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Research Article

Mixed Pellet and Forage Diet in Growing Rabbits: Effect of *Ipomoae batatas* on Growth and Health Performance

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Abstract

The aim of this work is to test the effect of green forage *Ipomoea batatas* on young rabbit (*Oryctolagus cuniculus)* digestive health and growing performance. Two group (T and I) of 15 rabbits were made. These animals were weaned at 35 days of age and slaughtered at 70 days. The mean weight per group was 500 ± 20 g. Control group T was feed only with industrial pelleted Ivograin®. Experimental group I was feed with the same pelleted diet and green forage *I. batatas* in the cage. Results showed that the growing performances in group I were lower than control. Group I daily gain was 0.89g lower than T ($P<0.01$). Fed intakes was 1.05 times lower with forage than control ($P<0.01$). For sanitary risk index (mortality + morbidity) was 2 part higher in group I than control (14 *vs* 7, $P<0.01$). However, the nutrient digestibility was higher with *I. batatas* group than control. Digestibility of DM, OM, CP, NDF, ADF and Hc was 26.68, 23.43, 9.67, 18.56, 18.74 and 16.46 respectively higher with group I than control ($P<0.05$). We can conclude that, associate green forage *I. batatas* with pelleted diet was not increased the young rabbit growing performances and health except nutrients digestibility.

Keywords: Rabbit, Forage, *Ipomoae batatas*, Diet, Zootechnical performance, Health

Introduction

Feed is an essential factor in rabbit breeding. It represents more than 70% of the production costs of rabbit farming (Gidenne, 2003). The success of a rabbit farm therefore requires quality feed at a lower cost. The breeding system in Côte d'Ivoire is mainly of the traditional type (Kimsé *et al*., 2016a). This system is characterized by a mixed-type feed using both industrial pellets and locally collected green fodder.

Several forages are used by small farmers including *Ipomoea batatas*. The use of fodder in addition to pellets is of purely economic and often therapeutic interest. This practice allows the breeder to reduce the amount of pellets used during breeding and to temporarily compensate for

their shortages. However, very few studies exist on the impact of these forages added to pellets on animals. The results of this work on zootechnical performance and the digestive health of animals vary from one study to another and are often contradictory because of the study conditions. Thus, some studies have shown that the intake of fodder such as *Centrosema pubescens* and *Pueraria phaseoloides* improves fiber digestibility (Kimsé *et al*., 2013; Kimsé *et al*., 2016b). Studies have shown that certain forages improve the growth performance of rabbits (Aboh *et al*., 2002) unlike other authors who have rather observed a drop in growth and health performance (Kimsé *et al*., 2014, Kimsé *et al*., 2016b).

Past work has shown that potato flour (*I. batatas*) can replace maize flour in rabbit diets (Agwunobi *et al*., 1997). Studies in artisanal breeding in Côte d'Ivoire clearly show that *I. batatas* is frequently used as fodder for rabbits (Kouakou *et al*., 2016; Kouakou *et al*., 2015). The nutritional value of green fodder used in animal husbandry and its impact on growth and digestive health are still poorly understood. This study aims to assess the nutritional value of green leaves of *I. batatas* and the impact of its use as a fodder supplement to pellets on rabbits in improved artisanal farming in Côte d'Ivoire.

Material and Methods

This study was carried out in the experimental farm of Nangui Abrogoua University. It required the use of Ivograin® brand anticoccidial-free industrial pellets produced in Côte d'Ivoire, green fodder and 30 rabbits. The animals were raised after weaning for 35 days under an average temperature of 27°C in the building. The animals benefited from 12 h of lighting from 06 h 30 min to 18 h 30 min. No veterinary product was used during this trial in order to avoid interactions between the effect of the food and that of the veterinary products.

Constitution of Animal Batches and Feeding

Two batches of 15 young rabbits (*Oryctolagus cuniculus*) weaned at 35 days of age were used. The average weight of the animals of the two batches was identical with an average weight per weaned rabbit which was 500 ± 22 g. The two batches were formed from weaning. The animals were reared in individual cages of 83.2 dm3 (5.2 dm x 4 dm x 4 dm). The first batch was identified as the control batch (batch T) and the second batch constituted the experimental batch (batch I). Animals in each batch were fed ad libitum from weaning until 70 days of age. Rabbits in batch T were fed only Ivograin brand rabbit pellets. Those of batch I were fed with the same pellet, supplemented with the green fodder *I. batatas*. The chemical composition of the forage and of each of the two rations is presented in Table 1. The fodder distributed to the animals, once collected, was disinfected with bleached water 24 hours before distribution. The proposal was made by soaking the fodder in 10 l of water containing 2 ml of Lacroix® bleach. It was then left to dry in the shade at room temperature for 24 hours.

