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BREEDING AND EFFICIENCY OF FEED UTILIZATION IN DIALLELCROSSED RABBITS FED DRIED COCOYAM (*Colocasia esculenta*) PEEL MEAL IN A HUMID CLIMATE

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Abstract
The study on breeding and efficiency of feed utilization was conducted using four rabbit strains; the New Zealand White (NZW), the Chinchilla (CHL), New Zealand Red (NZR), and the FCEABK-α (K-α), a newly developed rabbit strains through 4x4 di-allele crossbreeding experiment that generated 16 genotypes involving 4 straight bred and 12 crossbreds respectively. The performance of these rabbit strains was monitored to evaluate sire's feed intake and feed efficiency traits on average kit weight (AKW) at weaning and post-weaning age. The effect of feed intake and feed efficiency on production parameters of rabbit strains was estimated from two-way analysis of variance with sub-samples using General Linear Model of SAS (2019). The results indicated that effect of feed intake and feed efficiency on production traits varied with age, among the rabbit genetic groups due to variation in their genetic makeup. Recommendations were therefore made among others that variations that existed in this rabbit population should be thoroughly exploited through crossbreeding and selection programmes. This is desirable to take advantage of heterosis in enhancing numerical feed efficiency. The study therefore underscored the importance of feed efficiency on productive potentials in rabbits, which is a better tool of enhancing the genetic potentials of rabbitsas a sustainable pathway to addressing the challenges of climate change in animal agriculture in Nigeria.
Key Words: Climate change, Diallel analysis, Feed efficiency, Humid climate, Rabbit strains.

Introduction:

Livestock production is a very essential part of livelihood for health, economic and social reasons. The acute shortage of animal protein in the diets of most Nigerians has been caused by the low supply and high cost of feed, conventional meat and animal products such as beef, mutton, goat meat, poultry eggs and milk (North *et al.,* 2020). The resurgence of interests in livestock industry worldwide however, calls for research into economic traits in various species, breeds and strains of farm animals. The present state of the economy coupled with the current inflationary trend, scarcity and high cost of production contributes to the poor production of animal protein which is required in high demands, leading to malnutrition, undernutrition and security challenges of all age groups in Nigeria. Increased rabbit production is one sure way of meeting the animal protein requirements of Nigerian populace (Trocino *et al.,* 2018).

Rabbits are highly prolific animals with rapid turnover rate at very low cost. The daily weight gain is high in proportion to the body weight which gives them a rapid growth rate and early sexual maturity. Efficiency of feed utilization is an important factor to be considered in livestock production. This is true because animals that are able to adapt and utilize poor feed (quality and quantity) stand better chances of survival when the competition between man and livestock for food is posing challenges as evidenced in most African countries like Nigeria. These factors result in the rabbit reaching the weight of a sexually mature animal 30% faster than other animals and also make rabbits suitable as meat producing small livestock in developing countries (Akanni, 2012). Reports from FAO (Rouco *et al.,* 2012; Trcino *et al., 2018*) however, stated that from year 1998 to 2020 globally, 980,785,000 rabbits were slaughtered in 2016 and 1,428,085 tons of rabbit meats were produced (compared with the global meat production of 329,890,425 tons). Asia is recorded the largest rabbit meat producer in the world (approx. 73% of the global market) followed by Europe, Africa, and the Americas whose share of the global market is approximately 20%, 6.1%, and 1%, respectively.

Productive potential in rabbits

In recent decades, the high demand for food on global markets has contributed to the intensification and standardization of food production. In the coming years, this trend is likely to be maintained due to rapid population growth. However, consumers in highly developed countries show a growing interest in high-quality foods. As a result, food suppliers are beginning to diversify products to cater to the needs and expectations of various consumer groups. These marketing strategies involve the introduction of niche foods, organic products, and foods manufactured in less intensive production systems. The demand for foods from extensive production systems continues to increase because contemporary consumers are mistrustful of foods produced in traditional agricultural systems, where the main emphasis is placed on quantity rather than quality Akanni and Ajayi 2021. This trend can be attributed to growing levels of awareness about the impact of intensive crop and livestock production on the quality and health benefits of raw materials and end products. Many consumers believe that foods produced under intensive farming systems contain more harmful substances, have inferior sensory attributes, are deficient in valuable nutrients (vitamins, minerals, unsaturated fatty acids—UFAs), contribute to environmental degradation, and compromise animal welfare (Gillespie, 2018).

