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Review article

Use of non-classical feed resources and their influence on some performance indicators in rabbits

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ABSTRACT

Generally, it has been pronounced that the demand for animal products worldwide will drastically increase due to population boom in turn putting pressure on animal production systems. In view of meeting animal protein demand, suggestions have been put forward to the effect that mini-livestock production, which include rabbits should be part of the mainstream animal production strategies. However, it has been noted that commercial rabbit production has been adversely affected by the high cost of feeding and use of traditional feed stuff (grain and soya bean) that have direct competition with humans for food. There has been an unbearable continued increase in the cost of traditional feed resources (soya bean, maize, millet, groundnut, fish meal etc.) in the past decade, which in turn has led to exorbitant rabbit feed prices and consequently expensive rabbit meat and their products. This on the backdrop that feeding is a very critical aspect of rabbit production enterprise that influence overall performance (growth, mortality, reproduction, carcass and meat quality) in rabbits. In this aspect, it has been recommended to explore non-classical (alternative or non-traditional or non-conventional) feed resources to depart from exorbitant cost of feeding and the cost related influence of feed resources due to direct competition between rabbits and humans for food, while maintaining improved rabbit productivity. A series of studies have been carried out targeted on some local

non-classical feed resources on account of their nutritional values, as energy and protein sources in rabbits' diets. The inferiority and unbalance nutritive quality of some of the non-classical feed resources is a major challenge which restrict their successful use in rabbit production. Initial assessment of some non-classical feed resources has reported low nutritive value that distinctly depress voluntary feed intake and nutrient digestibility which in turn adversely affect weight gain in rabbits. However, some non-classical feed resources tested have shown marked potential as energy and protein substitute sources in rabbits' diets to enhance production. This point to the fact that successful use of non-classical feed resources can mitigate the current high cost and shortage of traditional feedstuffs, and also lessen the potential high competition between rabbits and humans on food. The purpose of this review is to discuss the use of non-classical feed resources and their influence on some performance indicators.

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1. Introduction

As a result of the direct competition between humans, rabbits and feed manufacturing industry, availability of traditional rabbit feed ingredients have been a challenge (Akinmutimi and Osuagwu, 2008) especially in developing countries. This scenario has been a catalyst for unattainable price upsurge on traditional feed resources which has forced the cost of production to account for more than 70% (Akinmutimi, 2004). In an attempt to reduce the cost of rabbit production, nutritional studies have refocused on testing local non-classical feed resources which are cheap and also characterized by low human preference and industrial usage (Olorede et al., 2002). In general, all livestock meat and their products can be made cheaper by utilizing non-classical feedstuff which have no direct bearing on humans as food (Asar et al., 2010). Bawa et al. (2008) are of the opinion that the increase in price and non-availability of traditional feedstuff is the major driver of the high cost of rabbit meat and their products, which has adversely affected large scale rabbit production. Diverse plant materials and industrial byproducts in different agro ecological regions of the world have been assessed for their nutritive potentiality as alternative feedstuff ingredients, these include: water spinach (Hongthong et al., 2004), whole cassava plant meal (Ainfala et al., 2003), wheat bran (Cunha et al., 2004), leucaena leaf meal (Tangendjaja et al., 1990), sweet potato fodder (Elamin et al., 2012), gliricidial leaf meal (Amata and Bratte, 2008), groundnut haulms and cowpea shells (Bawa et al., 2008), cassava tuber (Ekpo et al., 2009), rape seed (Gasim-Boubaker et al., 2007), paper mulberry (Inthapanya and Preston, 2009), olive pulp (Mehrez and Mousa, 2011), grass and legume combinations (Iyeghe-Erakpotobor et al., 2004), white lupin grain (Zwolinski et al., 2017) etc. the list is inexhaustible because the nature of local feedstuff depends on geographical ecological regions. However, it has been pronounced that non-classical feed resources such as forages may supply nutrients below the requirement for improved performance (Butterworth, 1967). The mediocrity due to nutrient imbalance of some of the non-classical feed resources is a major challenge which restrict their potential use in rabbit production. Ranjihani (1980) observed that 100 to 200g and 40 to 60g of green roughage and concentrate mixtures, respectively, may optimize production in rabbits. Sarhan (2005), Tag El-Din et al. (2002) and Ibrahim (2000) reported promising nutritive value assessment results with agricultural byproducts as non-classical feed resources. This was partly supported by Cheeke (1986) who acknowledged that rabbits can be favorably be reared on rations that are low in grains and high in roughage. The poor digestibility of grass based diets is ascribed to high fiber content, which is associated with the C-4 photosynthetic pathways (Raharjo, 1987). It is important to note that apart from legume forages, potential exist in other crop parts such as leaves, tubers, shells, peels, stems, etc. and grasses that have to be assessed to ensure satisfactory digestibility (Cheek, 1986). The purpose of this review is to discuss the use of non-classical feed resources and their influence on some performance indicators.