Effect of I. batatas Intake on Digestibility, Growth and Digestive Health

Intake was assessed daily by determining the difference between the amount of feed distributed and the refusals using a Roberval precision 1g scale. As for the growth monitoring, it was carried out individually by 2 weekly weighings every Monday and Thursday morning between 8am and 10am after the weighing of refusals, before serving the food of the day. These weighings made it possible to determine the average daily gain (ADG) and the consumption index (CI). The measurement of digestibility was carried out over 4 consecutive days from 50 to 53 days of age according to the Perez *et al*., 1995. During this period, all of the hard droppings were collected each day individually and packaged in plastic bags. The fresh weight of hard droppings was recorded upon collection. These samples were then stored at -18°C until laboratory analysis. The total weight of droppings excreted for each individual was obtained by adding the four consecutive collections for each animal

In this work, five excreta pools of three animals per batch were formed to reduce variability within the same group. The chemical analyzes of the food and faeces were carried out according to the ECRAN (2001) method. All excreta from each batch was oven-dried for 24 h at 80°C. Half of the excreta dried at 80°C was further dried for 24 h at 103°C to determine the dry matter in the droppings. The dry excreta was then ground for laboratory MS, MO, MAT, NDF, ADF and Hc in the faeces. A fraction of the feed distributed was taken from the feeders and analyzed for the determination of the chemical composition. Health monitoring was carried out by checking the general condition of the animals. Two checks were carried out per day. Animals that were counted as morbid were those with visible digestive disorders. Rabbits which also had their live weight decrease during two consecutive weighings were counted among the morbid animals. Mortality was assessed by counting rabbits whose death was caused by digestive disorders (Kimsé *et al*., 2013).

Statistical Analyses

The effect of green fodder intake on feed intake, growth, and digestibility was analyzed using a Student test. The impact of the food on the rates of morbidity, mortality and the health risk index (SRI) was analyzed and compared two by two using a G test. The two analyzes were carried out with R software version 2.10.1.

Results

The objective of this work is to evaluate the impact of the incorporation of green fodder *I. batatas* on zootechnical, health and digestibility performance in growing rabbits. The chemical analysis of the different rations shows that the

addition of fodder to the pellet led to a drop in the nutritional value of ration I (Table 1). The average concentration of fibers (NDF, ADF and Hc) and TNM decreased respectively by 30; 33; 25 and 40% compared to food T. On the other hand, the level of mineral matter in ration I reached 1.6 times that of ration T.

Table 1: Chemical composition of forage and T and I rations.

Nutriment	Forage	Diets	
		T	I
DM (%FW)	16,26	89,64	52,95
MM (%DM)	17,98	7,84	12,91
OM (%DM)	82,04	92,16	87,10
TNM (%DM)	3,4	18,04	10,72
NDF (%DM)	11,15	27,11	19,13
ADF (%DM)	4,6	13,88	9,24
Hc(%DM)	6,54	13,24	9,89

DM = Dry matter; MM: Mineral matter, OM = Organic matter; TNM = Total nitrogenous matter; NDF = Neutral Detergent Fiber; ADF = Acid Detergent Fiber; Hc = Hemicellulose T = Pellet; I = Pellet + forage; FW = Fresh weight