Rabbits are generally regarded as an animal species that are typically raised in small farms and traditional production systems. Meanwhile, rabbits are raised for meat in many countries and regions of the world. In 2016, global rabbit meat production reached 1,428,085 tons, where Asia, Europe, Africa, and America were responsible for around 73%, 20%, 6%, and 1% of the global production, respectively. In the European Union, rabbits are the second most farmed species in terms of numbers, where 34% of 180 million animals raised for meat are kept in family farms. Most of these farms are small and medium sized enterprises where rabbits are produced less intensively than in large commercial farms. Extensive farming differs from intensive production systems, mainly in housing conditions and animal diets. In extensive farms, rabbits are kept on litter in cages or pens, movable outdoor pens with access to indoor and outdoor areas, or even outdoors. Rabbits are fed farm-made diets, and the use of chemotherapeutics is limited. In many respects, extensive farming is similar or equivalent to organic farming. Modern rabbit breeds differ in their suitability for extensive and intensive production. The following rabbit breeds are most widely farmed for meat: native (local) breeds, colored (extensive) breeds, intensive breeds (such as New Zealand and Californian), synthetic breeds, and hybrids. Native and colored breeds are best suited for extensive production, but intensive breeds can also be used in these production systems. However, the conditions under which intensive breeds are farmed under extensive production systems have to be optimized to guarantee production success. Extensive (and organic) farming methods are highly varied, and they are difficult to compare with intensive production systems in terms of output (Adeyemi *et. al.,* 2018. The limited number of research studies involving such comparisons confirms the above observation. However, objective research findings are needed to shape consumer attitudes and undermine subjective and stereotypical beliefs about the superior quality of foods produced in less intensive systems. Due to considerable variations in production factors in extensive farming systems, the quality of the resulting products is not always superior to that noted in properly managed intensive systems. The above hypothesis could also apply to the fatty acid (FA) profile of rabbit meat which plays a significant role in human nutrition. The aim of this study was to compare the FA profile of meat from New Zealand White rabbits raised under intensive and extensive production systems (Gillespie, 2018).

Agro-Industrial products utilization in rabbit production

In developing countries like India, Rabbit production contributes to improving the nutrition as well as the economy of small holder families. It has a promising scope to meet the critical shortage of quality animal protein. However, like other livestock species, economic rabbit production is constrained by high cost of commercial rabbit feed and shortage of fodder. Under these circumstances, various locally available low cost feed sources such as dried cocoyam peel, moringa leaf meal, water hyacinth, duck weed and azolla were assessed in the past for reducing on the feed cost in the rations of livestock. However, information on dried cocoyam peel utilization in meat type rabbits is scanty. Hence, the present study was undertaken to explore the effect of graded dietary levels of sun dried cocoyam (*Colocasia esculenta*) as substitute to protein supplement on growth performance of Newzealand white rabbits (Tewe and Kasali, 2016; Adeyemi *et. al.,* 2018).

There has been increased awareness of the advantage of rabbit meat production in developing countries as a means of alleviating animal protein shortages. Rabbit occupies a unique niche in that it is a mini livestock that is easy to manage, highly prolific and has a short generation interval. Rabbits are renowned for their fecundity and prolificacy (Biobaku and Dosunmu, 2003) and ability to utilize forages (Aduku and Olukosi, 1990). In the last two decades rabbits have begun to make useful contribution to meat supply in Nigeria where there is shortage of animal protein (Agunbiade, 2009). The increasing popularity of rabbit in Nigeria arose out of the response to the exorbitant prices of the conventional sources of meat, such as cattle for beef, goats for chevon, sheep for mutton, pigs for pork and poultry for chicken meat.

