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Review

Review: Cassava (*Manihot esculenta*) use in chicken nutrition

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ABSTRACT:

The characteristics of cassava root and the issues and considerations included when utilizing it in poultry diets were reviewed. A high starch content and a low level of protein and amino acids are cassava's principle nutritional qualities. In any case, when cassava root meal is utilized as a part of poultry feeds, different elements ought to be thought about, including cyanogenic content, high concentration of potassium and silica, absence of carotenoids and dustiness. Cassavas typical rate of incorporation in poultry feeds in the European Union is around 25%. The incorporation of cassava root meal in poultry diets rely upon the cost and accessibility of energy and protein sources, synthetic amino acids and pigments.

Keywords:

Cassava (*Manihot esculenta*), Cyanogenic glucosides, Poultry.

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INTRODUCTION

The utilization of cassava (*Manihot esculenta*) as animal feed is very old. In tropical Africa the peels are utilized as feed for ruminants. Numerous examinations have been done to assess replacement of cereals with cassava in poultry feeds. These showed broad differences in feeding value, nutritional issues, and productive performance. The highest level of cassava root meal in broiler feeds regimen has gone from 10% (Osei and Duodu, 1986) to 30% (Gomeq *et al*., 1987) and as high as 40 to 60% (Christensen *et al*., 1977). A comparative range in the level of incorporation is found in the feeds of laying hens, with the cassava addition level extending from 15% of starter feeds (Thirumalai *et al*., 1990) to 30 or 40% in the layer diets (Iyayi and Tewe, 1994). This variation has been because of contrasts in numerous factors that will influence its incorporation in poultry feeds, for example, nutritional factors, cassava root preparing strategies, and nutritious and physical elements.

Cassava is grown in the tropical regions of in Africa, Asia, and Latin America, with 70% of the world's cassava generation originating from Nigeria, Brazil, Thailand, Indonesia, and the democratic Republic of the Congo. Cassava root could be utilized to produce cassava chips, cassava pellets, and cassava starch, which are sought all through the world. Thailand, Indonesia, and Brazil are the most noticeable exporters of cassava starch, with their generation representing 95% of the world's supply (FAO, 2008). Cassava pulp is a solid by-product during cassava starch production, representing approximately 10 to 15% of the original root weight. As cassava starch production increases, a vast volume of wastes are produced. In Thailand, not less than 1 million tons of pulp is produced every year. Subsequent to drying, a portion of the by-product is utilized for compost or is incorporated into diets for ruminants and swine. Anyhow, a wealth of by-product still remains. Cassava pulp contains 69.89% starch, 1.70% ash, 1.55% CP, 27.75% CF, and 0.12% EE on a Dry Matter (DM) basis (Khempaka *et al*., 2009; Sriroth *et al*., 2000). The fiber substance of Dried Cassava Pulp (DCP) is apparently in the form of insoluble fiber. Suksombat *et al*. (2007) stated that the fiber components of DCP as 36.7% neutral detergent fiber, 9.8% acid detergent fiber and 3.9% acid detergent lignin.

Regarding to the practical utilization DCP as poultry feed, the high fiber content is an undeniable concern. Large amounts of fiber, bulkiness and dustiness in DCP are conceivable factors prompting reduced growth performance and edibility. A solid negative relationship between the fiber portions and nutrient digestibility has been accounted for the past investigations (Hetland *et al*., 2005; Hetland and Svihus, 2001). It has additionally been accounted for poultry diets with high fiber levels that have decreased performance and abnormal fat contents. The length and weight of the digestive organs are also modified (Eruvbetine *et al*., 2003; Eruvbetine, 1995). Despite the fact that the fiber level of DCP is tricky, its content is additionally made out of a high quantities of starch. Thus, it is unquestionably worthy to research the utilization of DCP as an energy source for poultry, and the literature is very limited. Hence, the aim behind this examination was to assess the impact of DCP on Body Weight (BW) gain, Feed Intake (FI), Feed Conversion Ratio (FCR), carcass traits, digestive organ weight and length, and nutrient digestibility in broilers.

