UTILIZATION OF CASSAVA PEELS AS ENERGY SOURCE FOR CHICKENS

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DECLARATION

This is to certify that this dissertation has been written by me as a record of my research work. It has not been presented in previous application for a higher degree. Sources of information are hereby acknowledged by means of references.

Sekoni — 12/11/97

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CERTIFICATION

This dissertation titled: **"Utilization of Cassava Peel as Energy Source for Chickens"** by *Mrs. Adetoun Adetokunbo Sekoni* meets the regulations governing the award of the degree, **Doctor of Philosophy (Ph.D.)** of Ahmadu Bello University and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This dissertation is dedicated to my dear husband, Prof. V. O. Sekoni and beloved children, Olutayo, Olubunmi, Olufemi and Adewale Sekoni.

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ABSTRACT

The effects of feeding graded levels of cassava peel meal (CPM) on the performance of broilers, chicks, growers and layers were investigated.

The first study on broilers was to determine the optimum level of CPM that could be incorporated in diets fortified with palm-oil to balance for energy. The second was a factorial design to determine the optimum dietary levels of CPM and methionine required for broilers.

Results of the broiler studies showed that 25% CPM in broiler starter diets did not reduce performance of the birds and 20% CPM in the finisher stage was adequate for good economic returns. Methionine supplementation did not have any significant effect on the performance of the birds at the starter and finisher stages.

The first study on egg type chickens was to investigate the optimum level of CPM in chicks and grower diets. The results indicated that chicks could be fed 20% CPM diets while growers could be fed 25% CPM without adverse effect on their performance.

The second study investigated the effect of feeding graded levels of CPM in grower diets on the subsequent laying house performance of the pullets. Results showed that dietary levels of CPM fed during rearing did not have any significant effect on the subsequent laying performance of the birds.

The third study investigated the chronic effect of graded levels of CPM on the laying performance of pullets reared on CPM. The results showed that feeding 5, 10, or 15% CPM diets for 60 weeks did not have any significant effect on laying performance.

The final study investigated the effect of graded levels of CPM in diets of hens reared on CPM free diet. The results showed that up to 20% CPM in layer's diet did not have any significant effect on laying performance and this level replaces about 50% of the maize content in the control diet.

In conclusion, these results show that cyanide did not limit the use of CPM, rather the energy content of CPM in comparison to maize which it replaces limits its usage.

CHAPTER ONE

INTRODUCTION

Feed cost and scarcity of feed ingredients are the major limiting factors in the growth of poultry industry in Nigeria. Feed accounts for over 70% of the total cost of intensive livestock production in Nigeria (Longe and Adetola 1983; Oluyemi 1984; Ogunfowora 1984). The ever increasing cost of feed coupled with the scarcity of some feed ingredients make research into feeding agro-industrial by-products to poultry a necessity.

The importance of identifying and utilizing locally available Nigerian feedstuffs in formulating poultry diets cannot be over-emphasized. There is need to investigate possible ways of reducing and replacing expensive ingredients like maize, groundnut cake and wheat offals in the diet so as to cut down the cost of production of poultry products to suit both the producer and the consumer. One of the ways of reducing the cost of production is to reduce the cost of the feed without compromising the quality of the feed. The use of readily available, cheap agro-industrial by-products that are not consumed by humans can help to achieve this desired reduction in cost. Cassava peel is one of the agro-industrial wastes that can be used for this purpose.

Cassava (Manihot esculenta) which belongs to the family Euphorbiaceae is mainly grown for its tubers which are rich sources of carbohydrates, but contains a relatively, low amount of protein. Cassava is generally easy to grow and readily thrives in a wide range of soil and climatic conditions. It yields 6.4 ton/hectare in traditionally cultivated varieties and between 15-

20 tons/hectare in improved varities through the efforts of International Institute for Tropical Agriculture (IITA) in Ibadan (Tewe and Egbunike 1988). In Nigeria, cassava production is mainly restricted to the humid tropical zones where it can be grown all year round. It may also be grown northwards as for as Zaria but the yield in these areas may not be economical.

Generally, animals use much of their food to obtain energy to maintain their various body functions such as anabolism and catabolism. In poultry, feed consumption is regulated by the energy content of the diet and the ambient temperature. Hence energy is an important factor in poultry nutrition. The energy content of cassava peel (2036 kcal ME/kg) (Aduku, 1992) is higher than some other agro-industrial by-products such as wheat bran (1256 kcal ME/kg) (Aduku, 1992) and rice offal (1319 kcal ME/kg) (Aduku, 1992). It is possible to use the peel as some replacement for maize.

In addition, the crude fibre content of cassava peel (9.5%) (Aduku, 1992) is not as high as those of the wheat bran (10%) (Aduku, 1992) and rice husk (37.55%) (Aduku, 1992) therefore its fibre content may not limit its usage on younger birds. The crude protein of the peel is very low (5%) and hence it cannot be used as a protein source. Cyanide may be the major limitation in the use of cassava and cassava products when fed to animals in the unprocessed state.

As a result of the few problems associated with the peels, most studies have been limited to the use of low levels of the peel and the duration of the studies have been short spanning between 8-12 weeks (Osei and Duodu, 1988a; Eshiett and Ademosun, 1981). In addition, some workers have fed very high levels of animal protein (fishmeal) along with CPM as reported by Osei and Duodu (1988a) in order to get satisfactory growth results with broilers. The high level

of animal protein makes the diet too expensive and hence impracticable under the present economic limitation.

The present studies were therefore designed to address some of the gaps not yet addressed in literature. All the experimental studies employed protein sources of plant origin which were more readily available and cheaper than the proteins of animal origin used by Osei and Duodu (1988a). This present study has inclusion rate of the peel higher than the 10-25% usually reported in literature (Eshiett and Ademosun, 1981; Osei and Duodu, 1988a; Tewe and Egbunike, 1988). The chronic effect of feeding the peel was also investigated. Most studies in literature were for short periods ranging between 4-20 weeks (Eshiett and Ademosun, 1981; Osei and Duodu, 1988a; Aina, 1990; Ogbonna and Adebowale, 1993), but the present study was designed for the life span of broilers, pullets and layers.

The parameters measured for the two types of chickens include mortality rate, weight gain, feed intake, feed conversion efficiency, ages at first egg, 50% and peak of egg production. Weight of birds at 4, 8, 20 and 60 weeks, egg production (henday and hen-housed) and thiocyanate levels in blood, faeces and eggs were also determined.

CHAPTER TWO

2. REVIEW OF LITERATURE

2.1 Yield of Cassava and Methods of Generating Peels

Cassava is one of the most important energy food crops of the tropical world and, in terms of total calorie yield, cassava is superceded only by rice, maize and sugar-cane (Cock, 1982). Over the past 30 years, global production has almost doubled, from 76 to 153 million metric tonnes (FAO 1973; 1991). Out of the total cassava produced, approximately two-thirds is consumed by humans while the remaining 30% is used for animal feeding and for industrial purposes.

In tropical Africa, cassava is one of the most important staple food crops, cultivated in the lowland humid tropics. It plays a major role in efforts to alleviate the African food crisis because of its efficient production of food energy, year-round availability, tolerance to extreme stress conditions, and suitability to current farming and food systems in Africa (Hahn and Keyser, 1985; Hahn *et al.*, 1987; Hahn, 1988). Cassava is capable of providing high average yield of 20-30 tonnes per hectare.

In Nigeria an estimated 13-15 million tonnes of cassava are being produced annually (IITA, 1985). The average yield of cassava in traditionally cultivated varieties is 6.4 tonnes/ha. This has been greatly improved to 15-20 tonnes/ha by research efforts of the International Institute for Tropical Agriculture (I.I.T.A) in Ibadan (I.I.T.A., 1985). The level of yields reported for I.I.T.A. cassava variety is still lower than the world average of 30-40 tonnes per hectare (Onabowale, 1988). In addition, cassava is capable of providing high yields of energy per hectare. For example cassava yields 13 times more energy per hectare than maize or guinea

corn (Oke, 1978). Zaire, Nigeria and Tanzania are the major Africa cassava producers with average yield ranging from 9 tonnes per hectare in Nigeria to less than 5 tonnes per hectare in Tanzania (as shown in Table 2.1 below).

Table 2.1: Cassava Production in Selected Countries

Country	Area cultivated (million hectare)	Yield ton/hectare	Production (million tonnes)
Africa	7.32	6.4	46.44
Zaire	1.82	6.8	12.40
Nigeria	1.18	9.2	10.83
Tanzania	0.94	4.9	4.60
Ghana	0.23	8.0	1.80
Togo	0.03	16.2	0.45
Thailand	3.80	11.6	43.97
Brazil	2.07	11.80	24.47

Source: F.A.O Production Year Book Rome, 1981.

Out of the estimated 13-15 million tonnes of cassava produced in Nigeria, only 0.30% (0.401 million tonnes) of this amount is available for livestock feed. The 13-15 million tonnes of cassava can generate 1.3-1.9 million tonnes of cassava peels a year since the peel is between 10-13% of the tuber weight (Tewe *et al.*, 1976). This quantity of peels will significantly increase the amount of feedstuffs that will be available for livestock feed. A ton of cassava root

will generate 100-130 kg of cassava peels which can reduce the pressure on cassava roots as animal feed.

Cassava peels can be generated from most traditional cassava processing methods in use. Some traditional foods which generate peels as by-products are: **"gari"**, fermented and dried cassava pulp (**"lafun"**), wet pulp, smoked cassava balls (**"kunkun"**) and **"chickwangue"**. The processing methods involve peeling of tubers which generates the peels. Large scale processing of starch, gari and dried cassava chips involves the process of peeling either mechanically or by hand. Mechanical peeling generates peels of uniform size while hand peeling generates peels of different sizes.

2.2 Processing Cassava Peels to remove the Cyanide

The presence of toxic hydrogen cyanide in cassava and cassava peels is a limiting factor for their various uses as food for man and livestock. Hence processing helps to remove or reduce the level of toxic cyanogenic glucosides present in the cassava and its peels. The detoxification of cassava peel for the removal of residual cyanide can be achieved by dehydration or drying, fermentation and acid hydrolysis or a combination of some of the above mentioned processes. These processes can be mechanized to take care of large volumes of cassava roots or peels (Onabowale, 1988).

I) **Drying or Dehydration**

This is the simplest method of processing cassava roots and peels. Drying reduces moisture, volume and cyanide content of the roots and peels thereby prolonging the shelf life of the product. This process is practiced primarily in areas with less water supply.

Since cyanogenic glucosides are soluble, physical removal of water will result in the elimination of these glucosides. This can be achieved by (a) pressing and (b) heating (Meuser and Smolnik, 1980).

(a) ***Pressing***: In the case of pressing, the cassava or its peels are soaked, the water can be pressed out by means of pressure using logs of wood, stones or a hydraulic press (Bokanga, 1989).

(b) ***Heating***: The elimination of cyanogens by heating will depend on the temperature, the physical state of the cassava and its peels and the type of heat (Oke, 1994).

If cassava chips or peels are heated at a high temperature, it is possible to eliminate the water rapidly thereby leaving the residue with higher concentration of cyanogens (Oke, 1994). Sun-drying or air-drying at low temperature (22°C) slowly eliminates cyanogens. At 40°C, drying is very rapid within the first 2 hours, resulting in about 80% cyanogen loss. Complete elimination occurs in about 8 hours at 40°C (Oke, 1994). A similar curve was obtained for 60°C except that it was faster, resulting in about 90% cyanogen loss in 2 hours and the process was completed in 6 hours (Meuser and Smolnik, 1980). Because of the stability of the cyanohydrin at low pH values, fermented pulps are resistant to cyanogen removal. Under the same conditions fresh pulps easily eliminate a large proportion of the cyanogens. Thus, drum-drying of fresh pulp reduces the cyanogen content of cassava from 900mg HCN equivalent kg^{-1} to about 8mg HCN equivalent kg^{-1}. That of fermented pulp is reduced to 121mg HCN equivalent kg^{-1} (Meuser and Smolnik, 1980; Table 2). Due to the stability of cyanohydrins at low pH, cyanogens are only slowly eliminated from fermented pulp by steam distillation. A large proportion can be distilled in a small volume from fresh pulp as shown in Figure 1 (Meuser and

Smolnik, 1980).