Besides, rabbit meat is low in fat and cholesterol (Biobaku and Oguntona, 1997) thus making the flesh a desirable one for diabetics, hypertensive and middle-aged people. The cost of feeding rabbits is however very high, a condition that also prevails for other Nigerian livestock species (Adeyemi *et. al.,* 2018). Less developed countries, including Nigeria, are facing serious competition between human and animal nutrition (especially, the monogastric animals) for available conventional foodstuffs. This problem is exacerbated by the high cost of feeding, and consequently, the resulting animal products. Increased competition for available conventional feeds and scarcity of food have both led to nutritionists, scientists and agriculturists having the need for research into the use of unconventional feedstuffs that are cheap, readily available and possibly substitute for more expensive protein (groundnut cake and soybean meal) and energy sources (maize) in the future (Onyimonony and Onukwufor, 2003; Obun and Adeyemi, 2012). Among possible sources of cheap protein are leaf meal from some plants such as cassava and processed animal by-products such as blood meal, epithelium scrapings, etc. (Adeyemi *et. al.,* 2018).

Cassava is traditionally grown for the production of roots. According to FAO (2020), Nigeria is the world's leading producer of cassava which produced 36.822, 42.533, 52.403, 57.564 million tonnes in 2009-2012 respectively. The roots are used as staple while its byproducts of leaves and peels are used for farmstead feeding of ruminant animals. It yields about 10 – 30 tonne ha^{-1} of leaves that is usually wasted or used as manure. The peels account for l013% of the tuber by weight (Tewe and Kasali, 2016).

Furthermore, harvesting cassava leaves once every two months does not have negative effect on root yield (Lutaladio and Ezumah, 2011). In animal nutrition perspective, cassava leaves and peel meals have been extensively utilized as individual ingredients in rabbit feeding (Agunbiade *et. al.,* 2004; Okonkwo *et. al.,* 2010). Cassava peel meal (CPM) serves as a cheap fibre source while Cassava leaves are rich in protein but both are low in sulfur amino acids (Phuc *et al.,* 2000 and Ayasan, 2010). The nutritive value of cassava leaf meal (CLM) has been reviewed by Lancester and Brooks (2013). West *et. al.,* (2018) indicated that the proximate composition of CLM is favourably comparable with the composition of other feedstuffs such as soybeans and maize. It is believed that the effective combination of the two (CPM and CLM) will result in a feed ingredient of high nutrient value but one likely to suffer from high crude fibre content if fed to animals that are unable to handle fibre such as the poultry species.

According to Cheeke (2011), numerous studies have shown that rabbits digest protein in forages quite efficiently but do not use the fibre fraction efficiently. It was explained that while the low digestibility of the fibre may at first seem to limit forage utilization but may be advantageous as they make efficient use of the 75-80% of forage that is non-fibre, and rapidly excrete the fibre fraction. Martín-Cabrejas *et al.* (2004) observed that fermentation significantly decreased the soluble dietary fiber (SDF) content of Phaseolus beans and cellulose content of all samples was reduced by natural and lactic acid fermentation.

However, rabbit exhibit preference for diets based on forages rather than animal protein or commercial/ conventional feeds, this makes it a manipulable dietary means of regulating cardio-vascular diseases and other body ailments in all aged people. Considering the protein, iron, folic acid and low fat, sodium and cholesterol content of rabbits, rabbit meat is very tasty, highly nutritious and readily acceptable to many consumers without any socio-cultural or religious taboo. It is regarded as delicacy in hotels, restaurants and bars as well as during ceremonies. Also, because of the medicinal importance of rabbit meat, it has been recommended for diabetes, whooping cough, reduction of high blood pressure, asthma, anemia obesity and good infant growth (North *et. al.,* 2020).

Due to the awareness on the nutritional importance of rabbit meat, there have been increased demand for, and consumption of rabbit meat especially during the Covid 19 pandemic period when there was food shortage during lockdown crisis with consequent sharp growth of the rabbit industry. Reports have shown that rabbit meat production has increased in recent years, but not in all regions of the world. The highest increase was noted in Asia, accompanied by a limited increase in Africa and a decrease in Europe, North America, and South America. In Europe, rabbit farming is concentrated in Spain, France, and Italy, representing around 80% of the total EU production (North *et. al.,* 2020; Daszkiewicz *et. al.,* 2020; H″ogberg *et. al.,* 2020).