Dried cassava pulp contains starch that could be utilized as a energy source in the poultry feeds. Increasing DCP up to 8% did not altogether impact BW when contrasted with the control treatment (without DCP). The decrease in BW was doubtlessly because of the high fiber substance of DCP (13.59%). Numerous past examinations have announced that a high-fiber content feeds that can discourage FI, and thus can cause suppressed growth (Hetland *et al*., 2003; Hetland and Svihus, 2001). The decrease in FI in the 14-to 35-day period by incorporation of 12 and 16% DCP could be be-

Table 1. Influence of Cassava Root Meal (CRM) inclusion and rate of drying on performance and behavior response of broiler chicks fed pelleted diets (0-14 days) (Courtesy: Panigrahi *et al*., 1992)

S. No	Main effects[A]	Daily gain (g)	Food intake (g/day)	Food spillage (g/kg intake)
1	CRM[B] (%)			
2	0	323	406	4.4
3	25	305	369	7.7
4	50	298	257	36.2
5	Rate of drying			
6	Fast	189	253	37.6
7	Slow	298	373	6.2

[A] Significance of concentration and dry effects, and interaction: $P < 0.001$.
[B] Total cyanide content: fast-dried cassava, 481.7 mg/kg; slow-dried cassava, 38.4 mg/kg.

cause of the expanded bulkiness of the feed and restricted digestive tract capacity in broilers. Moreover, the increase in bulk has additionally been accounted to lessen palatability (Weiss and Scott, 1979) and in this way we may confine the FI of broilers. Despite the fact that data on utilizing DCP in broilers were constrained, the results of analyses with broilers fed different levels of cassava have been broadly detailed (Muller *et al*., 1974; Oke, 1978). Researchers abridged that when cassava was given in mash form at all levels, less growth and feed conversion were acquired than with corn-based feeds. Anyhow, similar performance was gotten when the feeds were pelleted (Muller *et al*., 1974; Oke, 1978). Hence, offering DCP in pellet shape may defeat the issue of bulkiness and guarantee an ideal FI by poultry. Moreover, DCP is low in protein (roughly 2% of DM) and lacks carotene contents. Hence, incorporation of DCP in eating methodologies should mull over these elements.

There were no huge contrasts in the percentage for carcass characteristics. It was found out that broiler fed a diet containing DCP showed a decrease in stomach fat. The loss of body fat might be related with the restraint of lipid synthesis in the liver and abdominal tissues due to the high fiber content in the test feed. In light of the low DM and OM digestibility recorded in the tests in broiler fed DCP diets it was estimated that this would likewise bring about poor digestibility of fat (discussed below). Akiba and Matsumoto (1982) found that chickens fed on a diet with high fiber (cellulose and alfalfa meal) had significant decreases in lipid deposition and plasma lipid content and had quickened lipoprotein activity in the fat tissue. This was similar to the reports of Eruvbetine *et al*. (2003) and Eruvbetine (1995), who announced that for broiler and layers fed diets high in cassava, broiler had a decreased abdominal fat content at advertise weight, and layers had a lessened stomach fat substance after 40 weeks in lay. An extra conceivable factor in the decrease of fat deposition might be related to the reduction in energy intake, and consequently decreased energy accessible for fat deposition. This outcome concurs with the report of Latshaw (2008), who found that in diets containing comparable levels of energy and protein yet a fluctuated fiber content, expanding levels of fiber caused extensive declines in ME intake. The fiber contained in DCP is to a great extent insoluble. As of late, a few examinations have been directed to analyze insoluble fiber sources as functional foods for people and animals (Raupp *et al*., 2004; Khempaka *et al*., 2009).

Depressed performance of cassava-fed chickens were reported several years back (McMillan and Dudley, 1941). Cassava cultivars contain different measures of cyanogenic glucosides, and are named % “bitter” or "sweet" in view of the level of these compounds. The cyanide level shifts from about 75 to 350 ppm, however can be 1000 ppm or more (Piva, 1987), relying upon the variety, plant age, soil condition, manure application, climate, and different factors (Gomez and Valdivieso, 1983). Notwithstanding, the utilization of new varieties with a low cyanogenetic glycoside content is progressively normal.

Very toxic Hydro Cyanic Acid (HCN) is discharged from the cyanogenic glucosides amid hydrolysis by the catalyst linamarase (present in the root peel of cassava), by the glucosidic enzymes of intestinal microflora (Fomunyam *et al*., 1984), by acid hydrolysis in the digestive system (Casadei, 1988), and by glucosidases of the liver and different tissues (Padmaja and Panikkar, 1989). The respiratory procedure in animal tissues is impeded by HCN through de-activation of the cytochrome-oxidase enzyme system (Pudek and Bragg, 1974). In spite of the fact that this response is reversible, at high dosages it can prompt a buildup of lactate in the brain that will cause degeneration (Smith *et al*., 1963). The HCN is changed in the liver by the enzyme rhodanese to thiocyanate (SCN), which is discharged in the urine (Oke, 1973). This detoxification procedure uses sulfur from methionine (Jalaludin and Ltong, 1973), expanding the necessity for this amino acid. The level of methionine required for detoxification depends of the quantity of HCN ingested. On the off chance that the bud's methionine necessity is fulfilled, at that point different sources of sulfur could be utilized for detoxification (Adegbola, 1977).

