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# Effect of *Moringa oleifera* on Growth Performance and Health Status of Young Post-Weaning Rabbits

Bouatene Djakalia, Bohoua Louis Guichard and Dabonne Soumaila
Department of Food Sciences and Technology, Universté d'Abobo-Adjameé, Abidjan,
Cote d'Ivoire (West Africa)

**Abstract:** This research was conducted to study the effect of *Moringa oleifera* on the growth performance and health status of young post-weaning rabbits. Three feeding supplements different in their composition were used: (Moringa supplement, mixed and the standard supplement). The Moringa supplement was added at 3% in the basic feed. The standard supplement used at 3% was made of 0.12% oxyboldine, 0.25% lysine, 0.1% methionine, 0.6% vitamin premix and 0.6% of dibasic calcium. The mixed supplement was composed of 1.5% Moringa supplement and 1.5% of the standard supplement. The performance of these 3 types of feeding formulation was measured on young post-weaning rabbits. The best results were obtained with Moringa supplement. The highest rabbits weight average was given by the Moringa supplement (820.62 g) followed by the mixed supplement (658.78) g and the standard supplement (632.75 g). The growth rates were 126.19, 69.85 and 68.66 g week$^{-1}$, respectively for rabbits fed with Moringa, mixed and standard feeding formulations. The moringa supplement rabbit feeding formulation showed the highest apparent fecal digestibility (85%) compared to the mixed and standard feeding formulation that were respectively 80 and 81%. This index showed a high protein digestibility. However, the digestibility of different fiber components such as Acid Detergent Fiber (ADF) and Neutral Detergent Fiber (NDF) were low regardless the feeding formulation used. In terms of mortality, the mixed feeding formulation gave the highest mortality rate (12%) compared to the moringa and the standard fed rabbit groups (4%). No difference was observed in the feed consumption index.

**Key words:** *Moringa oleifera*, growth performance, health, rabbit, post-weaning, digestibility

## INTRODUCTION

In the majority of developing countries, the population is mainly composed of farmers or breeders. In Cote d'Ivoire, livestock counts for about 4.5% of the agricultural Gross Domestic Product (GDP) and 2% of the overall GDP. The strong demographic growth in the last recent years has created an imbalance between demand and supply of animal protein. Malnutrition has been installed and the consequences can be very serious especially for children (NRC, 1991).

Given the poverty in most developing countries and lack of space for livestock breeding especially in areas of high population density, the development of the mini-farm is becoming a key solution to fight against protein malnutrition found out that this activity is booming.

It includes grass cutter, cavia and rabbit breeding. Rabbit breeding is widely done especially in the southern part of Cote d'Ivoire. This activity is very promising given the fact that rabbit breeding provides a good quality meat and requires a small capital and investment. Despite the dynamism of this activity, many problems remain insolved. In rabbit breeding, digestive system diseases are very common in young rabbit and are responsible for significant economic losses (mortality, treatment costs). Solutions to prevent these diseases are implemented: development of health and medical prophylaxis, mastering of good breeding practices (renewal of breeders, breeding rate, feeding programs etc.). Among them, the feeding is an interesting matter. As a matter of fact, the fundamental function of the feed is to provide the body with necessary nutrients for its maintenance, growth and eventually production needs (lactation, pregnancy etc.). A well balanced feed must maintain the rabbit health status. Moreover, the immune system is regulated by numerous hormones at a certain level of secretion depends upon nutritional factors (Klasing and Leshchinsky, 2000). The idea of improving the performance of rabbits has conducted researchers to introduce various plant extracts in the feed of rabbits. Ben-Shaul *et al*. (2000) have shown in rabbits receiving extracts, a decreased in the oxidative stress and a resistance to endotoxemia induced by

**Corresponding Author:** Bouatene Djakalia, Department of Food Sciences and Technology, Universté d'Abobo-Adjamé, Abidjan, Côte d'Ivoire (West Africa)

lipopolysaccharides. Many plants present antibacterial and anti-inflammatory activities (Ben-Shaul *et al*., 2000; Tzung-Hsun *et al*., 2005). Other researchers have highlighted the positive effects of these plants upon coccidiosis (Mandal *et al*., 1994; Allen and Dansforth, 1998; Allen *et al*., 2000; Youn and Noh, 2001). The use of Moringa in the present study fits in the strategy of reducing induced diseases. *Moringa oleifera* also known as the tree of life is a plant originated from India and with many properties (Fuglie, 2001a). It is used in human food and animal feed, medicine, industry, water purification (Foidl *et al*., 2001; Fuglie, 2001b).