The increasing demand for animal protein has encouraged greater interest in the production of fast growing animals with short generation interval. Domestic rabbit production which was neglected in the past has the potential of becoming an important source of meat protein. In recent years interest in rabbit production in Nigeria has increased dramatically (Anya *et al.*, 2010). The potential of rabbit production in alleviating the low animal protein intake in Nigeria and other developing countries especially those in sub-Saharan Africa needs no emphasis (Amaefule *et al*., 2005). In addition to the above mentioned facts there are no religious edicts preventing their production and consumption unlike pigs. The competition between man, animals and industries for conventional feed resources and the high cost of compounding concentrate and pelletized feed has been a major constraint militating against the increased production of valuable sources of animal protein (Animashaun *et al*., 2006; Ogunbajo *et al*., 2009). With the constant threat of hunger/malnutrition in developing countries there is an urgent need to source for nonconventional or alternative feedstuffs within our respective localities for incorporation into the diets of our farm animals at least cost. Such alternative feedstuffs should not be in great demand as human food or having any industrial use and should be readily available and not subjected to the dictates of season (Agwunobi *et al.,* 2002; Agiang *et al.,* 2004). Two of such feedstuffs envisaged that appears to fit into this description are cassava peel and cocoyam peel. Cassava is abundantly produced and processed in Nigeria. Cassava peels account for between 10-13% of the whole cassava tuber by weight. Nigeria is presently the largest producer of cassava in the world with about 50 million metric tonnes annually (Ogunjimi *et al*., 2010). However, this enormous feed resource is often discarded as waste and in most cases constitute environmental nuisance. This unconventional legume can be effectively utilized as supplement to low-nitrogen crop residues such as dried cocoyam peel. This study therefore investigated the growth potentials of growing rabbits feed on different levels of dried cocoyam peel meal based diets.

Materials and methods

The research was carried out at the Rabbitry Unit of the Department of Agricultural Education, School of Secondary Education (Vocational and Technical), Federal College of Education, Osiele, Abeokuta, Nigeria. Osiele (7^{0}10'N and 3^{0}2'E) is in Odeda Local Government Area of Ogun State, Nigeria. The experiment was conducted using 16 does and 2 bucks from each of the pure line and their crosses. These animals were raised between February 2022 and January 2023 in an experiment that lasted for 52 weeks.

Management of the experimental animals

The experimental rabbits comprised 20 each of four pure breeds; the New Zealand White (NZW) and the American Standard Chinchilla (CHL), New Zealand Red (NZR) and the FCEABK-ALPHA (K-α), a newly TETFund funded developed rabbit line were used for the study. These rabbit strains were sourced from the on-going TETFund funded Rabbit Breeding and Multiplication research farm, Federal College of Education, Abeokuta, Ogun State.Twelve lines inclusive of straight and reciprocal crosses were generated from the 4 x 4 di-allele crossing of these rabbit strains. The pure line served as thecontrol line to all the crosses. A total of 256 growing rabbits per strain averaging 10 weeks in age and 850g – 950g in body weight were reared till 20 weeks of age when the average body weight reaches 1450g) and used as parents.

Bucks and does from each genetic group were properly identified by ear tagging. The rabbits were housed in hutches. Each hutch has the following dimensions. Length – 144cm; width – 24cm / 48cm and height – 36 cm for both growers and breeder hutches. The hutches were raised on both wooden and metal standsabout 24cm above the ground. The rabbits in hutches were placed inside a low walled house built with wooden material and corrugated iron sheets as roofing material. The wooden hutches were covered to some extent with mesh that would permit inspection, ventilation and dropping of rabbit faeces and urine to the floor. Kindling boxes, feeding and watering troughs, made from concrete and clay respectively were provided inside the hutches. The rabbit and its surroundings were kept clean.

