ROOT AND TUBER CROPS AS AN ALTERNATIVE DIETARY ENERGY SOURCES FOR POULTRY- A REVIEW

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Abstract

Tuber crops are staple food in many parts of the tropics, being the source of daily carbohydrate intake for large population of man and livestock. These carbohydrates are mostly starches. Found in storage organs, which may be enlarged roots, corms and tubers. Due to high cost of conventional energy sources in animal feed, efforts are being made towards developing alternative sources of energy in the area of utilization of tuber meal. The tubers examined were cassava (*Mannihot esculentum*), sweet potato (*Ipomoea batata*) and cocoyam (*Colocasia esculetum*). It was found that cassava root meal replaced up to 30% of maize without detrimental effect on the growth performance of poultry. Also cassava sievate meals are included up to 20% in the starter cockerel diet. Sweet potato meal is included up to 38.73% in the diet of Japanese quail, cocoyam could replace maize up to 30% for finisher broiler. For more efficient utilization of the tuber meals, effort should be geared towards sourcing the best processing technique like decomposing directing by heating them above a temperature of 150^0c. Crusting the tubers to allow greater interaction and microbial detoxification that will ensure reduction in the levels of anti-nutritional factor such as hydro cyanide (HCN) in cassava and calcium oxalate in cocoyam and pelleting the tuber meals to reduce dustiness.

Keyword: Root, tuber crops, alternative, energy and poultry

Introduction

Root and tuber crops as an alternative dietary energy sources for poultry

Diet can be defined as feed ingredients or mixture of ingredients which when consumed provides the animal with nutrients (Atteh, 2002). The word diet is at times used interchangeably with the term ration. There are four main components that go together to make up a poultry diet. While protein, vitamins and minerals are referred to as nutrients energy the fourth and most costly part of the diet is not a nutrient but the property of energy yielding nutrients. Dietary nutrients that yield energy are protein, fat and carbohydrates (Summers, 2000). Energy feed sources (maize and sorghum) are expensive feedstuff, constituting about 40-60% of the formulated poultry diets (Ojowola and Olugbemi 2011; Okereke *et al*., 2015). The incessant increase in the cost of maize is brought about by the declining production and the stiff competition by industries, man and his livestock for its use (Agbede *et al*., 2002; Hamzat *et al*., 2003). The livestock producer appears most hit in terms of serious scarcity and high cost of feed (Babatunde *et al*., 1975). With the present trend of rising prices of animal feed stuff all over the world, greater attention is being paid to the search for safe, cheap and locally available feedstuff (including unexplored feed-stuff, by–products of agriculture and industry) especially in the developing countries that cannot afford the expensive diets for livestock. Nigeria, like most other developing countries suffer greatly from a constant shortage of livestock feeds, especially those supplying protein and energy (Babatunde *et al*., 1975; Okereke *et al*., 2015). Limitation imposed by scarcity of maize and completion with human consumption have forced many farmers into employing alternative sources of energy for poultry feed formulation, Such alternatives include feeding of farm by products (rice-husk ,maize straw, cocoa pod, maize –cob, etc) and effort had also been geared towards the utilization of relatively cheaper and available root tubers in recent years. The paper is therefore aimed at evaluating the progress made so far in the use of root and tuber crops and to articulate the various problems being faced and the way out, primarily for the advancement of poultry industry.

Cassava (*Manihot esculenta crantz*)

Cassava is used in West African as a cheap source of carbohydrate food for man and livestock (Oyenuga, 1968). The metabolizable energy value of cassava unpeeled cassava root meal (3870kcal/kg) is higher than that of maize 3430kcal/kg (Tion *et al*., 2000) previous studies have shown that peeled cassava root meal could be used effectively for broilers and layers (Vogt, 1966;

Ademosum and Eshiett, 1980; Tewe and Egbunike, 1992; Erubetine, 1994). However, the low protein content (Yeoh, 1971) and the dustiness of the feed (Oke, 1978) are among the major setback in the use of cassava root meal. The success of using it as a substitute for maize therefore depends largely on the availability of an excellent source of protein (with sufficient methionine to meet both the body requirement and cyanide detoxification) (Okereke, 2017). Erubetine and Oguntona (1997) showed that unpeeled cassava root meal (URCM) could be included at levels up to 30% in diets for layers throughout the laying period (40 weeks) without any detrimental effects. Consequent upon the continued search for alternative source of cheap feed ingredient in poultry production, CPM (cassava peel meal) could successfully be used in starter diets and finishers diets at 30% and 60%, respectively (Babatunde *et al*., 1975; Okereke *et al.,* 2015). Tion and Adeka (2000) also demonstrated the beneficial effect of using cassava root meal to replace up to 30% maize in a broiler diet while attempts are made to reduce the dustiness through the addition of oil and supplementation with adequate levels of methionine and lysine. According to Akinola and Oruwari (2007) cassava root meal is capable of totally replacing maize in diet for laying hens. Edache *et al.* (2007) reported that 35% cassava root meal based diet is recommended for growing Japanese quail. Nwokolo *et al.* (2000) from his study showed that cockerel starter birds could tolerate only about 20% level of cassava sievate in their diet (Table 1). Onwujiariri *et al.* (2008) revealed that wet maize milling waste and cassava root sievate could effectively replace maize up to 35% of the diet without adverse effect on growth and feed utilization on finisher broilers.