The same researchers have reported that cattle with fed this plant as a supplement gained significantly more weight than those which received none. Similarly, the use of multi-nutrient complex (vitamin premix and amino acids) in animal feed has a positive effect on animal growth (Karikari and Asare, 2002).

However, their cost of production is very high. This study was undertaken to improve the performance growth and health status of rabbits at a lower cost. The research therefore aims at studing the effect of *Moringa oleifera* on the growth performance and health status of young post-weaning rabbits.

## MATERIALS AND METHODS

**Animals:** The study was conducted on 270 New Zeeland freshy weaned, 1 month aged and a body weight of 400±10 g. The rabbits were divided into 3 groups of 30 rabbits. The experiment repeated 3 times.

**Raw materials for feed formulations:** Corn, soybean, copra, cotton seeds and shells of oysters purchased at the big market of Abobo, wheat bran was obtained from Grand Mouin d'Abidjan (GMA), rice straw and rice bran were purchased from SODERIZ Agboville. Cocoa husks were supplied by the CONDICAF company. Methionine, lysine, vitamin premix and Dibasic calcium were purchased from PROVETO, Abidjan. Oxyboldine was bought from a drugstore pharmacy. *Moringa oleifera* leaves were collected from the University of Abobo-Adjame.

**Feed formulation:** The feed formulation called Moringa and mixed were made from the basis diet (Table 1). The granulation was carried out using as a binder solution of sugar at 50 g $L^{-1}$ (water). Soybean meal and cotton are used after oil extraction using a mechanical press. Extraction was done at 140°C to destroy soybean trypsin inhibitors and cotton gossypol.

Table 1: Feeding ingredients of experimental batches (during the period of the experimentation, the feeding ingredients used for different rabbit batches are mentioned)

| Ingredients (%) | Moringa suppement batch | Mixed supplement batch | Standard batch |
|---|---|---|---|
| Corn | 19.0 | 19.00 | 19.00 |
| Wheat bran | 12.0 | 12.00 | 12.00 |
| Rice bran | 12.0 | 12.00 | 12.00 |
| Rice straw | 10.5 | 10.50 | 10.50 |
| cocoa shell | 21.0 | 21.00 | 21.00 |
| Soya bean meal flour | 04.0 | 04.00 | 04.00 |
| Cotton waste cake | 12.0 | 12.00 | 12.00 |
| Copra meal cake | 5.4 | 5.40 | 5.40 |
| Shells of oysters | 0.9 | 0.90 | 0.90 |
| Moringa powder | 3.0 | 1.50 | - |
| Methionine | - | 0.10 | 0.10 |
| Lysine | - | 0.15 | 0.25 |
| Dibasic calcium | - | 0.60 | 0.60 |
| Vitamin premix | - | 0.50 | 0.60 |
| Oxyboldine | - | 0.12 | 0.12 |

**Determination of animal performance:** Three types of feed formulation have been developed and distributed to 3 groups of rabbits. The standard batch is fed to the standard supplement, the moringa feed and mixed batches have received, respectively in the feeds 3% moringa supplement and the combination of 1.5% of the moringa supplement and 1.5% of the standard supplement. The experiment was conducted over 7 weeks. Each week the performance parameters were measured.