Table 2.2: Effect of drying process on cycanogen content of cassava

Drying Process		Residual cyanogen content (mgHCN equivalent kg^{-1})
Freeze drying	(pulp)	439
Flash drying	(slices)	432
Air-drying 40°C	(chips, pulp)	13
Heated air-drying 180°C	(chips)	14
	(fermented pulp)	77
Drum drying	(pulp)	8
	(fermented pulp)	121
Total cyanogen content of pulp		900

Source: **Meuser and Smolnik 1980.**

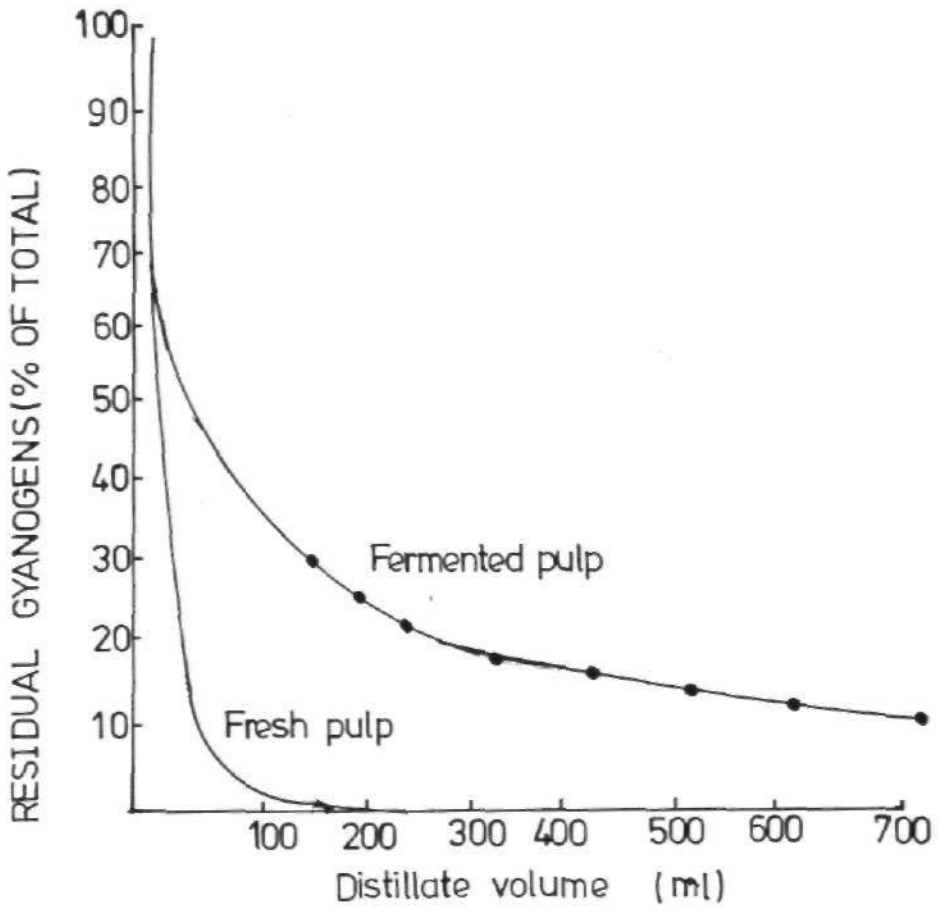


Fig.1 Release of HCN by steam distillation of a fresh and a fermented pulp (Meuser and Smolnik, 1980)

It should be noted that freeze drying or flash drying tends to eliminate only the free cyanide, which is often a small fraction of total cycanogens and so it is not very effective. Drum drying appears to be the most effective. The melting point of linamarin is 142-143°C. If therefore a high temperature is used for drying such as in roller drying, it is possible to eliminate most of the glucoside by decomposition. Under this condition, the cyanogens are eliminated with subsequent adjustment of the equilibrium condition to favour degradation rather than synthesis (Oke, 1994).

Mahungu *et al.*, (1987) reported that the total cyanide content of cassava chips and peels could be decreased by only 10-30% through the fast air-drying while slow sun-drying produces greater loss of cyanide. Sun-dried peeled cut pieces of roots gave HCN concentration lower than 10mg/100g and the loss was more effective than oven drying. Drying may be in the sun or over a fire. The former is more common for both the roots and the peels under the village condition because it is simple and does not require wood for fuel (Hahn, 1988).

II) Fermentation Process

The first stage of this process consists of washing of the cassava roots or peels. The washed roots or peels are then fed through a conveyor to a grater where they are properly grated to specific size. The grated cassava roots or peels in the mash form is poured into a 400 litre tank constructed from plastic, fibre glass or aluminium. A known quantity of water is added to the mash which is mixed thoroughly and left to stand for 24 hours. Adequate ventilation is required here because of the toxic hydrogen cyanide given off. The fermented cassava mash is dewatered using either a basket centrifuge, hydraulic press or a screw press to produce a thick fermented cassava cake of about 45-47% moisture content (Oke, 1994).

There are two main types of fermentation. The aerobic and anaerobic fermentations are used mainly for human food, and silage fermentation is used for animal feed. In the preparation of food, peeled roots are usually soaked in water for periods extending from as short as one day to 8 days. The micro-organism in the roots ferment the soluble carbohydrates (sugars) to form lactic acid and some acetic acid. These acids decrease the pH of the medium from about 6.0 to 3.5 after 5 days.

When the soluble carbohydrates are decomposed, lactic acid level rises steadily to about 1% after 5 days. Similarly, the acetic acid level also rises as shown in Figure 1. The pH value decreases slowly from an initial value of about 6 to about 3.8 after 3 days. Fermentation is completed in about 5 days.

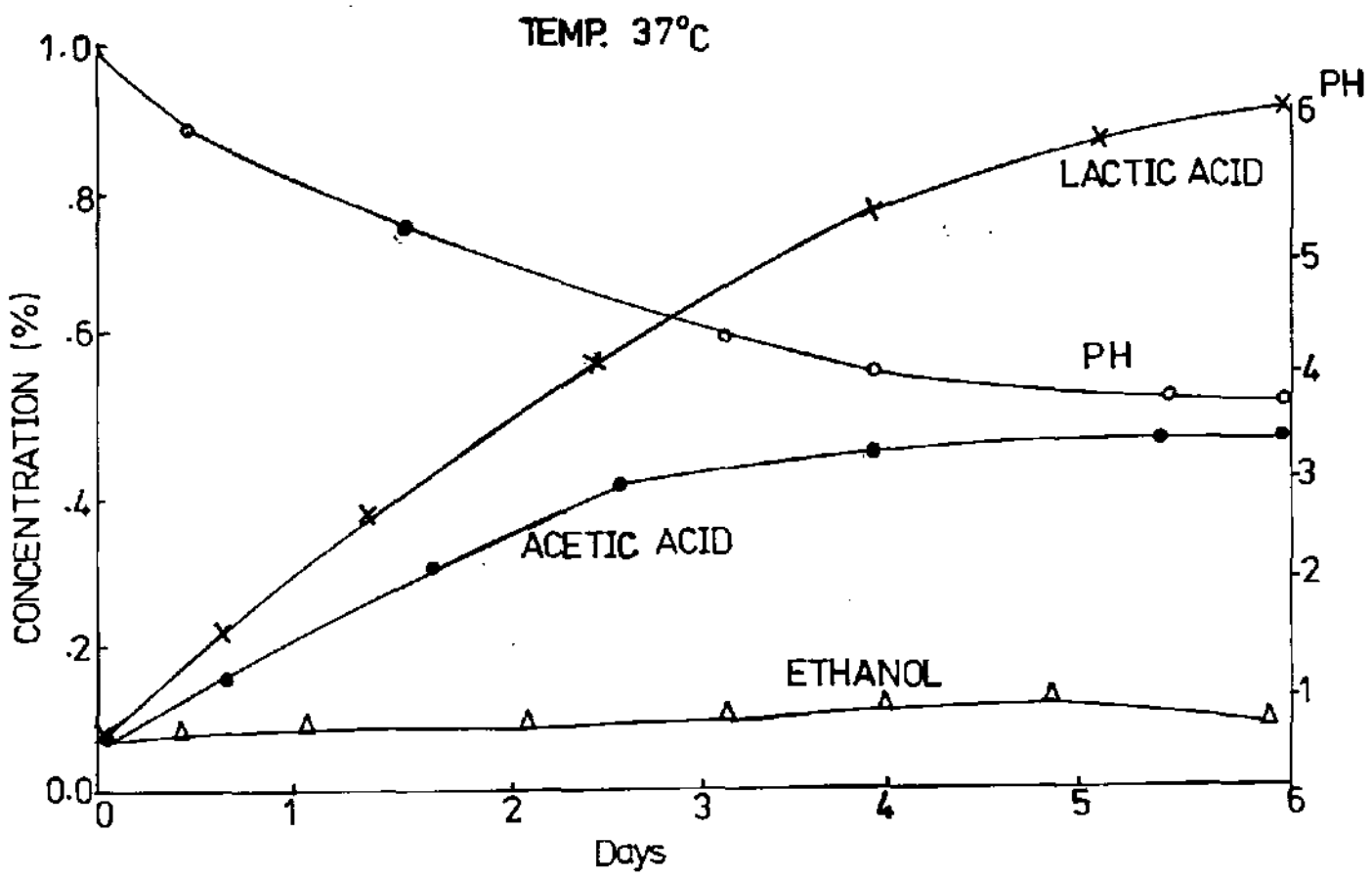


Fig.2 Fermentation of cassava pulp: **Acid and Alcohol balance.**
(Meuser and Smolnik, 1980)

Fermentation involves some micro-organisms. Bokanga (1989) isolated 15 microbial species belonging to 10 genera in the production of **"Chickwanghe"**. Nwachukwu and Edwards (1987) isolated 5 yeasts (including *Geotricum candidum*), 2 moulds (*Aspergillus niger* and *Penicillium* sp.) and 3 bacteria (*Leuconostoc* sp., *Cornebacterium* sp. and *Lactobacillus* sp.) in cassava fermentation for **"lafun"** production. These fermenting micro-organisms cause softening of the pulp. This is accompanied by increased hydrolysis of the cyanogenic glucosides by the endogenous linamarase and the microbial B-glucosidases (Nwachukwu and Edwards, 1987).

Silage production involves fermentation of cassava peels. Lactic acid fermentation takes place resulting in a drop of pH to about 4. The process is enhanced by the presence of molasses, and glucose as additives. As in the ordinary fermentation, there is a rapid loss of cyanogens to insignificant levels through microbial decomposition (Oke, 1994). Onabowale (1988) reported 89.75% loss of HCN when cassava peel was fermented for 24 hours.

III The Acid Hydrolysis Process

This process involves washing and grating adopted in the fermentation process (Onabowale, 1988). A known concentration of mineral acid such as concentrated hydrochloric acid previously diluted with water to give a known strength, is added to the cassava peel mash. It is then mixed thoroughly and allowed to stand for 2 hours for acid hydrolysis to take place. This is followed by the neutralization of the acid with a known concentration of mineral alkali such as sodium hydroxide for five minutes. Dewatering, drying and seiving are done as in the process of fermentation. The acid hydrolysis process is faster and more efficient than the fermentation method described above.

About 95% loss of HCN (Onabowale, 1988) can be achieved as compared to 89.75% for the fermentation process. A combination of fermentation and acid hydrolysis process will give 97.73% loss of HCN (Onabowale, 1988).