2. Non-classical feed resources, feed intake, digestibility and feed conversion ratio

Cheeke and Raharjo (1988) in their review on non-classical feed resources, concluded that tropical grasses were inadequate as an exclusive feed source for rabbit production due to their low digestibility which is less than ten percent. In contrary, Iyeghe-Erakpotobor (2007) observed the digestibility of crude protein was comparable higher in soybean forage than sweet potato forage. There was distinct relationship between forage intake and cost, which was not observed between concentrate and forage intake and digestibility. Supplementation of 10% white lead tree (*Leucaena leucocephala*) and 10% Siratro (*Macroptilium atropurpureum*) leaves registered improved daily feed intake which in turn increased weight gain in rabbits. However, increasing their levels to 20% resulted in a decline in weight gain and feed intake. The depressed weight gains and feed intake was probably due to the presence of antinutritional factors such as tannins in White lead tree (*Leucaena leucocephala*) and Siratro (*Macroptilium atropurpureum*) leaves. Generally, it is pronounced that antinutritional factors are predominant in most raw leguminous plant material (D'Mello, 1982). Baba (2003) assessing inclusion of palm press fiber on feed intake observed that feed intake were 78.7 grams per day, which was an improvement over 53.3 to 60.4 grams per day reported by Mohammed et al. (2011), however, significantly lower than 136.3 and 149.9g/j (Gidenne et al., 2009). There was partly increased in feed intake as the fiber levels increased from 5 to 15%. This was in consonance with recent reports by Djago (2010) who reported that feed intake was positively correlated with dietary fiber content. This partly agrees with report that inclusion of elevated fiber content is that it compromises dietary digestible energy level resulting in reduced efficiency utilization in growing rabbits (Gracia et al., 1993; Ortiz et al., 1989). Feed intake increased by 23% in a 50% pea by product diet (Zeweil, 1992), while also an increased was registered in rabbits fed mung bean hay and rice straw better than rabbits fed sugar beet pulp and sweet potatoes tops diets (Amber et al., 2002). Different studies have produced contradictory reports on the optimal content of dietary fiber, however, have agreed on the dietary inclusion of fiber in order to develop intestinal microflora that promote efficient digestion. Sweet potato foliage improved rabbit performance (Mutetikka et al., 1990) as compared with Rhodes grass which had depressed digestibility possible due to high fiber content. Bawa et al. (2008) observed a higher feed intake of rabbits fed groundnut haulms and cowpea shell based diets. The high feed intake was ascribed to energy density of the rations with proportionate increase in fiber content. This was in agreement with earlier observations that elevated fiber content tend to increase feed ingestion in rabbits (Jokthan et al., 2006). On the other hand, physiologically rabbits adjust their feed intake in order to suit their energy provision (NRC, 1977). It is also reasonable to suggest that various dietary fiber sources can influence voluntary feed intake based on the character of the fiber (Alawa and Amadi, 1991). Low dietary fiber protracts retention time of digesta in the ceacum affecting feed intake in turn adverse weight gain (Taiwo et al., 2005). Martinez et al. (2005) in a study of feeding lucerne hay substituted by mulberry leaves observed a higher retention time of digesta which translated into increased digestive content at slaughter in mulberry fed rabbits. The carcass weight of mulberry fed rabbits were longer compared to lucerne group, but were no differences in the weight of kidneys and thoracic viscera. In a similar study, 15% white lupin grain in a basal diet did not influence feed conversion ratio as compared to rabbits fed soybean meal (Volek and Marounek, 2009). By products of agricultural nature such as carrot top, corn cobs, dried watermelon, wheat bran, beet pulpo, pea pulp hay, pea hulls have registered improved feed conversion efficiency values in rabbit feeding (Genedy et al., 2000; Falcão-e-Cunha et al., 2004; Sarhan, 2005).