**Determination of the feed consumption:** The feed consumption is the difference between the remaining and the distributed feed.

$$FC\ (g) = QDF\ (g) - QRF\ (g)$$

FC (G) = Feed Consumption
QDF (g) = Quantity of Distributed Feed
QRF (g) = Quantity of Remaining Feed

**Determination of the average feed consumption:** The Average Feed Consumption (AFC) is the ratio between the total Quantity of Feed Consumed (QFC) on a given period over the Number of Subjects Fed (NSF) on the same period.

$$AFC\left(\frac{g}{day}\right) = \frac{QFC\left(\frac{g}{day}\right)}{NSF}$$

**Determination of the average weight:** The Average Weight (AW) is the ratio between Total Weight of Subjects (TWS) in a given batch and the Number of Subjects (NS) of this batch:

$$AW(g) = \frac{TWS(g)}{NS}$$

**Determination of the average weight gained:** The Average Weight Gained (AWG) is determined weekly. It represents the difference between the Average Weight (AWc) of the current week and that of the previous week. It is determined as follows:

$$AWG = AWc - AWp$$

Where:
AWG = Average Weight Gained (g)
AWp = Weight of the previous week (g)
AWc = Average weight of the current week (g)

**Determination of the Growth Rate (GR):** The growth rate represents the ratio between weight gained and growth period.

$$GR\ (g\ week^{-1}) = \frac{(Weight\ gained\ (g))}{(Growth\ period\ (week))}$$

Where:
GR = Growth Rate (g week$^{-1}$)

**Determination of the consumption index:** It is the necessary feed intake needed to increase the unit of the subject weight by one. It is obtained from the ratio of average feed consumption and weight gained of subjects. It is calculated as follows:

$$CI = \frac{AFC\ (g\ day^{-1})}{AWG\ (g\ day^{-1})}$$

Where:
CI = Consumption Index
AFC = Average Feed Consumption
AWG = Average Weight Gained

**Determination of the rate of mortality:** The rate of mortality is the ratio between the number of the dying animals and the initial total number of subjects in the bacth multiplied by 100.

$$Mortality\ (\%) = \frac{Number\ of\ subjects\ dead}{Total\ number\ of\ initial\ subjects} \times 100$$

**Apparent digestibility:** The apparent fecal digestibility of the feed (DA) is the proportion of feed not excreted, considered as absorbed into the gut after a period of adaptation to the feed during at least 7 days. It is evaluated by the European reference method (Perez *et al*., 1995).

Table 2: Feeding chemical composition of feeding formulations (analysis on the chemical composition of the feeding formulation were performed)

| Composition | Moringa supplement | Mixed supplement | Standard feed |
|---|---|---|---|
| Digestible energy (kcal kg$^{-1}$ gross) | 2441.00 | 2443.00 | 2443.00 |
| Crude protein (%) | 17.00 | 16.36 | 16.36 |
| Fat (%) | 3.65 | 3.60 | 3.60 |
| Crude fiber (%) | 13.00 | 12.00 | 12.00 |
| Calcium (g kg$^{-1}$) | 0.90 | 0.70 | 0.70 |
| Total phosphorus (g kg$^{-1}$) | 6.15 | 6.00 | 6.00 |
| Sodium (g kg$^{-1}$) | 0.20 | 0.20 | 0.20 |

$$DA\ (\%) = \frac{Quantity\ consumed\ (g) - Quantity\ excreted\ (g)}{Quantity\ consumed\ (g)} \times 100$$

**Chemical analysis:** Chemical analysis of feeds, Moringa leaves and feces were performed. The Dry Matter (DM), Organic Matter (OM), ash, Phosphorous (P), Calcium (Ca), Potassium (K), Sodium (Na) and lipid content (TL) were determined by the method AOAC (1990). The Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF), hemicellulose and the cellulose were determined by the method of Van Soest *et al*. (1991). The nitrogen content was determined by the method of Kjedahl (AOAC, 1990). Crude Protein (CP) was calculated by multiplying the nitrogen content by 6.25. The energy was been determined by calorimetry (Table 2).

**Statistical analysis:** ANOVA 6 was used to compare weight gained, the index of consumption and the average weight obtained from each type of feed with the statistical software. The comparisons at 5% were made with Duncan test.

## RESULTS AND DISCUSSION

**Nutritional value of Moringa leaves:** The results of chemical analysis of Moringa leaves are shown in Table 3.

**Variation of zootechnical parameters:** The same letter on the same line means that there is no significant difference among batches. The Moringa batch has the best average weight and the best growth rate while the mixed and standard batches average weight and growth rates were similar (Table 4). However, no significant difference was observed in the three batches index of consumption.