Chronic cassava toxicity in chickens has been accounted for bringing down egg quality and production in layers (Jalaludin and Ltong, 1973) and lessen shell thickness and hatchability of eggs (Omole, 1977). Stevenson and Jackson (1983) announced that cassava root meal resulted in growth depression when incorporated into the feed at 486kg. Moreover, weight was unaffected by diet containing 50% cassava root meal. In any case, the excreta were sticky and the authors viewed the meal as reasonable just up to a level of 30%. Panigrahi *et al*. (1992) revealed that the cyanogen substance of the feeds may discourage performance at concentration of less than 140mg total cyanide per kg. They additionally recorded watery excreta and higher feed spillage - a behavioral reaction identified with the cyanogen content of the diet (Table 1). Gomez and Aparicio (1988) reported that performance of poultry on cassava diets was acceptable if the HCN content in the final ration did not surpass 100ppm. Cyanide content of 83m/kg did not influence chick growth. Such proportions must, in any case, be nutritionally adjusted, particularly as far as energy and essential amino acids.

Cassava is handled by different strategies to decrease toxicity and enhance palatability and storage qualities. Processing techniques fluctuate extensively from area to area, however all seek to decrease the toxic cyanoglucosides to a safe level. The processing methods for cassava tubers include peeling, boiling, steaming, roasting, fermenting, and drying. Drying is the most well-known practice to decrease cyanide in numerous tropical nations. Since the time of linamarase contact with the glucosides is higher with sun drying, this strategy disposes of the cyanide more adequately than oven drying. Thinner chips may hold more cyanide than thicker chips in light of the fact that the latter dry more gradually. Before sun drying, crushing the tubers enhance the contact surface and can thoroughly eliminate cyanide. Boiling cassava chips in water likewise expels an apparent amount of cyanide. Post cooking, as opposed to sun drying, thin chips have less residual cyanide than thicker chips.

Soaking and fermentation are interrelated processing techniques honed regularly in Africa. The most imperative conventional staple in west Africa is called gary and is produced by grading cassava roots, dewatering, fermenting, and roasting the fermented product. Roughly 80 to 95% cyanide decrease could be accom-

Table 2. Nutrient composition of cassava pellets and chips

S. No	Analysis	Cassava pellets		Cassava chips	
		INRA [52]	CVB [53]	INRA [52]	CVB [53]
1	Dry matter	85.0	88.8	87.0	88.0
2	AME_n, kcal/kg	2860	2832	-	2990
3	Starch	62.0	62.3	69.5	69.3
4	Crude protein	2.5	2.5	2.2	2.5
5	Ether extract	0.7	0.4	0.7	0.4
6	Crude fiber	4.6	5.2	3.0	3.7
7	Ash	5.2	5.9	3.1	4.1
8	Lysine	0.09	0.09	0.08	0.09
9	Methionine	0.03	0.03	0.03	0.03
10	Methionine + Cystine	0.06	0.06	0.04	0.06
11	Calcium	0.30	0.53	0.20	0.20
12	Phosphorous	0.19	0.09	0.15	0.09
13	Sodium	0.04	0.01	0.03	0.01
14	Potassium	0.10	0.64	0.40	0.73

plished through the different phases of garry production (Padmaja, 1995).

Conventional detoxification strategies don't guarantee the safety of cassava; anyhow, the introduction of cassava varieties with low cyanogenetic glycoside content, together with semi-industrial detoxification forms, can yield a low toxicity product (Casadei, 1988). Levels of cassava use lower than 50% inclusion (Tewe, 1994) or less than 50mg HCN equivalent for every kg (Tewe, 1994) are utilized as a part of compound feeds produced in the European Union.

The most widely recognized kinds of feedstuffs produced from cassava roots are chips and pellets. Chips are the dried shredded root and are of variable size, shape, and quality relying upon rate of drying and contamination with sand amid the processing. The chips could be ground and utilized as a part in mixed feeds or pelleted. The root pellet is a uniform cylindrical product of around 0.5 to 0.8cm diameter and 1.0 to 2.0cm long (Panigrahi *et al*., 1992). Pelleting produces a more conservative item and decreases dust, along these lines encouraging storage and transportation. Pellets have a less nutritional value than chips as they incorporate a part of the shoot, which improves fiber and ash content content from 1.5 to 2.0% (Padmaja, 1995).