IV) Storage

Storage seems to reduce the level of cyanogens in "**gari**". Mahungu *et al.* (1987) reported that the cyanogen content of "**gari**" stored for 4 months decreased from 26.6 mg HCN equivalent kg^{-1} to 2.9mg HCN equivalent kg^{-1}. There was no cyanogens detected in 57 samples after 2 years.

2.3 Nutritional Contents of Cassava Peel

Omole (1988) reported that wet cassava peels contain 27.9% dry matter, 5.3% crude protein, 1.2% ether extract, 20.97% crude fibre, 5.93% ash and 66.6% nitrogen free extract. Dried cassava peels contain 87.6% dry-matter, 5.1% crude protein, 15.7% crude fibre 2.1% ether extract 6.1% ash and 71.0% nitrogen free extract (Onabowale, 1988). The proximate analysis of both wet and dried cassava peels show that the peels have nutrients that can support livestock production. The proximate analysis of the dried cassava peel meal is similar to that of maize (Table 2.3) and hence it is possible to substitute the peel for maize in the production of livestock and poultry feeds as an energy source.

Table 2.3: Proximate Composition of Maize and Dried Cassava Peel (% dry matter)

Ingredient	Dry Matter	Crude Protein	Crude Fibre	Ether Extract	Ash	Nitrogen Free extract
Maize	86.2	8.8	2.5	3.6	1.4	83.6
Cassava Peel	87.6	5.1	15.7	2.1	6.1	71.0

Source: Onabowale, 1988.

Cassava peel meal contains 5.3% crude protein in the wet form and 5.1% in the dried form (Omole, 1988; Onabowale, 1988). This level of protein is inadequate to support adequate growth rate of chickens and hence needs protein supplementation from other sources such as groundnut-cake, soya cake, full fat soyabean or fish meal. In studies involving cassava peels, higher levels of protein were recommended in the diets to take care of the anti-nutritional factor (cyanide) in the peels. Adegbola (1977) showed that the addition of methionine to cassava based diet could improve the quality and the protein utilization.

Physical and physiological activities of the birds leads to energy expenditures. It is therefore of importance to relate these facts to the dietary energy available to the bird. The available energy in feedstuffs for poultry is expressed as metabolizable energy (ME). ME also refers to the portion of the dietary energy that is available to the animals for growth, production of egg, meat, maintenance of body temperature and other vital functions. The metabolizable energy of cassava peel meal range between 2036-2400 kcal/kg (Aduku, 1992) or ⅔ of the value of maize. This energy value is adequate for formulation of diets in which cassava peel can replace part of the maize in the diets. In the tropics and in arid climates, the energy requirements of chickens are lower than that which is required in the temperate environment. Olomu (1976) reported that 2400 kcal ME/kg diet was found to be adequate in raising broilers in the tropics. El Zubeir and Mohammed (1993) reported that as the energy level of the diet increases, the feed intake decreases and the results suggest that pullets need 15% CP and 2390 kcal ME/kg diet in hot environment.

The fibre content of cassava peel meal ranges between 9-15.7% depending on the type and variety of cassava that was peeled (Onabowale, 1988; Aduku, 1992). Fibre is defined as

the portion of feed that is resistant to the action of hot sulphuric acid (1.25% H_2SO_4) and hot sodium hydroxide (1.25% N_aOH) solutions. It is the portion of a feedstuff that is insoluble, less digestible, ash-free and which remains after vigorous boiling with dilute alkali and then with dilute acid (Feltwell and Fox, 1978). Fibre consist primarily of cellulose, hemicellulose and lignin which are known to be almost nutritionally valueless to monogastric animals.

In addition, species differ in the extent to which they can digest fibre and digestibility is not the same even among individuals within the same species, digestibility figures will always vary (Lloyds *et al.*, 1978). Monogastric animals do not have the necessary enzymes for degrading cellulose. Lloyds *et al.* (1978) reported the digestibility of crude fibre by poultry, pigs and rabbits as 20-30, 3-25 and 16-18% respectively. Fibre aids digestion because its bulk stimulates peristalsis and secretion of enzymes and opens up concentrated food so that digestive juices can come in contact with them (Hedge *et al.*, 1978). This stimulation increases the availability of nutrients to the animal. One of the most important physical properties of dietary fibre is its ability to hold water. This increases the bulk of the intestinal content, consequently gut dimensions increases and this improves nutrient absorption (Hedge *et al.*, 1978; Summers and Leeson, 1983). Any or all of these factors could influence the efficiency with which a diet is utilized as was noticed in broilers fed fermented and unfermented cassava peel (Osei and Duodu, 1988a,b).

Hydrogen cyanide (HCN) is another constituent of cassava peel. The wet cassava peel contains 180.00 ppm of HCN and a pH of 5.37 (Onabowale, 1988). Below (Table 2.4) is the cyanogen contents of Nigerian cassava, peels and some products used for animal feeding.

Table 2.4: Cyanogens content of Nigerian cassava and some products used for animal feeding (dry weight basis)

Cassava/Products	Cyanogens content (mg HCN equivalent kg^{-1})
Fresh whole root	88.3 - 416.3
Fresh pulp	34.3 - 301.3
Fresh peel	364.2 - 814.7
Sun-dried whole root	23.1 - 41.6
Sun-dried pulp	17.3 - 26.7
Oven-dried whole root	264.3 - 321.5
Oven-dried pulp	23.7 - 31.3
Oven-dried peel	666.8 - 1250.0
Dried cassava waste (peels and discarded small tubers)	240.0

Source: Tewe (1994).

The cyanogen content of cassava has been the main limitation to its widespread use as livestock feed. The safety of cassava for livestock can be guaranteed if the dietary cyanogen level is less than 100 mg HCN equivalent kg^{-1} (Tewe, 1994). This level can be obtained by drying or fermentation.

2.4 Cyanide Detoxification and Metabolism

Detoxification is a broad term that denotes any method or process whereby any poison (e.g. gossypol, cyanide) is removed. It could be removed from its precursor (the glycosides), in cyanogens or in bound forms in the body in any convenient way so as to limit its toxicity in the body of animals.

The traditional detoxification methods for cassava and cassava based foods through processing have been reviewed. In principle most traditional food preparation techniques appear to be designed to bring together enzyme and substrate by cell rupture, followed by the elimination of the liberated hydrocyanic acid by either volatilization or solution in water. In some processes, the initial hydrolysis of the linamarin is assisted by the use of fermentation processes (Coursey, 1973; I.I.T.A., 1990).

The detoxification pathways of cyanide have been reviewed by Oke (1973). The major detoxification product of cyanide is thiocyanate. The high amount of thiocyanate found in the urine, saliva and blood of people who eat a lot of cassava is from the detoxification of the cyanide in the cassava. There are two possible pathways for the formation of thiocyanate as illustrated in Figure 3.

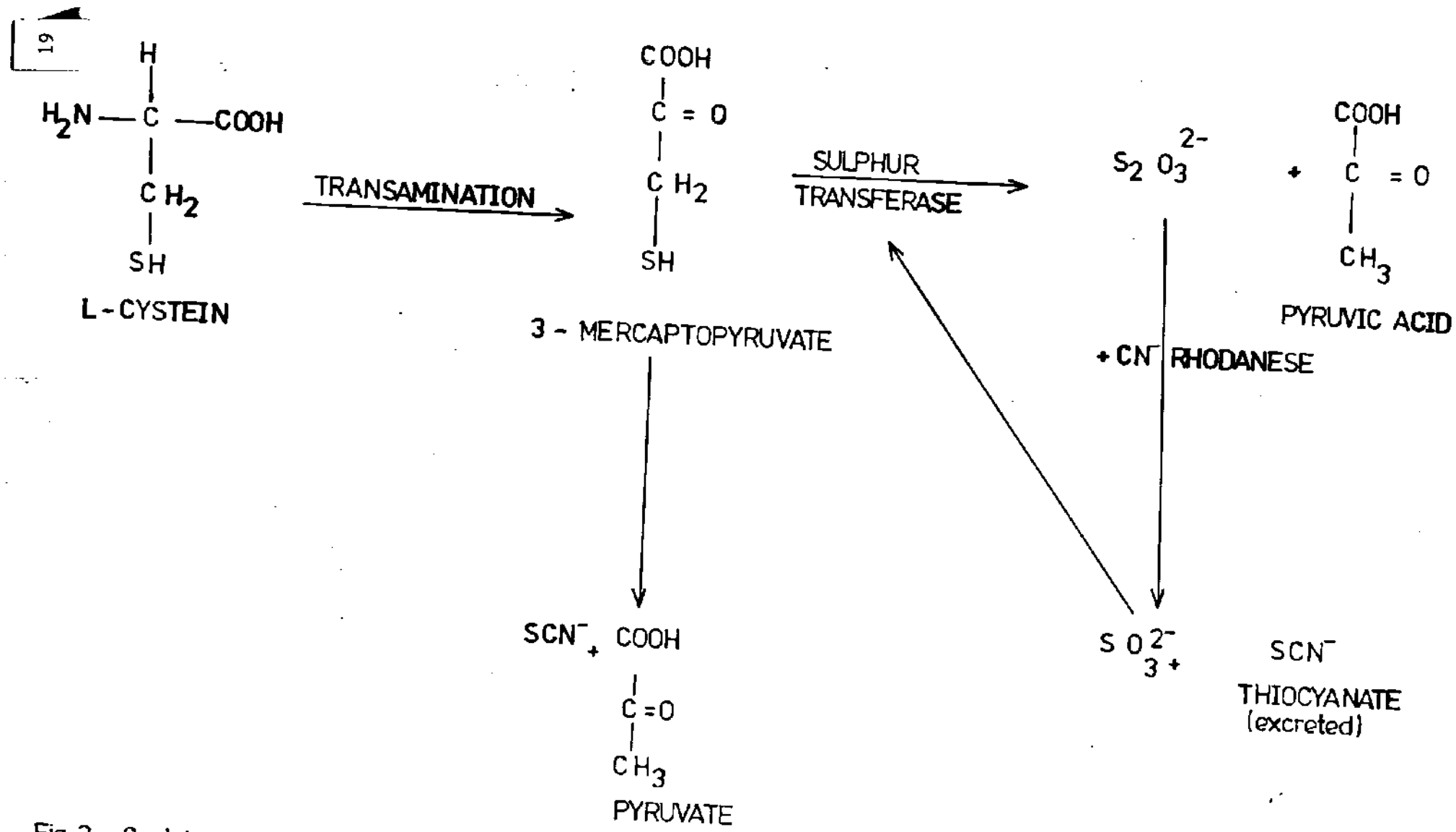


Fig. 3 Cystein as a sulphur source for Rhodanese. (Oke, 1973)

In one pathway, L-cysteine, which serves as the sulphur donor is transaminated to 3-mercaptopyruvate and the sulphur in turn is transferred to a sulphite radical by sulphur transferase, forming thiosulphate and pyruvic acid in the process. Rhodanese catalyses the reaction between thiosulphate and cyanide to produce thiocyanate and sulphite. The sulphite combines with sulphur (catalysed by sulphur transferase) to produce S_2O_3 thereby entering the cycle again. The pyruvate produced goes into the tricarboxylic acid cycle (TCA cycle) while thiocyanate is excreted.

Methionine can also provide sulphur for the rhodanese system by conversion to cysteine (Figure 4). This important role by methionine has been recognised for long (Oke, 1973; 1984). Improvement in poultry performance following methionine supplementation of cyanide-based diets have been reported by Carew (1981) and Ngoka (1986). The less important alternative pathway is catalysed by cyanide sulphur transferase producing thiocyanate and pyruvate from 3 mercaptopyruvate but without the production of S_2O_3 as in Figure 3. The rhodanese pathway represents the chief route of detoxification and occurs in all parts of the body with the largest concentration of enzymes in the liver.