Table 1: Performance characteristics of cockerel starters feed the experimental diets Cassava sievates meal between 0 and 8 weeks

	Diets (percent inclusion)				
Parameter	0%	20%	40%	80%	100%
Initial live weight (g/bird)	31.64	31.69	31.92	32.19	31.15
Final live weight (g/bird)	753.16	666.75	618.00	461.60	406.25
Weight gain (g/bird/day)	12.85^{c}	11.25^{c}	10.48^{b}	8.23^{b}	6.70^{a}
Feed intake (g/bird/day)	33.18^{b}	38.46^{c}	36.07^{c}	29.59^{a}	34.35^{b}
FCR	2.58^{a}	2.97^{a}	3.44^{b}	3.60^{b}	5.13^{c}
Nitrogen retention (%)	64.24^{a}	69.05^{b}	72.18^{c}	72.11^{c}	73.12^{c}

Source: Nwokolo *et al*. (2000)

Sweet potato (*Ipomoea batata)*

The fresh tuber of sweet potato consists of about 60-70% water and 15-25% starch. The tuber can be fed to livestock either in the fresh form or in the form of chips (Onwueme *et al.*, 1991). The sweet potatoes tuber (*Ipomoae batata)* as an energy source for poultry is perhaps the most studied, Yoshida *et al.* (2001) stated that recommended level of inclusion of oven dried potato flour in livestock/poultry rations are 10% for layers, 12% for starter broiler, 18% for finisher broiler and 17% for weaner and grower pigs. Shoremin and Job (2000) revealed that sweet potato at a substitution of 45% can safely replace maize in pullet mash. Onyekwere *et al.* (2008) studied that sweet potato root meal, improved its value to the extent that 20% dietary inclusion of the meal produce no adverse effect on broiler starter. In a related study, Maphosa *et al.* (2003) carried out a study on the use of raw sweet potato tuber meal as an ingredient in broiler diets and concluded that, it should not be added to broiler starter diets but could be added to 50% inclusion levels in finisher diet without affecting the performance of the birds. The tube is rich is diatose. The carbohydrate of sweet potato is highly digestible and soluble. It is low in fibre and consists predominantly of starch between 4-7% which occurs as sugar (Tewe, 2001). Also, high reducing sugar in sweet potato tuber and flour causes diarrhea at high levels, thus limiting inclusion rate in livestock rations. The use of non-sweet clone is therefore recommended (Tewe, 2001).

Table 2: Effect of different sweet potato meal level on mean feed consumption, weight gain and feed/weight gain ration of quail chicks at 6 weeks of age

Parameter	A (0%)	B (13.73%)	C (23.73)	D (38.73%)	SEM
Initial weight (g/bird)	9.03	8.78	9.03	8.93	± 0.112
Final weight (g/bird)	131.03	139.28	130.40	131.40	± 6.52
Feed consumption (g)	702.10[a]	818.62[b]	688.59[a]	689.96[a]	± 7.20
Weight gain (g)	122.00	130.50	121.37	122.15	± 4.42
Feed cost (₦/kg)	6.67	7.61	6.12	6.26	± 1.43
Cos/kg gain (₦)	97.87[a]	94.23[a]	104.94[a]	134.81[b]	± 24.47

Source: Edache *et al*. (2009)

Edache *et al.* (2009) revealed that 38.73% dietary sweet potato will support acceptable growth performance for Japanese quails Table 2 above.

Cocoyam

In many part of Africa, the term cocoyam is used to refer collectively to members of the genus *Colocasia* and *Xanthosoma* which are used for food and feed, when referred to separately, *Colocasia* species are called taro while *Xanthosoma* species are called tannin. Wild cocoyam (*Caladium bicolor)* is a neglected high moisture tuberous root stock; it is not directly consumed by man and equally of no industrial use as at now. Available literature on the feeding of wild cocoyam to finisher broilers suggests that it is a satisfactory energy ingredient at up to 20% of the whole ration (Esonu and Bamgbose, 2000, Onu *et al.*, 2001). Abdulrashid and Agwunobi (2009) revealed that cocoyam meal with proper processing will effectively replace maize at 50% level of inclusion as a major source of energy in finishing diet of broiler birds for maximum profit (Table 3). However, its use in the feeding of monogastric animal could be encumbered by the presence of some anti-nutritional factors (calcium oxalate, tannins and trysin inhibitions) which adversely affect protein and energy utilization in broilers (Sebastian *et al,* 1997; Onu *et al,* 2001).