**Study of the gross weight of rabbits:** Figure 1 shows the evolution of rabbits from the weaning to the end of the experiment with an increase of the weight from 400-1200 g, the rabbits from the Moringa supplement have a higher weight gain than the standard and the mixed groups with a final average weight of 1200 g (Fig. 1).

Table 3: Chemical composition of Moringa leaves expressed in percentage of dry matter

| Composition | DM | CP | Cellulose | Fat | Ash | Ca | P | K | Na |
|---|---|---|---|---|---|---|---|---|---|
| Moringa leaves | 14.49±1.5 | 23.63±0.5 | 18.30±3.35 | 4.77±0.6 | 13.34±1.2 | 1.36±0.4 | 0.44±0.1 | 3.60±0.7 | 0.02±0.01 |

DM: Dry Matter; CP: Crude Protein; Ca: Calcium; P: Phosphorus; K: Potassium; Na: Sodium

Table 4: Statistical comparison of animal performance

| Statistical analysis | Moringa batch | Mixed batch | Standardbatch |
|---|---|---|---|
| Average weight (g) | 820.62±306$^{a}$ | 658.78±173.89$^{b}$ | 632.75±75.0$^{b}$ |
| GR (g week$^{-1}$) | 126.19±46.18$^{a}$ | 69.85±22.030$^{b}$ | 68.66±16.9$^{b}$ |
| CI | 2.76±1.010$^{a}$ | 3.95±1.5000$^{a}$ | 3.28±0.86$^{a}$ |

Statistical analysis was performed on the average weight and the growth rate of the rabbits; CI: Consumption Index; GR: Growth Rate

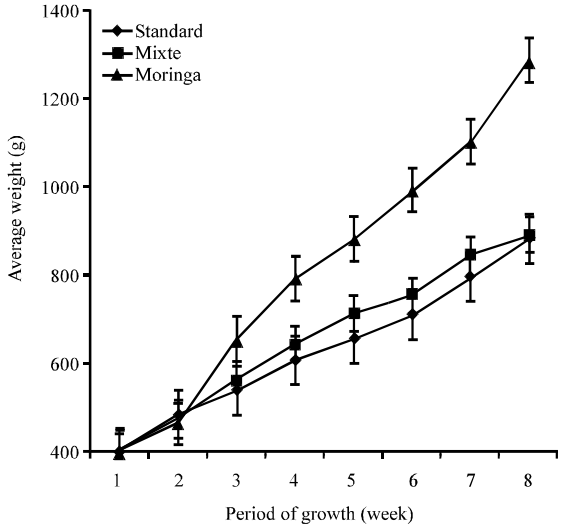


Fig. 1: Evolution of the weight of rabbits

**Study of the growth rate:** The trend of the different groups growth rate varies considerably. However, throughout the period of the experiment, the rabbits fed with Moringa supplement showed the highest growth rate (Fig. 2).

**Study of the Consumption Index (CI):** The trends of the consumption index are shown in Fig. 3. The trends of the 3 groups of rabbits are irregular. In general, the indexes are low, reflecting a good feeding conversion. Statistical analysis indicates that there is no significant difference among batches.

**Health status:** Health status for each batch of rabbits was evaluated. The mortality rate recorded in the Moringa, mixed and standard batches are respectively 4, 12% and 4.

Symptoms observed were mainly bloating and scabies. The group fed with the mixed supplement feeding had the highest mortality rate. Upon looking at symptoms, researchers noticed that only the standard batch was contaminated by scabies (Table 5).