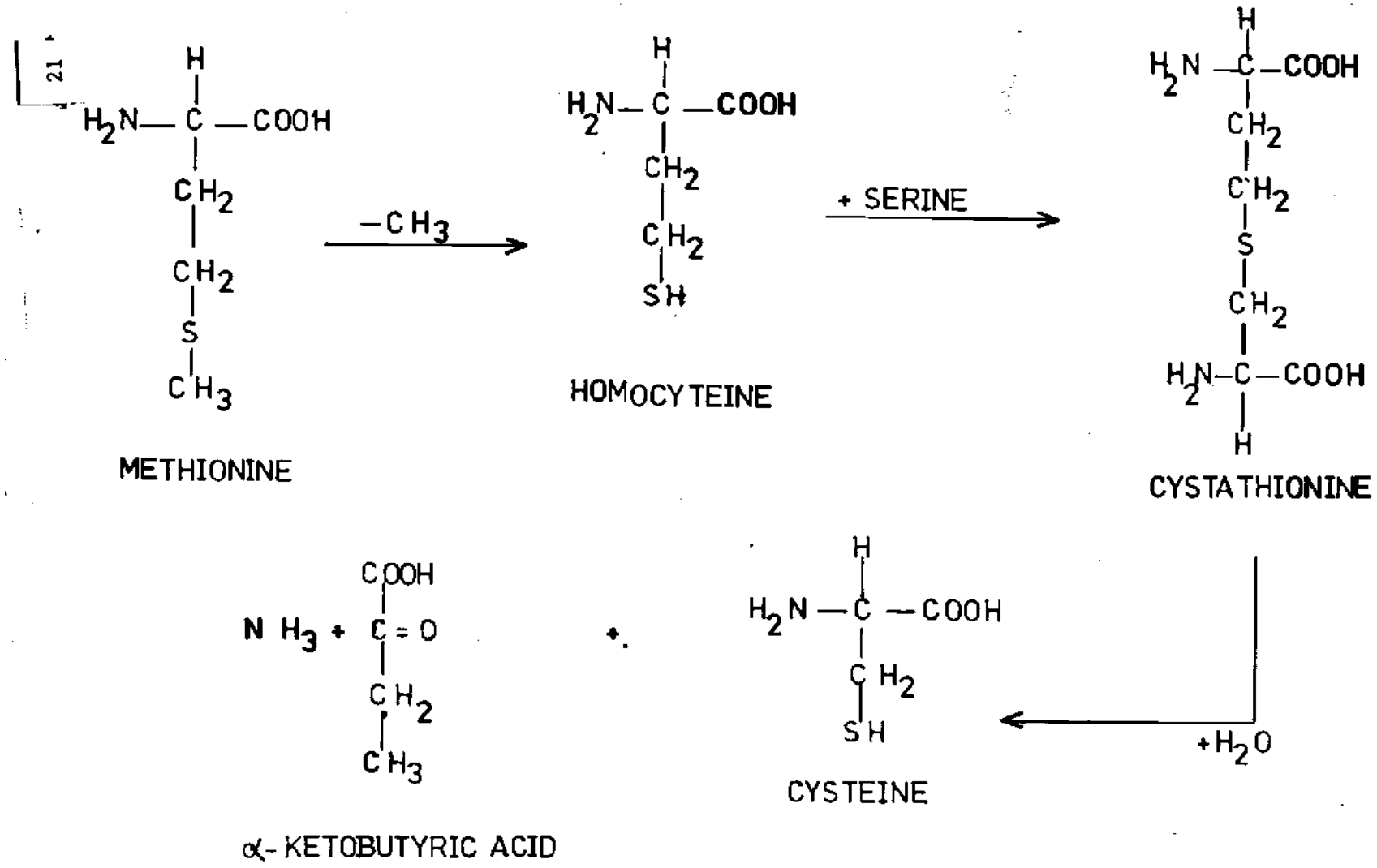
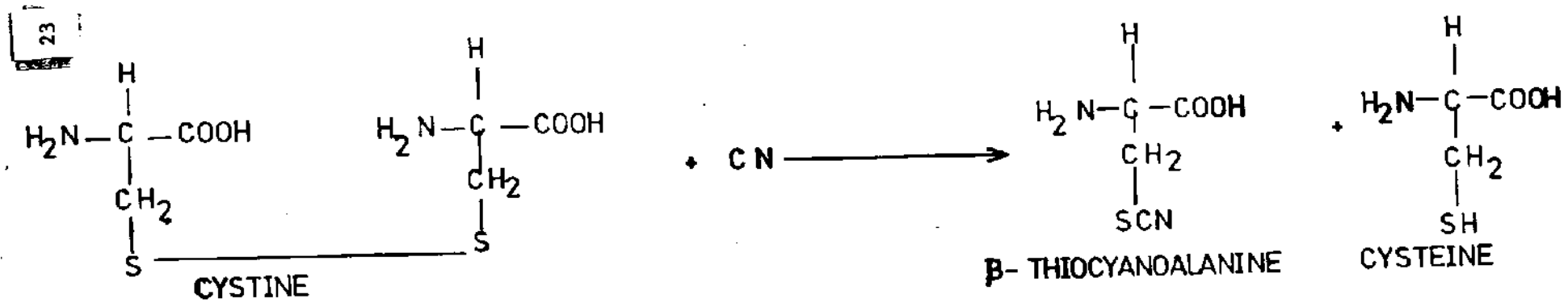


Fig.4 Methionine sulphur made available for Thiocyanate formation through conversion to cysteine. (Oke,1973)

The amount of rhodanese in the liver varies with different animals. Frogs which prey on cyanogenic insects and millipedes, rabbits and rats which subsist on a wide range of plant materials have higher liver rhodanese activities than cats and dogs that are not likely to encounter large amount of cyanide under normal circumstances (Oke, 1969; Okoh, 1978).

Another detoxification process (Figure 5) starts with cystine and cyanide to form cysteine and B-thiocyanoalanine which tautomerises to 2-aminothidizolidine-4-carboxylic acid or its equivalent 2-imino-4-thiazolidine carboxylic acid which is excreted (Oke, 1973). The cysteine so formed enters the "**Rhodanese**" detoxification process to produce free thiocyanate which is excreted (Oke, 1973).



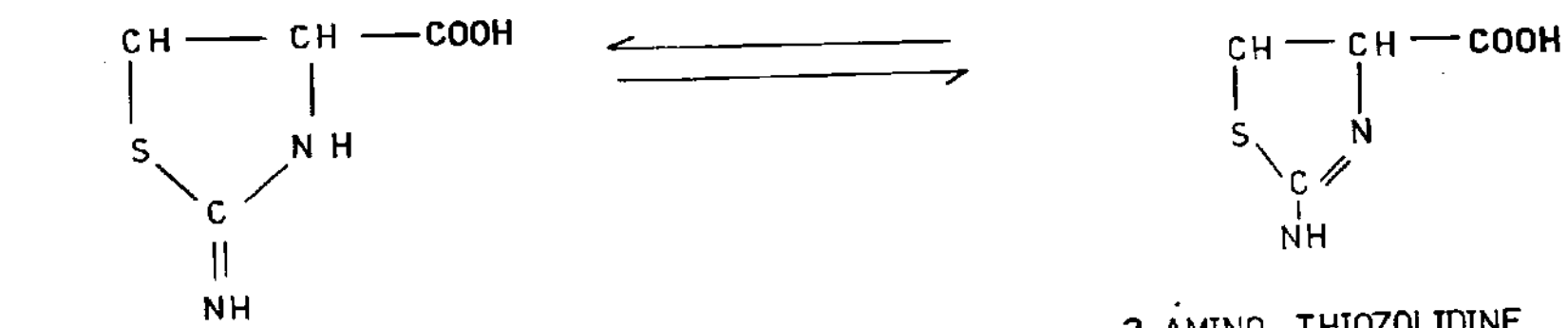


Fig.5 Conversion of cyanide to 2-Imino-4-Thiozolidine carboxylic acid. (Oke,1973)

commercial pullets. Three iso-nitrogenous diets containing 0, 10, and 20% cassava peel meal were fed to commercial pullets for twelve weeks. Their results showed that during the growing stage, birds fed 0% CPM consumed less feed ($P<0.01$) and were more efficient ($P\leq0.01$) in their feed utilization than the other treatment groups. There were no significant differences between the other two treatments in their efficiency of feed conversion and feed intake. Onabowale (1988) reported satisfactory results when growing chickens were fed cassava peel meal detoxified by acid hydrolysis or by fermentation. In growing chickens, the detoxified cassava diet produced no adverse effect on growth performance and mortality. In addition, the cassava based feed was cheaper than the maize based feed.

Satisfactory results were also obtained when laying birds were fed cassava peel meal. Inclusion of up to 27% of the meal at the expense of maize gave satisfactory feed intake, egg production and feed per unit egg produced. The economy of feed conversion was also more efficient with the cassava peel meal compared with the maize control (Tewe, 1983; 1987). Eshiett and Ademosun (1981) reported that laying birds reared on cassava peel meal gave satisfactory laying house performance. Feed consumption, egg production, efficiency of feed conversion and egg weight were not significantly affected by the level of CPM fed during rearing. Onabowale (1988) also reported satisfactory results when laying birds were fed cassava peel meal detoxified by acid hydrolysis or by fermentation. Egg production performance of the birds fed detoxified peel was higher (71.43%) than egg production performance (66.67%) from birds fed maize based diets.

Cassava peels were also fed to cockerels and this shows a greater potential (Ogbonna and Adebowale, 1993). Preliminary studies have shown satisfactory performance in finisher

cockerels with up to 45% inclusion of cassava peel as a replacement for maize in their diets (Ogbonna and Adebowale, 1993). Ogbonna and Adebowale (1993) reported that 17.71 and 17.62% CPM in the starter and finisher diets of cockerels gave the highest nitrogen retention value and there was no evidence of cyanide poisoning due to the ingestion of CPM by the birds.

II Swine

Cassava tubers and cassava peels have been found suitable for feeding pigs by various researchers. The potential of cassava peel as a good substitute for maize meal for all classes of pigs cannot be over-emphasized (Nghi 1986; Iyayi and Tewe, 1988).

The protein deficiency of cassava and its peels demands higher protein supplementation in such diets. Iyayi and Tewe (1988) demonstrated that 40% level of cassava peel in place of maize was adequate for growing pigs. Feed intake and growth rate of pigs were enhanced when the diets were supplemented with plant and animal protein and at least 15% protein was necessary for satisfactory growth performance. Maust *et al.* (1972) showed that cassava can affect mineral balance which results in para-keratosis in pigs and this can be prevented by the inclusion of zinc salts in the diet. Oke (1978) and Tewe (1987) showed that because of its low energy, dustiness and low protein content, cassava peel meal or cassava root-based diets must be supplemented with rich protein sources and oil in order to improve their palatability and digestibility. Dustiness of cassava based rations can also be removed by adding molasses or by pelleting to make the feed acceptable to pigs. Job (1975) and Tewe (1975) showed that dietary protein and not cyanide of cassava peel was the major factor of concern in feed intake and growth. When pigs were fed sweet and bitter cassava roots, the toxic factor of bitter cassava did not have any inhibitory effect on growth.

Tewe and Oke (1983); Tewe *et al.* (1987) fed growing pigs diets containing 40% cassava peel meal and obtained satisfactory performances. These pigs produced leaner carcasses and showed an economy of feed conversion as shown in Table 2.5.

Table 2.5: Cassava peel in growing pig rations, Effect on performance, carcass characteristics and economy of production

Parameter	Experiment I Cassava peel level (%)				Experiment II Cassava peel level(%)	
	0	10	20	30	0	40
Daily weight gain (kg)	0.41	0.38	0.39	0.40	0.40	0.53
Daily feed intake (kg)	1.45	1.45	1.46	1.60	1.35	1.31
Feed/gain	3.79[b]	3.69[ab]	3.69[ab]	3.69[ab]	2.81	2.48
Dressing Percentage	74.1	69.8	73.1	70.3	81.9	81.7
Percentage Lean cut	64.52	55.42	66.94	64.84	66.90	64.50
Percentage trimmed fat	10.69[a]	10.44[a]	9.29[b]	9.63[ab]	16.0	**16.6**
Gross gain/ feed cost(₦)*	132.5	129.2	149.2	145.7	162.0	191.0

Sources: Experiment I: Tewe and Oke 1983
Experiment II: Tewe *et al.* 1987

Notes: Means without common letter(s) on horizontal rows are significantly different ($P \leq 0.05$).