Effect of I. batatas on Feed Intake, Growth and Feed Efficiency

From 35 to 46 days of age, the daily intake was the same for the two batches (Table 2). The average is 43 g/d. From 47 to 58 days of age, the animals of the experimental batch (batch I) ingested 2 g of feed per day more than those of the control batch (P = 0.02). On the other hand, from 59 to 70 days of age, the animals of group T ingested 8 g/d more feed than those of the experimental group (P < 0.01). Over the entire breeding period (35 to 70 days of age), the quantity of feed ingested by the animals in the two batches is equal and the average was 64 g/d. The addition of forage in addition to pellets had a variable effect on the animals during their growth. During the start-up phase, between 35 and 46 days of age, the young rabbits fed with ration I showed greater growth than those of the control batch. These animals had an average weight higher at 46 days than batch T of 11g (P = 0.02). On the other hand, weight gain and consumption index between weaning and 46 days were identical in the two batches. They were respectively 27g/d and 1.7 on average. However, growth was slowed in batch I between 47 and 70 days of age. The average weight was 43 g lower in batch I compared to batch T at 58 d of age (P < 0.05). However, this resulted in a decrease in ADG only between 47 and 58 days of age of 4g/d (P = 0.01) and an increase in CI of 0.3 points (P < 0.01) in the experimental lot compared to the control. No significant variation was observed between 58 and 70 days of age for the ADG and the CI. The respective averages were 20 g/d and 6. Over the entire duration of rearing, from weaning to 70 days, no effect of forage intake (*I. batatas*) was observed on ADG and CI although the final mean weight was 30 g lower (P < 0.01). . The mean ADG and CI were 26 g/d and 2.6, respectively.

Table 2: Effect of *I. batatas* on ingestion and growth

Age (day)	Diets		RMS	P>F
	T	I		
Ingestion (g/d)				
35 à 46d	43	43	5,2	0,71
47 à 58d	54	56	0,7	0,02
59 à 70d	98	90	0,3	<0,01
35 à 70d	65	63	4,7	0,9
Weight (g)				
35d	500	500	4,8	0,8
46d	807	818	24,5	0,02
58d	1193	1150	10,5	<0,01
70d	1421	1391	7,7	<0,01
ADG (g/d)				
35 à 46d	26	27	1,6	0,3
47 à 58d	32	28	3,0	0,01
59 à 70d	19	20	2,1	0,3
35 à 70d	26	25	20,3	0,8
CI				
35 à 46d	1,7	1,6	0,001	0,08
47 à 58d	1,8	2,1	0,001	<0,01
59 à 70d	6,2	5,8	0,07	0,08
35 à 70d	2,6	2,5	0,002	0,1

ADG = Average daily gain; CI = Consumption index; RMS = Residual mean square; T = Pellet; I = Pellet + forage

Effect of I. batatas on Nutrient Digestibility

Analysis of table 3 shows that nutrient digestibility was higher in animals in batch I compared to those in batch T with the exception of TNM. The observed mean was 49.8% for TNM. However, the digestibility of DM and OM were 1.5 and 1.4 times higher in Batch I (P<0.01), respectively. As for the digestibility of NDF, ADF and hemicellulose fibres, they were 1.3, 1.5 and 1.2 times higher in batch I (P<0.01), respectively.

Table 3: Digestibility (%) of nutrients between 50 and 53 days of age.

Digestibility	Diets		SE	P>F
	T	I		
dDM	54,00	80,68	3,00	< 0,01
dOM	57,24	80,67	2,97	< 0,01
dTNM	43,46	55,13	6,57	0,11
dNDF	54,78	73,34	4,27	< 0,01
dADF	37,98	56,72	6,44	< 0,01
dHc	72,41	88,87	5,07	< 0,01

D = Digestibility; DM = Dry matter; OM: Organic matter; TNM: Total nitrogenous matter; Hc = Hemicellulose; SE = Standard error; NDF = Neutral detergent fiber; ADF = Acid detergent fiber ; T = Pellet ; I = Pellet + forage

Effect of I. batatas on animal health

During the start-up phase, between weaning and 46 days of age, the mortality rate was equivalent in the two batches. The mean mortality was 3.34%. On the other hand, during the same period, morbidity and HRI were respectively 4 times and 2.7 times higher in batch I compared to the control batch (P<0.01). Between 46 and 58 days of age, no significant difference was observed in terms of mortality

and morbidity. The averages observed were 21.4% and 25.1% respectively. However, the HRI was 3.3 times higher in batch I (P<0.01). Between 58 and 70 days, no significant difference was observed for mortality, morbidity and HRI rates in the two batches. The average rates were 3.8, 3.8 and 7.6% respectively. From weaning to 70 days of age, mortality, morbidity and HRI were respectively 4, 1.7 and 2 times higher in batch I (P<0.01).