3. Non-classical feed resources and growth performance

Some studies have reported that utilization of non-classical feed resources such as agricultural by products did not have adverse effects on growth performance of rabbits: *Leucaena* leaf meal (Abd El-Galil et al., 2001), sugar beet and dried okra processed byproducts at 30% (Tag El-Din, 1996), sunflower cake at 21.6% (Ismail and Gippert, 1999), sweet potato leaves (Abonyi et al., 2012). A maximum of 15% palm press fiber content in the diet improved moderately rabbit growth performance without any detrimental effect on survival (Houndonougbo et al., 2012). Mature body weights ranged from 1718 to 1805g which was comparably to 1746g observed in local rabbits in Tunisia (Hamouda et al., 1990). Eiben et al. (2012) suggested that apple and carob pulp can be efficiently used in rabbits weaning diets principally because they improve health. 4% CP in carob pulp diet was associated with high digestible sugars, nature of fiber and presence of antioxidants. Use of carob pulp had the benefit of improved digestibility and health (Teillet et al., 2011). In contrary, reduced growth rates with 14% apple pulp were observed in rabbits when used in high ratio to substitute wheat straw and alfalfa hay (Alvarez et al., 2007). Rabbits fed sun

dried corn plant as a replacement for clover hay grew comparably to those of the control (El-Sayaad, 1997). Dietary replacement of sugar beet pulps up to 15% had no adverse effect on growth (Garcia et al., 1993). Watermelon by product influenced growth as compared to the control when supplemented at 12% level (Genedy et al., 2000). White lupin seed was a good enough dietary crude protein source for lactating does without an adverse effect on feed intake and performance (Volek et al., 2014). The white lupin seed is a promising protein source with the capacity of improving meat and milk fatty acid profiles in rabbits. On the other hand, it has an enhanced nutrient digestibility, which augers well with solutions to reduce rising conventional feed costs. Lukerfahr et al. (1983) observed that a diet constituting 74% Alfalfa improved feed intake as compared to a commercial diet. Concentrate and forage influenced positively on nutrient intake and availability resulting in improved kits growth during pre-weaning phase (Effiong and Wogar, 2007). It is important to note that there is need to establish the tradeoff between use of conventional and non-classical feed resources. Feeding cassava meal and cassava peel meal enhanced growth in rabbits when used at levels of up to 30 to 40% of the diet (Omole, 1990). In agreement, Radwan et al. (1985) reported improved growth rates of 41g per day of rabbits fed cassava meal (50%) substituted for barley. In contrary, Reed et al. (1982) observed the existence of anti-nutritional factors, such as tannins and cyanogens in cassava, which are associated with poor performance in rabbits. Tannins and cyanogens may also reduce palatability (Raharjo, 1987) and suggested that compound diets have a dilution effect on these anti-nutritional factors. Supplemented fish meal due to its good protein quality than groundnut meal registered improved growth rates in rabbit kits (Omole and Sonaiya, 1981). Strychalski, Juśkiewicz et al. (2014) and Gugolek et al. (2015) observed that at 5% replacement level of soybean meal with rapeseed cake did not influence any changes in body weight gain, feed conversion ratio of rabbits. Growth performance of rabbits fed with alfalfa wheat bran diet (16% CP) were similar to those fed soya bean meal (21% CP) (Raharjo, 1987). It was demonstrated that pea grain or meal can be included in rabbit ration to as much as 30% without an adverse effect on body weight gain and feed conversion efficiency and dressing percentage (Castellini et al., 1991). Clemence et al. (2002) experienced depressed weight gain in rabbits fed rapeseed diet rabbit weight loss which was ascribed to compromised metabolic nutrient utilization as opposed to nutrient digestibility. This was partly supported by Gidenne and Perez (2000) who observed that nutrients and energy from rations which differed in fiber and starch levels were comparatively digestible. In a similar study, mulberry leaves improved feed intake and digestibility and considerable weight gain (Bamikole et al., 2005). This observation is supported by earlier report that mulberry leaves are a rich source of protein and minerals, however low in fiber content (Omar et al., 1990) and the protein quality is similar to soybean meal (Marchii, 1989). Water spinach leaf meal could substitute groundnut cake at 12% content without negative influence on rabbit performance (Wafar and Tarimbuka, 2016). On the same note, Yakubu and Wafar (2014) confirmed that leafy meals can improve growth performance due to its appropriate nutritive value as good sources of protein, vitamins and minerals.