*: US$1.00 = ₦2.6 (February 1987).

The effect of cassava peels on a reproductive hormone such as estradiol in pigs was investigated by Iyayi and Tewe (1988). Serum estradiol in the two studies of these workers was not affected by dietary cyanide level up to 445 mg/kg but was affected by the level of protein in the diet. From this study it was observed that pigs were able to tolerate higher levels of cyanide than chickens.

Results of several studies suggest that maize can be partially or completely replaced by cassava roots or peels in swine grower-finisher diets with no decrease in performance (Obioha *et al.* 1985; Sarwart *et al.* 1988; Lekule and Sarwart 1988). The limitations commonly reported in cassava based diets result from inadequate supplementation with rich protein source, methionine and mineral-vitamin additives or incomplete removal of cyanide by efficient processing methods (Tewe, 1975; Iyayi and Tewe, 1988).

Pigs can also be fed fresh cassava peels and roots as commonly practised in small and medium scale pig farming in Nigeria (Iyayi and Tewe, 1994). These pig farmers usually depend on the cassava grown on their farms or sometimes supplement with those purchased from neighbouring farms. Cassava peels, either fresh or par boiled, are fed to pigs, but the death of many piglets has been reported due to cyanide toxicity in fresh cassava peels (Iyayi and Tewe 1994). To overcome this problem, farmers now sun-dry or ferment the peels or roots before feeding them to pigs, (Tewe and Oke, 1983).

III) <u>Rabbits</u>

Omole and Eshiett (1976) showed that the rate of weight gain decreased with increasing levels of cassava in the ration and the decrease was not significant until the diet contained 45% cassava root meal. The addition of 0.2% methionine to the control and to the 45% cassava diets

resulted in very slight improvement (0.22 and 0.48% respectively) in live weight gain over the unsupplemented diets. When 15% and 30% cassava diets were supplemented with methionine there were 5.9 and 3.5% gains over the unsupplemented rations. The results of the study showed that the addition of methionine to the diet did not improve the efficiency of feed utilization significantly neither did it affect the quantity of urinary thiocyanate excreted by the animals.

Omole and Sonaiya (1981); and Omole (1988) used cassava peel meal in rations of growing rabbits with some success. They found that CPM levels of up to 40% in the diet could be used provided that supplementary fishmeal or synthethic methionine were added to counterbalance the intrinsically low sulphur amino acid content of the meal. Although the HCN content of cassava peel is higher than that of the root, feeding relatively high levels of cassava peel did not appear to cause any problem of hydrocyanic acid toxicity especially when the diet was supplemented with methionine (Omole, 1988). Unlike pigs, the serum and urine thiocyanate level of rabbits were not influenced by the cassava peel meals when the diets were supplemented with methionine.

Palm oil supplementation of cassava peel meal diets also improved animal performance by increasing detoxification of hydrogen cyanide present in the meal (Hutagalung, 1977; Famunyan *et al.*, 1981; Omole, 1988). Hutagalung (1977) attributed improved performance with feeding palm oil in cassava based diets to increased energy intake by the animals. Famunyam *et al.* (1981) showed that the rate of hydrolysis of cyanogenic glucosides in cassava to produce the poisonous hydrogen cyanide was greatly reduced with palm oil. They therefore suggested that in animals fed cassava based diets supplemented with palm oil there is delay in

HCN decomposition which prevents absorption of the cyanogenic glucosides.

IV) Rats

Obioha *et al.* (1983) recommended 40% CPM for mice provided the diets are balanced for other nutrients such as protein, amino-acids and the cyanide is reduced substantially by appropriate processing method. In addition, CPM feeding has been associated with substantial feed cost savings. Rats were shown in the studies of Hill (1977) and Tewe (1983) to tolerate diets with high levels of cyanide. Hill (1977) fed young rats *ad libitum* on a diet containing 2,400 ppm potassium cyanide and no obvious signs of distress other than a decrease in weight gain was observed. Similarly rats fed for 12 weeks on a diet deficient in vitamin B_{12} and methionine and containing 1,500 ppm potassium cyanide appeared healthy. However, weight gains were reduced by the differences of vitamin B_{12} and methionine and by the addition of KCN. Rats receiving fatal doses of linamarin showed characteristic alterations in electrocardiograms similar to those resulting from fatal doses of potassium cyanide. Alterations in several biochemical parameters measured in the blood and in the heart tissues were observed in these rats and also in the rats receiving lower but non-lethal doses. The severity of the reactions to potassium cyanide and linamarin were strongly influenced by the manner in which they were administered. When the doses were mixed with the diet and fed over a period of hours, they were tolerated in large amounts whereas, death results from a single large dose.

Olusi *et al.* (1979) fed 50% raw cassava diet to rats which resulted in significantly lower birth weight and never attained the same adult weight as those of the controls. Adult female rats fed a diet consisting entirely on raw cassava had significantly reduced haematological and biochemical indices. This diet also caused an increased incidence of cannibalism and a

significant reduction in the frequency of pregnancy. The average number of the litter and the birth weight were reduced among the rats. In addition, there was an increased incidence of neonatal deaths among the offsprings which also had poor development, reduced brain weight and an increased tendency towards bitting their litter mates. Adult female rats fed diets containing 5 and 10g CN/100g laboratory diet survived for more than three months but never became pregnant, they developed enlarged thyroid glands and tumors of the large intestine. These results show the damages which unprocessed cassava can cause to the various body functions of the rat. There was an increase in urinary thiocyanate level of rats fed diets containing 173 ppm HCN and high cassava diets (Maner and Gomez, 1973; Tewe, 1983). Thiocyanate concentration of serum and amniotic fluid of gestating rats were also reported by Tewe (1983).

2.6 Influence of Caloric Density of Diets on the Performance of Chickens

Physical and physiological activities of birds lead to energy expenditures. It is therefore of importance to relate these facts to the dietary energy available to the birds. The available energy in feedstuffs for poultry is expressed as metabolizable energy (ME) values. This also refers to the portion of dietary energy that is available to the animal for growth, production of eggs and meat, maintenance of the body temperature and other vital functions (Smith, 1990). The utilization of the ME above maintenance for fattening and growth are directly influenced by diet composition (De Groote, 1974).

Generally, chicken tends to adjust to its daily consumption of feed so as to maintain an appropriate level of energy intake within a certain limit (Smith, 1990; Parsons *et al.* 1994). Parsons *et al.* (1994) evaluated the effect of abrupt dietary energy changes on caloric intake and

performance of young laying hens. The authors concluded that 18-week-old pullets adapt rapidly to abrupt dietary energy changes by adjusting their feed, intake. Lewis *et al.* (1994) investigated the effect of dietary energy level and lighting regimen on energy intake and expenditure of laying hens. Hens were reared on a normal or high-energy ration and then Metabolic Energy intake and heat production were calculated for a one year laying period. Daily energy intake, heat production and feed conversion were not affected by energy level of the grower diet. Fat weight gain during the laying period was less for pullets reared on the high-energy grower diet, but fat-free weight gain during the laying period was not affected by the energy level of the grower diet. Birds with relatively large daily calorie intake adjust their calorie intake less efficiently than smaller birds that consume lesser amounts of calorie per day (Dawan *et al.*, 1975). In an inbalance of nutrients, the birds tend to compensate by consuming more food and hence more energy than is normal for their weight and the excess is either lost as heat or deposited as fat (Jackson, 1972). The effect observed in raising the energy level of feed is a reduction in the amount of feed consumed per kilogramme of egg or meat produced. Once the bird consumed sufficient amount of feed to satisfy her energy requirements, increase in the energy level of the diet results in proportionate reduction in feed intake (Sibbald and Price, 1975; Summers, 1975; Dawan *et al.*, 1975). Feed intake of chickens is inversely related to the dietary energy concentration (Farrell *et al.*, 1973; Olomu, 1976). Farrell *et al.* (1973) observed that there is both a minimum and optimum level of energy requirements by chickens for optimum performance. At very low energy concentrations the chicken may not consume enough feed to meet its energy requirements while at high energy concentrations, the chicken may consume more feed than is required for maximum growth rate and the excess may be

deposited as fat.

The energy requirements of birds reared under the tropical environment is lower than those reared under the temperate climate because of the differences in environmental temperatures (Olomu, 1976). Sugandi *et al.* (1975) observed depressed egg production at ME levels of 3050 kcal/kg diet while ME levels of 2650 and 2800 kcal/kg diet supported adequate egg production in the tropics. Similar results were reported by Scott (1974) and Olomu and Offiong (1983). They noted that the best ME level for layers in the tropics was about 2400 kcal/kg diet. These results therefore showed that ME requirements in the tropics are lower than those recommended for the temperate regions.

Balnave *et al.* (1978) observed that under *ad libitum* feeding conditions, the matured hen will consume more energy than what is required for body weight, maintenance and egg production. Hence this represents an inefficient utilization of energy. This excess energy is either stored as fat or lost as heat. ME intake of laying hens may be restricted by up to 10% of the *ad libitum* intake without affecting egg output. Jackson (1972) reported that the direct restriction of ME intake resulted in a marked improvement of ME conversion to egg production. This improved efficiency of ME utilization according to the author may not be due to the deprivation of the bird of excess calories, but may be due to a lower percentage of spillage with a decreased amount of feed being offered to the bird. While such feed restriction maintained egg production, a drop in body weight was observed. The effect of reduction of ME intake would be felt only on the body maintenance allowance. It is thus clear that the efficiency of feed conversion is directly related to the energy concentration of the diet.

Cassava peel meal which has ME value that is about 2/3 the value of maize (Aduku, 1992) will be a good ingredient to compound low energy diets that are more suitable for the tropical environment. Obioha and Anikwe (1982) recommended cassava peel meal as feed ingredient where high energy content of the diet is not desirable. The use of cassava peel in animal feed was earlier hampered by its high content of prussic acid especially the bitter variety. This has been taken care of by adopting different processing methods such as soaking and boiling (Longe, 1980; Longe *et al.* 1977; Obioha and Anikwe, 1982), ensiling and sun-drying (Obioha *et al.* 1984).

2.7 Influence of Dietary Fibre on Chicken Performance

Fibre is defined as that portion of feed that is resistant to the action of hot sulphuric acid (1.25% N_2SO_4) solution. Fibre consists primarily of cellulose, hemicellulose and lignin which are known to be almost nutritionally valueless to monogastric animals.

Lloyds *et al.* (1978) reported the digestibility of crude fibre by poultry, pigs and rabbits as ranging between 20 to 30, 3 to 25 and 16 to 18 percent respectively. According to Fetuga (1977) the differences in the available and utilizable energy contents of different feed materials are due to radical differences in their chemical composition particularly of fractions such as fat, nitrogen free extract and crude fibre. The author further stated that the greatest differences tend to result from differences in the absolute content as well as chemical components of the fibre fraction. Variation in the overall energy values of different feeds may result from the digestibility of these fractions which differ among materials. Smith (1990) reported that bulk in fibrous feeds stimulates peristalsis and secretion of enzymes and opens up concentrated food so that digestive juices can come into contact with them.