Table 3: Performance of broiler finisher on varying levels of boiled tannin cocoyam meals

	Dietary treatments levels			
Parameters	0%	25%	50%	100%
Average initial live weight (g)	508.00	550.00	558.00	575.00
Average final live weight (g)	2830.00	2550.00	2690.00	2000.00
Average daily feed intake/bird (g)	167.86	172.14	155.24	151.19
Average daily weight gain/bird (g)	55.00	57.38	50.95	31.67
Feed conversion ratio	4.4	3.86	7.71	13.57
Mortality	0	1	0	1
Cost of production				
Average cost of feed ₦/kg	51.13[a]	48.97[a]	46.81[a]	42.49[b]
Average cost of daily feed intake	8.58	8.43	7.27	6.42

Source: Abdulrashid and Agwunobi (2009)

Mean within the same row bearing different superscripts (a-b) are significantly ($P<0.05$) different.

Anti-nutritional factors (ANFs) are substances that when present in animal feed they either by themselves or through their metabolic products reduce the availability of one or more nutrients.

Anti-nutritional factors present in root and tuber crops are as below

Phytate:

Phytic acid interferes with the utilization of mineral element. It forms compounds which are not readily broken down, thus reducing the absorption of the metal (Oberlease, 1973)

Hydrocyanic Acid:

When a high level of hydrogen cyanic acid is injected by man and/or animals, it will react rapidly with metal ions such as Fe^{++}, Cu^{++} and Zn^{++} in the blood. The hydrocyanic acid then combines with the iron in the heamoglobin of red blood cells to form a complex called cynohaemoglobin. This complex causes the haemoglobin to lose its oxygen carrying capacity in the animal body. Hydrocyanic acid can also combine with copper of the cytochrome oxidase and thereby inhibit its oxygen carrying capacity (Omeje, 1999)

Tannins:

Tannins are poly phenols non-nitrogenous plant toxins. They are important group secondary metabolites found in higher plants (Roberts. 1981). Vohra *et al.* (1966) reported that 1% of tannin brought growth retardation in chicks due to difficulty in breaking down protein-tannin complexes and they pass out in the faeces.

Oxalate:

It forms a complex with the minerals resulting to an insoluble complex compound, example calcium oxalate which causes irritation of the body and gut in raw cocoyam thereby resulting in low feed intake. It can also result in deficiency of calcium, leading to poor bone formation and energy metabolism particularly regulation of pyruvate dehydrogenase complex enzymes in the conversion of pyruvate to acetyl-coA (Robert *et al.*, 2003). The presence of toxins, inhibitors and anti-nutritional factors in food and feeding-stuff is a problem that limits their maximum utilization.

Processing technique for cassava and cocoyam

Root and tubers are traditionally processed by a wide range of methods which reduce their toxicity, improve palatability and convert the perishable fresh root and tubers into stable products. These processing methods consists of different combinations of one or more of

Peeling: In this you remove the outer part of the tuber.

Chipping: In this you cut those tubers into smaller size to increase the surface area.

Grating → soaking → drying → boiling → fermenting are all detoxification steps.

Three other methods of detoxification

i. Decomposing directly by heating them above a temperature of 150^0c

ii. Crushing the tubers to allow greater interaction

iii. Microbial detoxification, sometimes a combination of (i) and (iii) methods above can be used in order to be assured of the safety of the root and tuber products (Omeje, 1999). While all these processing methods for cassava is geared toward reducing the cyanide level and for cocoyam reducing the oxalate effect. For cassava sun-drying of cassava chips has been shown to reduce the cyanide concentration to lower than 10mg/100g (Mahungu *et al.*, 1987) and 100ppm (Tewe *et al.*, 1980*)*

CONCLUSION AND RECOMMENDATION

Cassava, potato, cocoyam should be pelletized in other to reduce dustiness and eliminate irritation of the respiratory organs and eye infection and ensure an optimum feed intake. Cassava, potato and cocoyam crops diet must be formulated with more care than cereal based diets. Great attention must also be paid to the balancing of limiting amino acids, essential fatty acids linoleic acid, especially for laying hens. Basic minerals and micro elements (such as zinc and iron) and vitamins also need to be considered. Finally, tuber crops yield in terms of dry matter per acre is high when compared to maize. If properly handled, it will successfully replace maize in animal diet.

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