Data Collection:

Data on daily feed intake per strain in all the genetic groups were pooled together and average recorded on weekly basis. These were arc-transformed into percentages and used to compute and generate feed efficiency for both weaning and post weaning ages.

Statistical analysis

The effect of feed intake and feed efficiency on production parameters of rabbit strains was estimated from two-way analysis of variance with sub samples using General Linear Model of Statistical Analytical System (SAS, 2019). This further generated significant differences among the means using the model: $Yij = \mu + Ti + \Sigma ij$. Where;

Yij = Observed value of the dependent variable (productive traits)

μ = Population means

Ti = Effect of i^{th} strain (i= 1- 16)

Σij = Random residual error.

Significant differences among means were also separated. Correlations were computed using Statistical Analysis System (SAS, 2019). All effects except error terms were fixed.

Results

Least Square Means ±SEM of strain effect on performance traits in terms of feed intake and feed efficiency per rabbit kits per day at ages of 6, 9, and 12 weeks are presented in Table 1. Genotype (strain) significantly ($P<0.05$) affected feed intake among rabbit strains in the study. Feed intake increased with the age of the rabbits throughout the experimental period. Higher feed intakes were observed in Chinchilla X New Zealand Red, New Zealand Red X Chinchilla crossed and the New Zealand White pure line. This was followed by FCEABK- ALPHA (K-α) X New Zealand Red, New Zealand White X K-α and New Zealand Red X K-α while K-α had the least feed intake, in descending order of 78.10±0.00g, 77.90±0.60g and 75.88±0.00g; 70.00±0.00g; 70.00±0.00g, 69.10±0.00g and 68.76±0.12g; and 41.62±0.00g, 40.02±0.00g respectively at weaning age of week six. This trend persisted till week 12 of the study.

Feed efficiency statistically ($P<0.05$) increased with increase in age from week nine to week twelve although the increase was not consistent across the genetic groups and across the weeks. Higher values were recorded in FCEABK- α (K-α) X Chinchilla cross and K-αpure line closely followed by New Zealand Red X New Zealand White, New Zealand Red X Chinchilla and New Zealand Red X K-α in descending order of 0.17±0.01, 0.17±0.01, 0.16±0.07; and 0.15±0.00, 0.14±0.05 respectively. Same trend was also observed during the post weaning age.

Litter weight gain characteristics of growing rabbits in terms of average kits weight (AKW) also increased with increase in age of the rabbits across the genetic groups. Higher weights observed revealed K-α X Chinchilla and the K-α pure line having the values that ranged from 679.40±14.09g, 599.60±12.03g and 589.52±13.14g at weaning age to 1375.56±33.22g, 1331.50±46.74g and 1276.25±54.27g at post weaning age of 12^{th} week. Feed efficiency to a large extent had influenced the body weight gain of the rabbit across the genetic groups studied.

In some strains, it appeared that increased feed intake has brought about concomitance increase in feed efficiency. However, this was not true across all the genotypes, as some rabbits that consumed moderately low quantity of feed were noticed to have efficiently utilized it to produce higher body weight gain.

Table 1: Least squares means ± SEM of feed intake and feed efficiency of rabbit fed dried cocoyam peel meal.