Olomu *et al.* (1983) reported that wheat offal with a crude fibre of about 10% may replace 25% of the maize in broiler starter and finisher diets with no significant adverse effect on weight gain ($P>0.05$). Feed cost per kilogramme gain may also be reduced by the replacement of up to 50% of the maize with wheat offal in finisher diets especially under extreme case of maize scarcity. The level of crude fibre (5.75%) fed by the above worker is higher than the NRC (1977) recommendation of 5%. In another report Olomu *et al.* (1984) found that when all the maize in the feed was replaced with wheat offal and the diet was fed from day-old to 20 weeks of age, there was a delay of 16 to 20 days in attaining the 50% egg production of the pullets. There was also a depression in body weight at 20 weeks of age. These workers concluded that the maize content of pullet rations could be reduced by 75% with no adverse effect on body weight, mortality and age at sexual maturity. Feed cost per bird to 20 weeks of age was significantly reduced than when the normal pullet diet was fed. Maisamari *et al.* (1990) also observed that wheat offal replaced up to 75% of the maize in the diet with significant improvement ($P<0.05$) in weight gain. Zero maize was reported to give similar weight gain as the control diet. Feed cost (₦/bird) was significantly reduced for the wheat offal diets. These workers fed diets of 7.75-8.5% crude fibre which is higher than the NRC (1977) recommendation of 6 to 7 per cent fibre for replacement pullets from 0-20 weeks of age with no adverse effect. Their results showed that pullets could tolerate up to 8% crude fibre in their diets. The source of fibre is more important than absolute amount or proportion in chick diets (An, 1994).

For the laying hens, Olomu *et al.* (1983) observed that the best egg production was obtained on the diet in which 50% of the maize in the control diet was replaced by 43.85%

wheat offal. Obeka (1985) reported that rice offal (37.55% crude fibre) could replace 40% of the maize in growing and laying diets with no adverse effect on growth rate or egg production. McNaughton (1979) fed 8.75% cellulose to laying hens and observed no significant effect on egg production but lower yolk cholesterol was observed. The crude fibre contents of between 7.78-8.79% fed to laying birds mentioned shows that these birds could tolerate a fibre content higher than 7% recommended by NRC (1977). In addition, despite these successes reported on the use of wheat and rice offals in poultry diets, farmers and feed millers must however watch out for the effect such high fibre, low energy diets during the hot season when feed intake may drop by 20-30% of the normal intake. During this time, it may be necessary to increase the energy density of the diets as well as the levels of the essential nutrients in the diets so as to maintain optimum level of performance. Likewise cassava peel meal with crude fibre of 9.3% (Osei and Duodu 1988) has been shown to support good production. In the study of Osei and Duodu (1988a & b) 15% cassava peel meal (either sun-dried or fermented) was adequate for growing broilers between 0-8 weeks of age, and the crude fibre of the diet was 3.9%.

CHAPTER 3

EFFECT OF GRADED LEVELS OF CASSAVA PEEL MEAL AND METHIONINE SUPPLEMENTATION ON BROILER PERFORMANCE

ABSTRACT

Six dietary levels of cassava peel meal (0, 5, 10, 15, 20 and 25% CPM) and two levels of methionine supplementation (0.15 and 0.35% methionine for the starter phase and 0.1 and 0.3% methionine for the finisher phase) were tested in a 6x2 factorial design to determine the optimum dietary level of CPM and methionine for broiler diets. The diets were iso-nitrogenous and iso-caloric for starter and finisher diets. Palm oil was used to balance for the energy in the diets.

The results indicated that there were no significant effects of dietary level of methionine supplementation on weight gain, feed consumption, feed cost and percentage mortality on broilers on 0.15 and 0.35% methionine during the starter phase. For the finisher phase (0.10 and 0.30% methionine) there were no significant dietary effects on weight gain, feed consumption, feed efficiency and percentage mortality. This lack of significant effect of methionine supplementation infers that cyanide was not a limiting factor in diets containing up to 25% of CPM. Also, there were no significant differences in the final weight gain of broilers fed up to 25% CPM when compared to gains obtained on control diets. The trial indicated that iso-caloric and iso-nitrogenous CPM diets with 0.15 and 0.10% methionine supplementation in

the starter and finisher diets respectively is adequate and that cyanide is not a limiting factor in the utilization of sun-dried CPM.

Key words: *Broilers, Cassava peel meal, cyanide and methionine.*

INTRODUCTION

Cassava peel (2325 Kcal ME/kg) is an energy, waste by-product obtained from the peelings of cassava tubers for human and animal feeding. The peels are readily available from starch, fermented cassava, "garri" and cassava chips processing industries in Nigeria. With the prices of conventional feedstuffs escalating, the need to source for alternative feed resources cannot be over emphasized. However, the hydrocyanide content of cassava roots and peels has been the major constraint in its usage for poultry diets.

The cyanide content of cassava root varies with the plant variety and may range between 75 and 1000 mg cyanide/kg (Piva, 1987). The peel contains between 2 and 48 times more cyanogenic glucosides than the parenchyme (Gomez, 1983). Cyanogenic glucosides release the highly toxic hydrocyanic acid (HCN) when it became hydrolyzed by the enzyme linamarase which is present in the cassava root peel or by the glucosidic enzymes of intestinal microflora (Fomunyam *et al.*, 1984). HCN obstructs respiratory process in animal tissues by deactivating the cytochrome-oxidase enzyme (Pudek and Bragg, 1974). At high doses this reversible reaction can lead to a sufficient build-up of lactate in the brain to cause degeneration of nerves (Smith *et al.*, 1963). Hydrogen cyanide (HCN) is detoxified in the liver by the enzyme rhodanes to thiocyanate (SCN) which is excreted in the urine (Oke, 1973). This detoxification process utilises sulphur from methionine (Westley, 1981) and the animal requirement for this amino-acid

increases in cassava based died (Adegbola, 1977).

There are differing views on the maximum concentration at which cassava root meal of different cyanide content can be included in poultry diets without any adverse effects on production. Recommendations for inclusion of cassava root meal in diets range between 100g/kg (Vogt, 1966) and 450 g/kg (Eshiett and Ademosun, 1980). In the study by Gomez *et al.* (1988) cyanide content of 83 mg/kg diet achieved by including cassava at 300 g/kg did not adversely affect chick growth. However, Gowdh *et al.* (1990) reported that cassava root meal produced a growth depression when included in the diet at 486 g/kg.

The present study was undertaken to study the effect of methionine supplementation on the utilization of CPM in broiler diets.

MATERIALS AND METHODS

CPM used in this study was obtained from a composite of a local Nigerian varieties. The tubers were harvested and peeled with knives. About 0.25 cm of the pulp was removed with the outer rind during the peeling process. The peels were sun-dried on concrete floors until the moisture was reduced to between 8 and 10% in an atmosphere of 14.5% humidity at 21°C for 14 days. The peels were then milled with a hammer mill. The chemical composition of the CPM was determined by the A.O.A.C 1970 methods. A 6x2 factorial design was used to test six levels of cassava peel meal and 2 levels of methionine both at the starter and finisher phases. The levels of CPM used for the starter and finisher phases were 0, 5, 10, 15, 20 and 25%. The levels of methionine used for the starter phase were 0.15 and 0.35 and for the finisher phase were 0.10 and 0.30. The proximate analysis of the CPM and the chemical composition for the

starter and finisher diets are presented in Tables 3.1, 3.2 and 3.3 respectively.

Five hundred and forty day-old broiler chicks were purchased from a local hatchery and were used for this study. Each treatment consisted of three replicates of 15 birds. Complete randomised block design was used for this study. Body weight of replicate groups and their feed consumption were taken every two weeks throughout the study. Mortalities were recorded as they occured. At the end of the experiment six birds were randomly selected from each treatment and bled. The serum thiocyanate levels were determined (Bowler, 1944).

The data were subjected to the analysis of variance using the factorial design. Significant differences between treatment means were determined by the application of Duncan's Multiple Range Test at 5% level of probability (Steel and Torrie, 1960.

RESULTS

The table of means for response of variable for the starter, finisher and combined starter and finisher phases are presented in Tables 3.4, 3.5 and 3.6. The results for the starter phase (Table 3.4) showed that the different levels of CPM in the diets did not have any significant ($P>0.05$) effect on weight gain, feed consumption, feed efficiency and mortality rate. Only feed cost of the 20 and 25% CPM rations were significantly higher ($P<0.05$) than that of the control and other diets. For the two levels of methionine used, the higher level (0.35% DL-methionine gave significantly ($P\leq0.05$) higher weight gain and better feed efficiency than the 0.15% DL-methionine supplementation while the feed cost was not significantly affected.

Table 3.5 shows that during the finisher phase, weight gained on the 25% CPM diet was significatnly lower than weight gained on the control (0% CPM) diet. Feed cost was

significantly ($P \leq 0.05$) higher for the 25% CPM diet than the control diet. For the methionine levels only feed cost was significantly ($P \leq 0.05$) higher for the 0.30% methionine supplemented diet.

For the starter and finisher phases combined (0-8 weeks) the results are presented in table 3.6. Dietary levels of CPM did not have any significant effect on weight gain up to 20% level, but at 25% CPM level, there was a significant depression in weight gain. There was no significant difference in feed efficiency, feed consumption and mortality rate, but feed cost was significantly ($P < 0.05$) higher than that of the control at 20 and 25% CPM in the diet. The two levels of methionine used in the study did not have any significant effect on all the parameters measured.

DISCUSSION

The results of this study demonstrate that the levels of inclusion of CPM in broiler starter diets (Table 3.4) did not significantly ($P > 0.05$) reduce the performance of the broilers in terms of weight gain, feed consumption, feed efficiency and mortality rate. In terms of cost, CPM could only be used up to 15% level. Beyond this level, feed cost was significantly higher ($P \leq 0.05$) than that of the control feed. Supplemental methionine level of 0.35% in the diet was found to significantly improve weight gain and the efficiency of feed utilization. This result clearly indicate that CPM contain some residual cyanide which methionine helps to detoxify in the starter diet. In the study of Panigrahi *et al.* (1992), it was shown that slow drying of cassava root chips significantly reduced the total cyanide content of the root to 481.7 and 38.4 g/kg dry matter for 24 and 72 hours drying respectively. The CPM used in this study was sun-dried (for

approximately 14 days) and hence must have lost most of its cyanide content. The two levels of methionine used did not have any significant effect on feed consumption, feed cost and mortality rate. In terms of weight gain, birds on 0.35% methionine gained significantly ($P \leq 0.05$) more weight than those fed 0.15% methionine. In addition, the feed usage of birds on 0.35% methionine were significantly better utilized by the birds. The conjugation of cyanide with sulphur to form thiocyanate is the most important pathway for cyanide detoxification. It is the sulphur content of the sulphur amino acids that makes them important in cyanide metabolism. Therefore, in the above study it is indicative that the 0.35% DL-methionine provided more sulphur for the detoxification process than the amount supplied by the lower level of methionine supplementation.

The results for the finisher stage (Table 3.5) shows clearly that energy is the limiting factor in CPM utilization (Sekoni *et al.*, 1994). The inclusion of methionine at both 0.1 and 0.30% did not have any significant effect on all the parameters measured except feed cost. This effect on feed cost should be expected because of the high cost of methionine. Also for this phase, CPM could only be used up to 20% inclusion. Above this level, there is a significant decrease in weight gain and feed efficiency and a significant increase in feed cost. This is expected because as the inclusion rate increases, the amount of oil needed to balance the ration to meet the energy requirement also increases which subsequently increases the feed cost (Table 3.2).

The results for the combined starter and finisher stage presented in Table 3.6 shows similar trends as that of the finisher stage in Table 3.5. In terms of weight gain and feed cost, cassava peel meal could be used up to 20% without any significant effect. Also, the levels of

methionine used did not have any significant effect on all the parameters measured. This overall results shows that cassava peel meal could be used up to 20% inclusion rate without adversely affecting production.

In conclusion, for the starter phase (i.e. 0-4 weeks) CPM should not be included beyond 15% at a methionine level of 0.35% while for the finisher stage (i.e. 4-8 weeks), the CPM can be included up to 20% with 0.10% methionine.

Table 3.1: Analysis of sun-dried cassava peel meal (As fed basis)

FRACTION	COMPOSITION*
Dry Matter %	94.30
Crude Protein %	5.70
Crude Fibre %	9.26
Ether Extract %	0.71
Ash %	8.30
Nitrogen Free Extract %	69.30
Gross Energy (Kcal/kg)	3390.00
Metabolizable Energy (Kcal/kg)	2325.00
Free HCN (mg/kg)	45.75

*Means of 3 determinations.