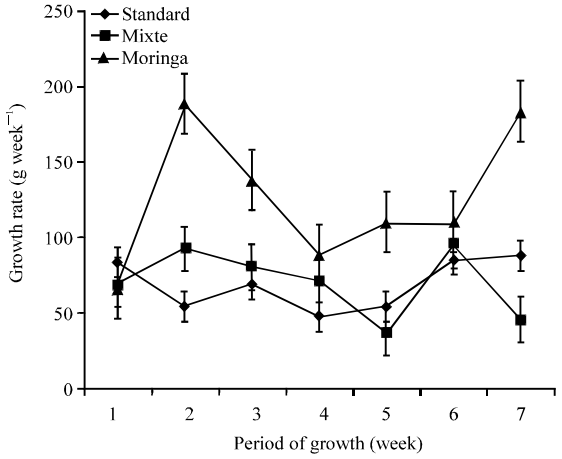


Fig. 2: Growth rate of rabbits

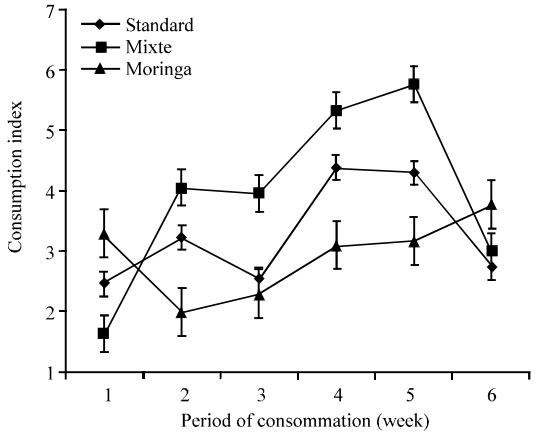


Fig. 3: Changes in the rabbits feed efficiency

**Study of the feed efficiency:** Means with the same letter in a given row are not statistically different. The three types of feeds (Moringa, mixed and standard) have a high digestibility for the protein (80-85%), the best performance was observed with Moringa feed. The digestibility of fat was the same for all the feeds. The digestibility of the hemicellulose was very low (15-20%) compared to ADF and NDF in the three feeds. Digestibility of ADF and NDF from mixed batch were the best (Table 6). The leaves of *Moringa oleifera* are a good source of protein, fiber and minerals, elements that are vital for the growth and the health of rabbits. The values obtained from the chemical analysis of Moringa leaves are in accordance with those obtained by have reported levels of crude protein and fat of 26.4 and 6.5%. These values are higher than the

Table 5: Health status for each batch of rabbits (the health status of rabbits in each batch was evaluated and the clinical signs were noted)

| Batch | Mortality rate (%) | Clinical signs |
|---|---|---|
| Standard | 4 | Scabies (40%) and death by bloating (60%) |
| Mixed | 12 | Bloating |
| Moringa | 4 | Bloating |

Table 6: Value of faecal apparent digestibility (%) (the apparent digestibility of each feed formulation was studied)

| Parameters | Moringa supplement feed | Mixed supplement feed | Standard feed |
|---|---|---|---|
| Protein | 85.00±0.80$^{a}$ | 81.00±0.75$^{b}$ | 80.85±0.45$^{b}$ |
| Fat | 68.70±0.75$^{a}$ | 67.00±0.50$^{a}$ | 67.50±0.65$^{a}$ |
| ADF | 28.85±1.00$^{b}$ | 33.52±1.04$^{a}$ | 18.59±0.85$^{c}$ |
| NDF | 44.43±0.65$^{b}$ | 49.62±0.85$^{a}$ | 39.36±0.70$^{c}$ |
| Hemicellulose | 15.00±0.70$^{b}$ | 16.10±0.95$^{b}$ | 20.77±0.80$^{a}$ |

NDF: Neutral Detergent Fiber; ADF: Acid Detergent Fiber

(23.63% for protein and 4.77% for fat). These variations can be explained by differences in agro-climatic conditions or age of trees. As a matter of fact, genotype, environmental factors, post-harvest treatments, the season of harvesting and maturation stage of the leaves have a strong influence on the nutrient content of Moringa leaves.

The effect of feed on the performance of young rabbits indicate that the Moringa supplemented feed is better in terms of weight gained than speed of growth. The performance of the Moringa supplemented feed could be explained by the presence of *Moringa oleifera* in the feed. Moringa has strengthened the content of the feed protein and fiber. Proteins of Moringa have very high biological values (Zarkadas *et al*., 1995). All essential amino acids present in Moringa are in a concentration greater than the one recommended by FAO and WHO mentioned in the feed reference that is soybeans (Zarkadas *et al*., 1995).