GENOTYPE	N	FED INT (6)	FEDEFF (6)	AKW (6)	N	FED INT (9)	FED EFF (9)	AKW (9)	N	FED INT (12)	FED EFF (12)	AKW (12)
NZW	16	75.88±0.00^{a}	0.15+0.07	448.34±27.0.7^{bc}	15	100.58±0.00^{a}	0.14±0.08^{b}	871.01±13.36^{bc}	14	115.80±0.00^{a}	0.12±0.03^{bc}	1211.41±17.50^{b}
CHL	16	52.30±0.00^{cd}	0.16±0.09	397.38±26.08^{c}	13	88.69±0.00^{c}	0.16±0.01^{a}	811.07±11.82^{bc}	12	100.20±0.00^{ab}	0.18±0.07^{a}	1165.75±18.41^{bc}
NZR	16	56.30±0.00^{cd}	0.13±0.01	644.62±21.35^{ab}	15	85.30±0.00^{c}	0.14±0.06^{ab}	797.01±17.19^{b}	12	101.20±0.02^{ab}	0.13±0.08^{b}	1077.95±15.39^{bc}
K-α	16	40.02±0.00^{d}	0.13±0.08	666.75±25.05^{ab}	15	65.23±0.00^{cd}	0.10±0.05^{c}	977.81±15.77^{ab}	15	80.41±0.00^{b}	0.08±0.03^{cd}	1255.34±10.64^{b}
NZW X CHL	16	56.10±0.00^{cd}	0.16±0.01	408.98±28.94^{bc}	15	75.90±0.00^{cd}	0.16±0.06^{a}	851.89±14.18^{c}	18	101.10±0.00^{ab}	0.18±0.04^{a}	1164.70±12.85^{bc}
NZW X NZR	16	56.98±0.00^{cd}	0.13±0.05	416.67±17.47^{bc}	12	88.63±0.00^{c}	0.15±0.02^{ab}	805.87±10.34^{c}	12	109.60±0.02^{ab}	0.13±0.06^{b}	1137.83±18.75^{bc}
NZW X K-α	16	69.10±0.00^{b}	0.13±0.95	652.93±25.41^{b}	12	90.30±0.00^{b}	0.11±0.08^{b}	1068.17±10.26^{ab}	11	108.56±0.00^{ab}	0.09±0.01^{c}	1372.59±16.39^{ab}
CHL X NZR	16	78.10±0.00^{a}	0.15±0.01	399.67±26.79^{c}	12	99.86±0.00^{a}	0.15±0.02^{ab}	988.13±19.25^{b}	12	112.50±0.00^{a}	0.12±0.09^{bc}	1231.47±29.63^{b}
CHL X K-α	16	56.90±0.00^{cd}	0.15±0.01	393.24±24.29^{c}	14	78.13±0.00^{cd}	0.13±0.01^{abc}	830.24±11.29^{bc}	13	107.30±0.00^{ab}	0.12±0.06^{bc}	1192.16±12.60^{bc}
CHL X NZW	16	59.75±0.00^{cd}	0.15±0.01	393.44±24.00^{c}	14	81.20±0.00^{cd}	0.14±0.00^{b}	980.68±18.45^{c}	12	114.20±0.00^{a}	0.13±0.07^{b}	1155.20±15.83^{bc}
NZR X NZW	16	77.90±0.60^{a}	0.13±0.01	442.30±23.30^{bc}	14	85.70±1.50^{c}	0.15±0.00^{ab}	777.55±13.03^{c}	7	106.40±0.00^{ab}	0.15±0.01^{ab}	999.76±11.43^{c}
NZR X CHL	16	68.76±0.12^{b}	0.14±0.01	477.37±15.62^{b}	10	87.20±0.00^{c}	0.15±0.01^{ab}	779.03±13.04^{c}	8	107.30±0.00^{ab}	0.15±0.02^{ab}	1035.53±15.01^{bc}
NZR X K-α	16	60.20±0.00^{c}	0.15±0.01	435.56±18.79^{bc}	15	100.45±0.00^{a}	0.15±0.07^{ab}	908.15±13.16^{bc}	13	112.40±0.00^{a}	0.14±0.01^{ab}	1233.10±20.14^{b}

K-α X NZW	16	58.99 ±0.00^{cd}	0.13 ±0.06	658.80 ±21.46^{ab}	7	92.33 ±0.00^{b}	0.11± 0.07^{bc}	1074.61±10.25^{ab}	7	113.50 ±0.00^{a}	0.09 ±0.06^{c}	1369.10±16.79^{ab}
K-α X CHL	16	54.27 ±0.39^{cd}	0.13 ±0.07	456.76 ±27.85^{bc}	12	79.33 ±0.00^{cd}	0.14± 0.07^{b}	700.18 ±15.03^{b}	11	111.80 ±0.00^{a}	0.11 ±0.06^{c}	1277.26±34.08^{b}
K-αX NZR	16	70.00 ±0.00^{b}	0.15 ±0.01	459.52 ±12.91^{bc}	14	77.12 ±0.00^{cd}	0.11± 0.08^{bc}	1109.12±0.03^{ab}	14	112.80 ±0.01^{a}	0.12 ±0.04^{bc}	1360.88±13.26^{ab}