Table 3.2: Graded Levels of Cassava Peel meal in Broiler Starter Diets

Ingredients/Diets	1	2	3	4	5	6	7	8	9	10	11	12
Maize	51..65	51.90	44.00	44.25	36.35	36.60	28.71	28.96	21.06	21.35	13.40	13.66
Cassava Peel Meal	0.00	0.00	5.00	5.00	10.00	10.00	15.00	15.00	20.00	20.00	25.00	25.00
Soyabean Cake	41..50	41.00	42.40	41.90	43.30	42.80	44.20	43.70	45.10	44.38	46.00	45.50
Palm Oil	1.60	1.65	3.35	3.40	5.10	5.15	6.84	6.89	8.59	8.42	10.35	10.39
Limestone	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Borne Meal	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Premix*	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Methionine	0.15	0.35	0.15	0.35	0.15	0.35	0.15	0.35	0.15	0.35	0.15	0.35
Total =	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Calculated Analysis:												
Metabolizable (Energy Kcal/kg)	2864.10	2864.10	2864.30	2864.30	2864.50	2864.34	2864.50	2864.34	2864.12	2864.02	2864.74	2864.74
Cyanide (mg/kg)	0.00	0.00	4.38	4.38	8.75	8.75	13.13	13.13	17.5	17.5	21.88	21.88
Crude protein (%)	23.01	23..01	23.01	23.01	23.01	23.01	23.02	23.02	23.02	23.02	23.02	23.03
Crude fibre (%)	4.15	4.07	4.41	4.38	4.72	4.70	5.04	5.01	5.35	5.31	5.67	5.61
Clacium (%)	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74
Available Phosphorus (%)	0.74	0.74	0.73	0.73	0.72	0.72	0.71	0.71	0.71	0.71	0.70	0.70
Lysine (%)	1.25	1.24	1.26	1.25	1.26	1.25	1.27	1.26	1.27	1.26	1.28	1.26
Methionine (%)	0.51	0.70	0.50	0.69	0.49	0.68	0.48	0.67	0.46	0.66	0.45	0.65
Cystine (%)	0.34	0.34	0.33	0.33	0.33	0.32	0.32	0.32	0.31	0.31	0.31	0.30
Methionine + Cystine (%)	0.85	1.04	0.83	1.02	0.82	1.00	0.80	0.99	0.77	0.97	0.76	0.95
Feed Cost(N/kg)	10.15	10.51	10.35	10.70	10.54	10.89	10.73	11.09	10.93	11.25	11.12	11.47

Table 3.3: Graded Levels of Cassava Peel meal in Broiler Finisher Diets

Ingredients/Diets	1	2	3	4	5	6	7	8	9	10	11	12
Maize	54..1	54.35	46.46	46.70	38.80	39.05	31.15	31.40	23.50	23.75	15.85	16.10
Cassava Peel Meal	0.00	0.00	5.00	5.00	10.00	10.00	15.00	15.00	20.00	20.00	25.00	25.00
Soyabean Cake	36.70	36.20	37.60	37.10	38.50	38.00	39.40	38.90	40.30	39.80	41.20	40.70
Palm Oil	4.00	4.05	5.75	5.80	7.50	7.55	9.25	9.30	11.00	11.05	12.75	12.80
Limestone	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Borne Meal	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Premix*	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Methionine	0.10	0.30	0.10	0.30	0.10	0.30	0.10	0.30	0.10	0.30	0.10	0.30
Total =	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Calculated Analysis:												
Metabolizable (Energy Kcal/kg)	3000.2	3000.2	3000.4	3000.4	3000.6	3000.6	3000.8	3000.8	3001.0	3001.2	3001.2	3001.2
Cyanide (mg/kg)	0.00	0.00	4.38	4.38	8.75	8.75	13.13	13.13	17.5	17.5	21.88	21.88
Crude protein (%)	21.06	21.07	21.07	21.07	21.07	21.07	21.07	21.07	21.08	21.08	21.08	21.08
Crude fibre (%)	3.85	3.82	4.61	4.13	4.48	4.46	4.794	4.76	5.10	5.03	5.42	5391
Clacium (%)	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74
Available Phosphorus (%)	0.63	0.63	0.62	0.62	0.62	0.62	0.61	0.61	0.61	0.61	0.60	0.60
Lysine (%)	1.13	1.13	1.13	1.13	1.13	1.13	1.14	1.13	1.15	1.13	1.15	1.14
Methionine (%)	0.43	0.63	0.42	0.62	0.41	0.61	0.40	0.60	0.39	0.59	0.38	0.58
Cystine (%)	0.31	0.31	0.31	0.30	0.30	0.30	0.29	0.29	0.29	0.28	0.28	0.28
Methionine + Cystine (%)	0.74	0.94	0.73	0.92	0.71	0.91	0.69	0.89	0.68	0.87	0.64	0.85
Feed Cost(N/kg)	9.99	10.34	10.18	10.53	10.37	10.72	10.57	10.92	10.76	11.11	10.95	11.31

Table 3.4: Response of Starter Broilers (0-4 weeks) to CPM and Methionine levels

Treatment	Weight gain (g)	Feed consumption (g)	Feed Conversion Ratio	Feed cost/kg gain (₦)	Mortality (%)
CPM Levels					
1 (0%)	1016.50	20485.00	2.02	20.83[b]	2.22
2 (5%)	1000.17	2036.17	2.04	21.49[ab]	0.00
3 (10%)	1013.67	2041.00	2.00	21.63[ab]	1.11
4 (15%)	1021.67	2082.00	2.03	21.48[ab]	1.11
5 (20%)	1046.67	2024.17	2.00	22.75[a]	1.11
6 (25%)	1025.00	2069.17	2.09	22.82[a]	0.00
SEM[1]	25.11	33.51	0.05	0.62	1.44
Methionine Levels					
1 (0.15%)	1003.22[b]	2045.94[a]	2.07[a]	21.72[a]	1.48[a]
2 (0.35%)	1038.00[a]	2054.39[a]	2.00[b]	21.78[a]	0.37[a]
SEM[1]	25.11	33.51	0.05	0.62	1.44
Interaction:					
CPM Levels	**Methionine Levels**				
0%	0.15%	951.67	1983.33	2.09	21.12	2.22
0%	0.35%	1081.33	2113.67	1.96	20.54	2.22
5%	0.15%	1046.67	2064.67	1.98	20.43	0.00
5%	0.35%	953.67	2007.67	2.11	22.56	0.00
10%	0.15%	968.67	2068.67	2.15	22.54	2.22
10%	0.35%	1058.67	2013.33	1.88	20.73	0.00
15%	0.15%	998.67	2058.67	2.06	22.15	2.22
15%	0.35%	1044.67	2105.33	2.01	22.35	0.00
20%	0.15%	1035.67	2067.33	2.06	21.87	2.22
20%	0.35%	1057.67	1918.00	1.93	21.09	0.00
25%	0.15%	1018.00	2033.00	2.06	22.24	0.00
25%	0.35%	1032.00	2105.33	2.11	23.40	0.00
SEM[1]		53.95	61.43	0.10	1.00	0.86

1 = Standard effort of the means.
ab = Means within each column with different superscripts are significantly different ($P \leq 0.05$).

Table 3.5: Response of Finisher Broiler (4-8 weeks) to CPM and Methionine Levels

Treatment	Weight gain (g)	Feed consumption (g)	Feed Conversion Ratio	Feed Cost/kg gain(₦)	Mortality (%)
CPM Levels					
1 (0%)	1104.17^{ab}	3498.67	3.20^{bc}	32.43^{b}	1.11
2 (5%)	1125.50^{a}	3505.17	3.13^{c}	32.46^{b}	0.00
3 (10%)	1036.50^{bc}	3541.67	3.42^{ab}	32.81^{b}	2.22
4 (15%)	1102.17^{ab}	3548.00	3.22^{bc}	34.63^{b}	1.11
5 (20%)	1161.00^{a}	3526.33	3.04^{c}	33.23^{b}	4.45
6 (25%)	991.67^{c}	3549.00	3.60^{a}	38.11^{a}	0.00
SEM[1]	31.40	67.10	0.11	1.12	1.81
Methionine Levels					
1 0.10	1094.61^{a}	3540.67^{a}	3.25^{a}	33.96^{a}	1.11^{a}
2 0.30	1079.06^{a}	3515.61^{a}	3.29^{a}	35.59^{b}	1.85^{a}
SEM[1]	31.40	67.10	0.11	1.12	1.81
Interaction:					
CPM Level	**Methionine Level**				
0%	0.10%	1016.67	3469.67	3.43	34.23	0.00
0%	0.30%	1191.67	3527.67	2.96	30.62	2.22
5%	0.10%	1198.00	3524.33	2.94	29.95	0.00
5%	0.30%	1053.00	3486.00	3.32	34.97	0.00
10%	0.10%	1042.00	3491.67	3.35	34.44	0.00
10%	0.30%	941.33	3606.33	3.84	41.17	4.45
15%	0.10%	1126.33	3625.00	3.32	34.03	2.22
15%	0.30%	1078.00	3471.00	3.23	35.22	0.00
20%	0.10%	1143.00	3589.00	3.14	33.79	4.44
20%	0.30%	1179.00	3463.67	2.94	32.67	4.45
25%	0.10%	1041.67	3544.33	3.41	37.34	0.00
25%	0.30%	1031.33	3539.00	3.43	38.87	0.00
SEM[1]		80.04	73.26	0.25	2.70	1.62

1 = Standard error of the means.
ab = Means within each column with different superscript are significantly different ($P \leq 0.05$).

Table 3.6: Response of combined Starter and Finisher Broiler Phases (0-8 weeks) to CPM and Methionine levels

Treatment	Weight gain (g)	Feed consumption (g)	Feed Conversion Ratio	Feed cost/kg gain(₦)	Mortality (%)
(CPM Levels)					
1 (0%)	2127.67[a]	5547.17	2.62	53.88[c]	2.22
2 (5%)	2117.33[a]	5511.50	2.61	53.79[c]	1.11
3 (10%)	2062.83[ab]	5590.00	3.30	54.71[c]	3.33
4 (15%)	2123.83[a]	5613.33	2.64	56.88[ab]	2.28
5 (20%)	2124.33[a]	5550.50	2.52	59.60[ab]	5.61
6 (25%)	2005.33[b]	5610.83	2.72	60.93[a]	0.00
SEM[1]	42.82	80.54	0.32	1.96	2.35
Methionine Levels					
1(0.15,0.10)%	2100.17[a]	5586.61[a]	2.67[a]	55.95[b]	3.00[a]
2(0.35,0.30)%	2120.28[a]	5554.50[a]	2.80[a]	57.31[a]	1.85[a]
SEM[1]	42.82	80.54	0.32	1.96	2.35
Interaction:					
CPM Levels	**Methionine Levels**				
0%	0.15;0.10%	1982.33	5453.00	2.76	56.59	2.22
0%	0.35;0.30%	2273.00	5641.33	2.48	51.17	2.22
5%	0.15;0.10%	2244.67	5589.00	2.49	50.38	0.00
5%	0.35;0.30%	1990.00	5434.00	2.73	57.20	0.00
10%	0.15;0.10%	2010.67	5560.33	2.78	57.30	2.22
10%	0.35;0.30%	2000.00	5619.67	2.82	57.90	4.45
15%	0.15;0.10%	2125.00	5683.67	2.67	56.18	4.56
15%	0.35;0.30%	2122.67	5543.00	2.61	57.57	0.00
20%	0.15;0.10%	2178.67	5656.33	2.60	55.66	6.78
20%	0.35;0.30%	2270.00	5444.67	2.43	53.76	4.45
25%	0.15;0.10%	2059.67	5577.33	2.71	59.58	0.00
25%	0.35;0.30%	2066.00	5644.33	2.74	62.27	0.00
SEM[1]		278.76	250.91	0.76	7.02	3.75

1 = Standard error of the means

a.b = Means within each column with different superscript are significantly different ($P \leq 0.05$).