Cassava root meal is for the most part a source of energy, with a high starch content (around 60-70%). In any case, the level of protein is low, being roughly 2.5% of dry matter (Table 2). In this manner, the incorporation of cassava in diets relies upon cost and accessibility of other energy and protein sources. At the point when a balanced poultry ration is formulated, the cassava must be supplemented with protein, amino acids, fat, minerals, and vitamins at more elevated amounts than are required in cereal based feeds. Cassava root items are deficient in carotene and other colouring carotenoids (Thirumalai *et al*., 1990). Hence, these components must be added to cassava based feeds if the market requires a high level of pigmentation of egg yolk or broiler skin. Since cassava pellets are high in potassium, restricting their inclusion to lower the moisture content of faces that might be appropriate (Osei and Duodu, 1986).

Garcia and Dale (1999) inferred that adequate confirmation exists in the literature to demonstrate that cassava can be securely utilized as a part of animal feed. Notwithstanding, it is hard to build up a most extreme level of use in poultry proportions because of inconsistencies in factors, for example, definition of product types and test conditions. The normal most extreme levels in the European Union are around 25% (10-15% in starter feeds). Its incorporation relies upon cost and accessibility of energy and protein sources, synthetic amino acids, and pigments.

Nutritive estimation of cassava for broilers wide variety has been seen between studies with respect to the accomplishment of feeding cassava meal to poultry. McMillan and Dudley (1941) and Vogt (1966), found that incorporation of cassava in poultry feeds lessened performance. However later examinations by, Khajarern and Khajarern (1992), Aderemi *et al*. (2000) and Tewe and Egbunike (1992), discovered more promising outcomes, likely because of enhanced awareness of how to adjust the nutrients and the negative effect of HCN. Feed intake of cassava items is constrained in poultry by the palatability of cassava-based rations, because of its dustiness and bulkiness. This could be halfway alleviated by preparing the cassava-based diets further through pelleting or conceivably addition of molasses or fat to enhance texture and decrease dustiness, while at the same time providing essential fatty acids. Muller *et al*. (1974) and Oke (1978) revealed that when cassava was fed in mash form, feed conversion and growth decreased contrasted with corn-based diets, yet comparative evaluation was seen between the two groups when the feeds were pelleted. Ogbonna *et al*. (1996) found that pelleting cassava based feeds significantly enhanced performance, and Adeyemi *et al*. (2008) reported pelleting altogether enhanced nutrient retention and reduced abdominal fat pad weight, contrasted with feeding mash diets. HCN concentration (Panigrahi *et al*., 1992). The viscous nature of cassava, especially at high temperatures, likewise causes diminished feed intake in birds fed cassava as it may make a gut-filling impact, lessening hunger. The most extreme prescribed level of cassava meal that can be utilized as a part of broiler diets vary enormously among researches. Osei and Duodu (1988) expressed the recommended level ought to be 10% and Gomez *et al*. (1987) suggested 30%, yet De Brum *et al*. (1990) recommended that the level could be as high as 40% to 60%. Onjoro *et al*. (1998) found that when maize was totally supplanted by fermented whole cassava there was a diminishment in weight gain, however when 20% to 80% of the maize was substituted there was no impact on performance. Likewise, Kana *et al*. (2012) found that BW was highest in birds fed on 50% maize replaced by cassava flour meal (with 3% palm oil and 1% cocoa husk), contrasted with birds fed 100% or 75% maize or 100% cassava flour meal. Cassava meal can likewise conceivably substitute other carbohydrate sources. For instance, it was observed that 15% cassava meal can substitute coconut meal in broiler diets with no negative impact on growth (Ravindran *et al*., 1986). The increased amount of cyanide and fiber and low energy in cassava leaves showed that its success as an alternative for maize is controlled. Ironkwe and Ukanwoko (2012) observed that final BW was significantly decreased and feed intake was enhanced when cassava leaves supplanted more than 50% dietary maize. Likewise, Tang *et al*. (2012) found that substituting maize totally with cassava pellets or chips brought about altogether growth reduction, non-starch polysaccharide and CP digestibility reduction and ME use in broilers. Lower levels of dietary cassava leaf can however possibly be utilized effectively in broiler feeds. Montilla (1997) and Ravindran *et al*. (1986) found that cassava leaf diet could be incorporated up to 15% to 20% in broiler diets with no negative effect