$^{a,b,c,d:}$ Means in the same column with different superscripts are significantly different (P<0.05)
FED INT (6) = Feed intake kitten^{-1} day^{-1} at weaning age of week 6 (g)
FED INT (9) = Feed intake kitten^{-1} day^{-1} at post weaning age of week 9 (g)
FED INT (12) = Feed intake kitten^{-1} day^{-1} at post weaning age of week 12 (g)
FED EFF (6) = Feed efficiency kitten^{-1} day^{-1} at post weaning age of week 6
FED EFF (9) = Feed efficiency kitten^{-1} day^{-1} at post weaning age of week 9
FED EFF (12) = Feed efficiency kitten^{-1} day^{-1} at post weaning age of week 12
AKW (6) = Average kits weight at post weaning age of week 6
AKW (9) = Average kits weight at post weaning ag e of week 9 (g)
AKW (12) = Average kits weight at post weaning age of week 12 (g)

Discussion of findings

Differences in feed intake and feed efficiency of various genotypes, as recorded in the results are both genetically and environmentally influenced. The feed intake increased with age across the genetic groups studied. Higher feed intake was noticed in New Zealand White and their crosses. This is due to their larger body size. Large bodied animals are known to consume large quantity of feed due to the large size of their caecca, and the high nutritional requirements needed to maintain their large body cells (Akanni *et al.,* 20189a). Environmental factors such as light, temperature, nutrition, diseases and social instinct (e.g. group feeding) have been found to influence the performance of rabbit. High temperature affects rabbits negatively, causing reduction in body weight resulting from lower feed intake in hot environment. Adejinmi *et al.* (2005) cited by Akanni (2012) reported that ambient temperatures above 30^{0}C decreased the amount and frequency of feed intake of 20-week-old rabbits. The average dietary intake at each diet changed very little between ambient temperatures of 10^{0}C and 20^{0}C, but at 30^{0}C the solid feed intake diminished from 5.6g to 4.4g for each diet and the liquid intake increased (Akanni *et al.,* 20189a). Nutrition of rabbits in terms of quality and quantity of feed also influence their feed intake. (Adjahossou *et al.,* 2017) had reported that the total feed intake of rabbit is largely dependent on the palatability of feed, the consistency and the crude fibre content. These authors also noted that with advancing age, rabbits compensate the low nutrient concentration of feed mixtures highs in fibre by a corresponding increase in feed intake.

The trend in feed efficiency observed among genotypes at different ages in this study showed that higher feed efficiency which resulted in heavier litter weights recorded in FCEABK- α (K-α), Chinchilla and New Zealand White and their crosses over other genotypes suggests that feed efficiency in pure and crossbreed rabbits is a function of breed/ strain differences. This therefore followed that feed efficiency to a large extent, is genetically influenced in rabbits, as recorded in K-α and its crosses. The genetic implication of this is that efficiency of feed utilization should be among the major factors to consider in terms of genetic characterization of pure and crossbred rabbits in the Humid and sub-humid climate. This is important because rabbits that are able to utilize low quality ration effectively for higher growth rate and greater productive and reproductive efficiency have better chance of survival when competition between man and animals for limited food is posing problems. (Adebambo 2008; Adebambo *et al.*, 2010; Akanni, 2012; Akanni *et al.*,2012). This could have informed the results obtained in this study.

Conclusion and Recommendations

Variations in the effect of feed efficiency on production showed that the rabbit lines all exhibited different breed advantages; this premised that standard selection procedures such as mass selection for feed efficiency should be employed for genetic improvement and better performance in rabbits.

Variations that existed in this rabbit population should be thoroughly exploited through crossbreeding and selection programmes. This is desirable in order to take advantage of heterosis.

Efficiency of feed utilization should be among the major factors to consider in terms of genetic characterization of pure and crossbred rabbits; as a sustainable pathway to addressing the challenges of climate change in animal agriculture in Nigeria.

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