only in reduction of cost of feed per kilogram but also in cost of feed per kilogram weight gain. However, cost saving in percentage was higher for the supplemented diets. This agrees with the report of Onu et al. (2001) that feed cost reduces with the inclusion of non-conventional feedstuff in monogastric animal diets.

**CONCLUSION**

The results of the study have shown that 50% maize in rabbit diet can be replaced with maize processing waste without reducing the performance of the animals. Its inclusion in rabbit feed would help to reduce the cost of feed and consequently the cost of production. The results also indicated that enzyme or probiotics supplementation of maize processing waste-based diet enhanced the performance of the animals.

It is therefore suggested that the practical abundance of maize processing waste in Nigeria and the beneficial effect of enzyme or probiotic supplementation should be exploited as a significant leap to reduce the high demand on maize, its accompanying high cost and its direct effect on the cost of rabbit production.

**REFERENCES:**