on performance. Feeding cassava leaf meal mixture with other cassava items has additionally been appeared to bring about no negative effect on broiler growth, feed conversion or carcass characteristics. Eruvbetine *et al*. (2003) found that broilers could be effectively fed a substitution of 10% half cassava root and half leaf meal. Abu *et al*. (2015) and Morgan and Choct (2016) found that up to 20% inclusion of cassava leaf meal and 20% cassava peelings could be utilized as a substitute for maize and soybean meal. Body weight decreases significantly when broilers are fed whole cassava. Akinfala *et al*. (2002) noticed that substituting maize with either 12.5% or 25% entire cassava plant brought about decreased growth rate of 13% and 19% respectively in broilers. Ochetim (1991) additionally recorded that totally substituting maize with sun-dried whole cassava brought about a decrease in final average BW, from 1.91 to 1.72 kg. However feed efficiency was not influenced, and intake of sun-dried cassava diminished the cost of the feed by around 30%, and cost per kilogram BW gain was brought down by roughly 26% (Ochetim, 1991). This recommends the focus ought not to be simply on the impact of cassava on BW, but instead on the general performance. It might be valuable to utilize sun-dried cassava rather than maize because of the attractive monetary return. Onyimonyi and Ugwu (2007), Osei (1992) and Tewe and Egbunike (1992), revealed that cassava peel and peel meal can be effectively utilized as a part of broiler meals up to a highest level of 15%, in spite of the fact that feed intake increments as the level of cassava increases. However, other researchers levels higher than 15% can possibly be fed to broilers. Oyebimpe *et al*. (2006) found that 200 g/kg cassava peel meal could supplant maize with no decrease in broiler performance. Also, Adeyemo *et al*. (2014) and Abubakar and Ohiaege (2011) reasoned that the ideal level of cassava peels as a substitute for maize was 50%, in view of perceptions of bird performance and the histology of broiler organs. It was discovered that there was a 20.6% decrease in the production cost of birds fed diets with 50% cassava peels contrasted with the birds fed 100% maize (Abubakar and Ohiaege, 2011). Dairo (2011) likewise found that cost of feed per kg and cost per kg flesh fained was lower and live weight, BW gain and protein efficiency were higher when broilers were fed diets containing 50% dried cassava peel and dried caged layers' compost, which was blended at a proportion of 5:1 (wt/wt) and ensiled for 14 days, contrasted with birds fed feeds of 100% maize. Agwunobi and Okeke (2000) found no noteworthy different in Apparent Metabolisable Energy (AME) between 19 unique cultivars of cassava fed to broiler. In poultry, the ME substance of cassava root meal ranges from around 2.87 to 4.27 kcal ME/g DM (Khajarern and Khajarern, 2007). Various examinations by Eshiett and Ademosun (1980), Ekpenyong and Obi (1986) and Stevenson and Jackson (1983), have shown that cassava root meal can be fed to broilers up to 50% with no negative impact on birds growth. Also, Gomez *et al*. (1983) discovered that performance of broiler fed 200 g/kg cassava root meal was similar with birds fed maize based feeds, and Ezeh and Arene (1994) found that cassava root meal could be an alternative up to 75% of dietary maize, bringing about cost benefit ratio of 1.41:1 against maize. The inverse was however outlined by Oso *et al*. (2014) in an examination in which unpeeled cassava root meal was fed to broilers up to a level of 200 g/kg. It was showed that live weight, weight gain, feed intake and crude protein digestibility reduced and serum glucose and cholesterol levels increased as the dietary cassava root meal level enhanced. Proficiency of nutrient use of cassava can be enhanced by utilizing microbial enzyme supplements.

Midau *et al*. (2011) found that a feed containing 50% cassava peel meal supplemented with a mixture of enzymes (maxigrain) brought about performance values like that of a 100% maize diet. Likewise, Bhuyian *et al*. (2012) found that occurrence of carbohydrase and phytase essentially enhanced live weight and ME energy in birds nourished with feeds containing cassava chips and pellets. The oil content of the cassava feeds may likewise impact proficiency. Kana *et al*. (2014) found that cost of diet consumed was lessened and growth of birds was enhanced when diets containing cassava flour and fiber were supplemented with palm oil. Furthermore, the viability of cassava in the bird likely changes with bird's age. Mhone *et al*. (2008) recorded a live weight of 2kg and dressed carcass weight of 1.2kg at week 7 when broilers were fed on 20% cassava from either 2 or 6 weeks of age, however when fowls were nourished with these diets from day old live weight and dressed carcass weight were lower.

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