4. Non-classical feed resources and carcass and meat attributes

Feeding is a very critical aspect of rabbit production enterprise that influences various properties of meat quality. This is on the backdrop that consumer oriented demands in health meat has made producers focus on appropriate nutritional forms of rabbit rearing. Sun dried cassava peel meal and retted cassava peel meal registered improved live, slaughter and dressing percentage than ensiled cassava peel meal. In addition, prime cuts (shoulder, loin and leg) were significantly low in ensiled cassava peel meal compared to the other cassava portions (Olafadeham, 2011). Growing rabbits fed ripe plantain and yam peels improved primal cuts and other carcass portions (Idowu et al., 2006). Chikaodi et al. (2017) assessing the contribution on dressed carcass, reported that internal organs were not influenced by dietary sweet potato vine level. Dressing percentage was depressed by inclusion of sweet potato vines at 30%, while supplementing with high levels of lysine. However, dressing percentage of 45.81 to 77.08% were registered, which were higher than those observed by Jegede et al. (2006) of 30.83 to 32.88%. It was demonstrated that pea grain or meal can be included in rabbit ration to as much as 30% without an adverse effect on body dressing percentage (Bonomi et al., 2003). The author concluded that pea meal is an important non-classical feedstuff with adequate nutritional value to replace soybean meal. Elsewhere, Lounaouci-Ouyed et al. (2014) disagreed on the inclusion of 30% level of pea meal as it did not influence growth or feed intake, however significantly improved conversion ratio.

Apart from rabbit carcass portions being influenced by quantity and quality of non-classical feedstuff, meat quality attributes such as physicochemical properties dressing yield, meat: bone ratio, protein: fat ratio, fatty acids

profile, pH, meat texture etc. are also affected (Kandeepan et al., 2009). Feeding high content of sugar beet pulp (46%) greater weight of gut content was registered and, as a result, a depressed liver weight and dressing percentage was observed (Falcao-Cunha et al., 2004). A rabbit non-classical ration of forage and grain milling by products, without cereal grain and protein supplementation improved meat quality (Raharjo, 1987). Cassava leaf meal sustained carcass properties when fed up to 40% level in growing rabbit diets (Ravindran et al., 1986). The relative digestive weight tract weight was not influenced by palm press fibre level. However, carcass abdominal fat slightly increased with higher level of 15% compared to no fiber diet. Due to fat level changes in the diet can speculate that palm press fiber level influences carcass quality (Houndonougbo et al., 2012).

5. Implications

In the past decades, the precarious trend in rising of rabbit commercial feed cost have desperately redirected nutritional research approach, towards testing the feed value of non-classical feed resources to escape from the rising cost of traditional feedstuff. It is important to note that rabbit production as one of the strategies in enhancing large volumes and high meat quality at affordable prices is facing production challenges due to high cost of feeding. Generally, it has been pronounced that feeding cost solution should be derived from inclusion of non-classical feedstuff in rabbit diets. The major focus is to test the nutritive value of available local feed resources that seem not important to man, but could be useful in provision of adequate nutrients to replace traditional feedstuff in rabbit production. Until now, various non-classical feed resources are being tested for their potential replacement or supplementation feed value in rabbit production. The nature or choice of the non-classical feed resources tested will depend on its availability in a particular ecological region. This on the backdrop that the viability and financial gain derived from commercial rabbit production, has mainly been underpinned on feed cost reduction, which essential consider available supplementation of protein and energy at a cheaper cost. The sufficiency of dietary energy and protein in rabbit production is crucial in order to enhance production in developing countries. A series of nutritional studies have ascertained that some non-classical feed stuffs could be better substitute as energy and protein sources in rabbit's diets, as well as their ready availability and predominance, cheapness and better economic gains to rabbit producers. However, in this respect the nutritive quality of some of the non-classical feed resources has been questionable and pose a major challenge which limit their effective utilization in rabbit production. However, researchers in rabbit nutrition are totally in agreeable that exploring the nutritional value of alternative feed resources is a viable option in eliminating the high cost of feeding emanating from the high competition between rabbits and humans for food, while maintaining improved productivity. Caution should be taken in utilization of some non-classical feedstuff e.g. raw legume based material due to the presence of antinutritional factors which can adversely affect rabbit performance. Despite this phenomenon, utilization of non-classical feedstuff of low economic significance would be a step towards better rabbit feedstuff resource mobilization and a viable option to curtail high production costs. This auger well within the context of sustainable rabbit production, which promote matching rabbit production with locally available and cheap non-classical feed resources.

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