The high content of Moringa fibers facilitates the digestive transit of rabbits. The mixed batch contain Moringa even though it does not give the same growth performance as the Moringa supplemented batch. The adding up of vitamin premix, methionine and lysine in addition to Moringa in the feed have limited the growth performance of the mixed batch. Moringa is rich in lysine and methionine, the addition of lysine-methionine to the supplement Moringa creates an imbalance by excess in the mixed batch. Moringa contains 14 g $kg^{-1}$ on a dry matter basis and 4.97 g $kg^{-1}$, respectively for lysine and methionine (Zarkadas *et al*., 1995). An excess of methionine also reduces the appetite. These researchers have shown that the coefficient of palatability of an unbalanced diet due to an excess of methionine is low. As a matter of fact, high concentrations of plasma amino acids that can not be channeled into protein synthesis may serve as a satiety signal. Thus, methionine would act on the satiety center from the plasma when its concentration exceeds a certain threshold. Besides, Daniel and Waisman (1969) showed that high doses of methionine injected into growing rats produced similar effects on appetite. Methionine has a net depressive effect on the consumption, weight and increases the mortality. The index of consumption observed, they are respectively 4.26, 4.56 and 2.97 for standard batch, mixed and Moringa supplemented batch. Statistical analysis shows no significant difference between these different batches at 0.05. Taking in account these results it is noticed that these three types of feeds satisfy the growth needs of young rabbits.

This results suggest that Moringa supplemented feed favors the development of young rabbits. The mortality rate during the experiment is 4% for the standard and moringa supplemented batches, 12% for the mixed batch. From clinical signs associated with the mortality (bloating and scabies), it seems that the mixed feed did not really ensure a smooth functioning of the digestive transit in rabbits fed with the above diet. A high amount of methionine causes poisoning of the body through the accumulation of free methionine in plasma. It also triggers major metabolic disorders such as hypoglycemia leading to coma in rabbits.

The poisoning of the body can negatively affect the immune response. In fact, the cell division during the immune response (phagocytes and lymphocytes) and the synthesis of effector molecules such as antibodies and lysozyme are affected (Klasing and Leshchinsky, 2000). Nevertheless it should be noted that during the experiment, only rabbits fed with the standard diet had scabies. This observation confirms the antimicrobial activity of Moringa.

Moringa leaf extracts have antimicrobial activities. They inhibit the growth of *Staphylococcus aureus* in the feed and animal intestines. The study of the feed efficiency determined by the fecal digestibility, shows as faecal apparent digestibility ranging from 80-85% for protein, 67-68% for fat and 15-49% for fibers.

These results are consistent with those made by Gidenne *et al*. (2000), Debray *et al*. (2003). The high digestibility protein of the three types of feed would be linked to the coprophagy phenomenon.

In fact, during this phenomenon hard droppings poor in protein are released in the litter while pout droppings (rich in protein) are reabsorbed by the rabbit. The high apparent digestibility of protein in Moringa supplemented feed compared to the two other would be linked to the wealth of Moringa protein. In fact, Moringa has reinforced the content of protein in the feed. Moreover, proteins are readily degraded.

The low digestibility of the hemicellulose in Moringa and mixed batch compared to the standard batch could be explained by the presence of *Moringa oleifera* in the first two feeds. Like protein, fat is an intra-cellular component which is readily degraded having therefore a good digestibility. Moringa leaves being poor in fat have no effect on the fat digestibility. The higher digestibility of NDF (Neutral Detergent Fibers) and ADF (Acid Detergent Fibers) comes from moringa leaves. Moringa plant due to its high quantity and quality fibers modifies the fiber profil of the moringa and the mixed supplemented feeds. However, the digestibility of hemicelluloses is the lowest. *Moringa oleifera* is rich in gold lignin; lignin is not degraded and reduced digestibility of hemicellulose by reducing its availability to bacteria.

## CONCLUSION

The supplementation of Moringa at 3% in the feed, gives the best results in terms of gross weight, growth rate and survival of young rabbits. The performances have been achieved due to the high digestibility of its proteins and its antimicrobial activity. However, no significant difference was observed in the index of consumption. The use of the mixed batch resulted in a high mortality. These results show the effectiveness of *M. oleifera* used as a single supplement in rabbit feed. Given its effectiveness, *M. oleifera* could be used as a bioceutique agent to replace antibiotics.

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