Table 4: Effect of *I. batatas* intake on the health risk index

Age (day)	Diets		P>F
	T	I	
35 to 46d			
Number	15	15	
Morbidity	2 (13,34%)	8 (53,34%)	< 0,01
Mortality	1 (6,67%)	0 (0)	0,91
HRI	3 (20%)	8 (53,34%)	< 0,01
47 to 58d			
Number	1	15	
Morbidity	3 (21,42)	2 (28,85)	0,29
Mortality	0 (0)	3 (42,85)	0,91
HRI	3 (21,42)	5 (71,42)	< 0,01
59 to 70d			
Number	14	12	
Morbidity	1 (7,14)	0 (0)	0,29
Mortality	0 (0)	1 (8,34)	0,91
HRI	1 (7,14)	1 (8,34)	0,36
35 to 70d			
Number	15	15	
Morbidity	6 (40)	10 (66,67)	<0,01
Mortality	1 (6,67)	4 (26,67)	<0,01
HRI	7 (46,67)	14 (93,34)	< 0,01

HRI: Health risk index

Discussion

The high moisture content, low nitrogenous matter and fiber content in the dry matter of forage would explain the low level of nutrients essential for growth and health of the rabbit such as protein (TNM) and fiber in the ration I. Moreover, the levels of these different compounds are well below the recommended thresholds in growing rabbits which are at least 16% TNM, 40% NDF and 20% ADF (Gidenne *et al*., 2004) thus justifying, the poor growth of the animals in batch I and the high health risk index in this batch. Indeed, it has been shown in several studies that the growth rate of young animals is greater when the protein content of the ration is between 17 and 18% (Blum, 1989). On the other hand, when this rate drops to 14%, growth is slowed down (Kimsé, 2009) as is the case in batch I rabbits where the protein content in the ration is only 10.8%.

Moreover, according to Henaff and Jouve (1988), there is a deterioration in the performance of growing rabbits when the level of proteins or of certain essential amino acids is lowered below the recommended values. This factor seems to come into play because analyzes of the feed used show that the protein level in the experimental ration is lower than the recommended values (16 to 17%) for fattening rabbits (Blum, 1989).

In terms of digestibility, it was greatly improved by forage intake. This result confirms that previous work has shown an increase in digestibility reaching 25% with the intake of *Centrosema pubescens* in addition to the pellet (Kimsé *et al*., 2013). This improvement in digestibility could be linked to that of starch and the action of digestive bacteria on the fibers of forage diets.

The digestibility of fibers observed in this work seems too high compared to that of the literature (Gidenne *et al*., 1994; Kimsé, 2009). This increase is partly due to the low fiber concentration of the rations (Gidenne *et al*., 2009; Gidenne *et al*., 2012). However, the forage ration is better digested. But the fiber content of this ration is insufficient compared to the needs of the animals which is for NDF and ADF respectively greater than 30 and 20%.

This low level would be responsible for the high mortality observed in batch I. Indeed, the biocenosis of rabbit ceacum is composed of facultative anaerobic microorganisms and strict anaerobic microorganisms in equilibrium. Among facultative anaerobic microorganisms, some are potentially pathogenic. The arrival of fibers in the cecum constitutes a substrate for these microorganisms and the maintenance of balance. Fiber intake lowers the risk of digestive pathology in growing rabbits. This decrease is due to the reduction in the proliferation of opportunistic bacteria such as *Clostridum perfingens* or *Campylobacter*. There is also the morphology and functionality of the intestinal mucosa and its immune response (Gómez-Conde *et al*., 2007). Mortality on farms linked to Rabbit Epizootic Enterocolitis (REE) is thus reduced with rations with good fiber content (30% NDF). In sum, *I. batatas* in forage form improves nutrient digestibility in growing rabbits. However, it causes a decrease in the nutritional value of the ration. It slows growth and increases the risk of digestive pathology in breeding.

Conclusion

The objective of this work was to evaluate the impact of the contribution of *I. batatas* in the form of green forage in feed on zootechnical and health performance as well as nutrient digestibility. Adding this forage to the pellet in the ration did not improve intake, growth rate or feed efficiency. Animals fed forage were more exposed to digestive disorders. The nutritional value of the ration was reduced with the addition of forage except for the mineral content. However, the forage improved the apparent digestibility of nutrients.

Authors' Contribution

Dr O.S. Soro is the initiator of the study. The data were analyzed by Dr V. Kadjo. The manuscript was revised by Dr K.S.A Yao. The work was supervised by Dr. M. KIMSE. Final form of manuscript is approved by all authors.

Conflict of Interest

The authors declare that there is no conflict of interest with present publication.

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