CHAPTER 4

THE SUPPLEMENTARY EFFECT OF PALM OIL ON GRADED LEVELS OF CASSAVA PEEL MEAL IN BROILER DIETS

ABSTRACT

A feeding trial was conducted to investigate the effect of graded levels of cassava peel meal (CPM) in broiler diets fortified with palm oil to balance for energy. Six levels of CPM were tested namely: 0, (control), 5, 10, 15, 20 and 25% of the ration using 0.15% methionine for each level of CPM for the starter phase and 0.10% methionine for each level of CPM in the finisher phase. All diets were iso-caloric and iso-nitrogenous, containing 2864 Kcal metabilizable energy (ME) per kg diet and 23% crude protein (CP) for the starter phase and 3,000 Kcal ME and 21% CP per kg diet for the finisher phase. The trial lasted for 4 weeks (0-4 weeks) for the starter phase and 4 weeks (4-8 weeks) for the finisher phase.

The results of the study indicated that cassava peel meal could be used up to 25% level of inclusion in the broiler starter rations without affecting the performance of the birds. For the finisher stage, the inclusion rate should not be more than 20% in order to have economic gains. Mortality rates for both phases of the study were very low and were not significantly different ($P>0.05$) from those of the control diets. This shows that there was no evidence of cyanide toxicity.

INTRODUCTION

Cassava peel is a medium energy (2324 Kcal ME/kg) waste by-product obtained from the peelings of cassava tubers for human and animal feeding. Until recently not much attention has been paid to this main by-product of cassava. The peels are readily available from starch, fermented cassava 'garri' and cassava chips processing industries in Nigeria. They are generally thrown away into rubbish dumps, although small fractions may be fed fresh to sheep and goats or cooked and fed to pigs on small holdings. With the prices of conventional feedstuffs escalating, the need to source for alternative feed resources cannot be over-emphasized.

Osei and Duodu (1988a) fed 5, 10 and 15% CPM to day-old broiler chicks. In their study, animal protein in form of fish meal was used at between 21-22.5% of the diet. Feed consumption significantly ($P<0.05$) increased with the addition of sun-dried CPM. Live weights were significantly ($P<0.05$) improved by the 5% CPM diet above the result for the control diet. But there were no significant differences in the live-weights for the control diet and those for 10 or 15% CPM diets.

Eshiett and Ademosun (1981) fed commercial pullets three iso-nitrogenous diets containing 0, 10 and 20% CPM for twelve weeks. Their results showed that during the growing stage, birds fed 0% CPM consumed less feed ($P<0.01$) and were more efficient ($P<0.01$) in their feed utilization than the CPM treated groups. There were no differences between the 10 and 20% CPM fed birds in their efficiency of feed conversion and feed intake. During the laying stage, the attainment of sexual maturity, feed consumption, egg production, efficiency of feed conversion and egg weight were not significantly ($P>0.05$) affected by the level of CPM fed during the growing stage.

Tewe and Kasali (1986) fed weanling giant rats four diets prepared to contain 31.12% of either corn (control) or processed cassava peels (sun-dried, oven dried or fermented). The trial lasted for forty-two days. Performance was best for those on control diet and poorest on the oven dried CPM. Metabolizable energy and nitrogen retention were poorer in giant rats fed the cassava peel rations.

The objective of this study was to evaluate the performance of broilers on graded levels of cassava peel meal fortified with palm oil to balance for energy.

MATERIALS AND METHODS

Cassava peel meal used in this study was obtained from a composite of local Nigerian varieties. The tubers were harvested and peeled with knives. About 0.25cm of the pulp was removed with the outer rind during the peeling process. The peels were sun-dried on concrete floors until the moisture was reduced to between 8 and 10% in an atmosphere of 14.5% humidity at 21°C for 14 days. It was then milled with a hammer mill. The chemical composition of the CPM was determined by methods of A.O.A.C. (1970).

Rations 1-6 were formulated to contain 0, 5, 10, 15, 20 and 25% CPM. Methionine was supplemented at 0.15% and 0.10% in starter and finisher rations respectively. Palm oil was added to the diets to balance for energy. The proximate analyses of CPM and the composition for the starter and finisher diets are presented in Tables 4.1, 4.2 and 4.3 respectively.

Two hundred and seventy day-old broiler chicks purchased from a local hatchery were used for this study. Each treatment consisted of three replicates of 15 birds each. Complete randomised block design was used for this study. Body weight of replicate groups and their feed

consumption were taken every two weeks through-out the study. Mortality rates were recorded daily. At the end of the experiment, six birds were randomly selected from each treatment and bled. The serum thiocyanate levels were determined (Bowler, 1944).

The Data were subjected to analaysis of variance and significant differences between treatment means were assessed by Duncan's Multiple Range Test (Steel and Torrie, 1960).

RESULTS AND DISCUSSION

The performance of the broilers on the starter (0-4 weeks), finisher diets (4-8 weeks) and the over-all performance (0-8 weeks) are presented in Tables 4.4, 4.5 and 4.6 respectively. In the starter phase, the inclusion of cassava peel meal up to 25% did not have any significant effect on weight gain, feed consumption, feed efficiency, feed cost per kilogramme gain and percentage mortality. The result show that the sun-dried cassava peel used for this study did not have any adverse effect on the birds. The result also shows that an iso-nitrogenous and iso-caloric ration of CPM up to 25% can be fed economically to broilers without detrimental effect during the starter phase. It is also interesting to note that broilers used for this study were able to tolerate crude fibre content of between 4.15 to 5.67%. The limiting factor to the use of cassava peel meal is the low energy content (Eshiett and Ademosun, 1981) and not high cyanide level (Alli-Balogun, 1989). The energy content of the cassava peel meal is about two thirds of the energy of maize and hence the energy of the diet need to be improved by the inclusion of vegetable oil. The higher the inclusion rate of CPM in the diet, the higher the amount of fat or oil required to meet the energy requirement of the broilers at the starter phase (Table 4.2). This result support the work of Osei and Duodu (1988a) who could not go beyond 15% CPM because

of its low energy content.

The finisher stage showed no significant difference in feed consumption and percentage mortality. This shows that the diets were iso-caloric and cyanide had no adverse effect up to 25% CPM inclusion in the diet. There were a highly significant difference ($P<0.01$) in weight gain, feed conversion ratio and feed cost per kilogramme gain on the birds fed the finisher rations (Table 4.5). There was no significant difference between birds on the control diet and those on 10, 15, 20 and 25% CPM. However, there was a highly significant difference ($P<0.01$) between birds fed control diet and 5% CPM which did not follow any trend as was observed by Osei and Duodu (1988a). This improvement in weight gain, feed conversion ratio and feed cost/kg gain may be due to higher numbers of males in the replicates fed 5% CPM. Also, at 5% CPM, feed conversion ratio and feed cost per kilogramme gain were significantly ($P<0.01$) better than the control. For this stage of the study, the birds fed 5% CPM diet performed significantly ($P<0.01$) better than the control birds in terms of weight gain and feed conversion ratio. Also, feed cost per kilogramme gain was significantly ($P<0.01$) less when compared with the control diet. The other four diets (10, 15, 20 and 25% CPM) were comparable to the control except the 25% CPM which was significantly ($P<0.01$) the most expensive (₦37.34/kg gain) of all the diets.

The overall effect of graded levels of cassava peel meal on broiler growth (0-8 weeks) is similar to the results of the finisher stage (Table 4.6). Treatment 2 was the most superior in terms of weight gain, feed conversion ratio and feed cost per kilogramme gain, while the other diets were comparable to the control diet in all parameters measured. The results clearly show that cassava peel meal could be included in the broiler diets up to 25%. It is also evident from

the results that the cassava peel meal did not have any detrimental effect on the growth performance of the birds up to 25% inclusion rate. The crude fibre content of 5.67 and 5.42% for the starter and finisher rations respectively did not have any significant effect on feed consumption.

The serum thiocyanate levels (Table 4.6) for all cassava peel meal diets did not show any significant difference ($P>0.05$) when compared with the control treatment which contained no cassava peel meal. This clearly shows that the sun-dried cassava peel meal did not contain cyanide at a concentration that could be toxic to the birds even at a dietary level as high as 25%.

In conclusion, the energy and not the cyanide content of the cassava peel may be the only limitation in its usage in broiler diets since broilers require high energy level feed to meet their fast growth rate requirement. A cheap source of fat or oil will promote the usage of the CPM up to 25% as shown in this study without any detrimental effect.

Table 4.1: ANALYSIS OF CASSAVA PEEL MEAL (AS FED BASIS)

Fraction	Composition*
Dry Matter %	94.30
Crude Protein %	5.70
Crude Fibre %	9.26
Ether Extract %	0.71
Ash %	8.30
Nitrogen Free Extract %	69.30
Gross Energy (Kcal/kg)	3390.00
Metabolizable Energy (Kcal/kg)	2324.00

***Means of 3 determinations.**

Table 4.2: Graded Levels of Cassava Peel Meal (CPM) in Broiler Starter Diet

Ingredients/Diets or Rations	1	2	3	4	5	6
Maize	51.65	44.00	36.35	28.71	21.06	13.40
Cassava Peel Meal (CPM)	0.00	5.00	10.00	15.00	20.00	25.00
Soya-bean cake	41.50	42.40	43.30	44.20	45.10	46.00
Palm oil	1.60	3.35	5.10	6.84	8.59	10.35
Limestone	1.50	1.50	1.50	1.50	1.50	1.50
Bone-meal	3.00	3.00	3.00	3.00	3.00	3.00
Premix	0.30	0.30	0.30	0.30	0.30	0.30
Salt	0.30	0.30	0.30	0.30	0.30	0.30
Methionine	0.15	0.15	0.15	0.15	0.15	0.15
Total	100.00	100.00	100.00	100.00	100.00	100.00
Calculated Analysis						
Metabolizable Energy (Kcal/kg)	2864.1	2864.3	2864.5	2864.5	2864.12	2864.74
Crude Protein (%)	23.01	23.01	23.01	23.02	23.02	23.02
Crude Fibre (%)	4.15	4.41	4.72	5.04	5.35	5.67
Calcium (%)	1.74	1.74	1.74	1.74	1.74	1.74
Available Phosphorus (%)	0.74	0.73	0.72	0.71	0.71	0.70
Lysine (%)	1.25	1.26	1.26	1.27	1.27	1.28
Methionine (%)	0.51	0.50	0.49	0.48	0.46	0.45
Cystine (%)	0.34	0.33	0.33	0.32	0.31	0.31
Methionine + Cystine (%)	0.85	0.83	0.82	0.80	0.77	0.76
Cost/kg feed (N/kg)	10.15	10.35	10.54	10.73	10.93	11.12

Table 4.3: Graded Levels of Cassava Peel Meal (CPM) in Broiler Finisher Diet

Ingredients/Diets or Rations	1	2	3	4	5	6
Maize	54.10	46.45	38.80	31.15	23.50	15.85
Cassava peel meal(CPM)	0.00	5.00	10.00	15.00	20.00	25.00
Soya-bean cake	36.70	37.60	38.50	39.40	40.30	41.20
Palm oil	4.00	5.75	7.50	9.25	11.00	12.75
Lime-stone	1.50	1.50	1.50	1.50	1.50	1.50
Bone-meal	3.00	3.00	3.00	3.00	3.00	3.00
Premix	0.30	0.30	0.30	0.30	0.30	0.30
Salt	0.30	0.30	0.30	0.30	0.30	0.30
Methionine	0.10	0.10	0.10	0.10	0.10	0.10
Total	100.00	100.00	100.00	100.00	100.00	100.00
Calculated Anaylsis						
Metabolizable Energy(Kcal/kg)	3000.2	3000.4	3000.6	3000.8	3001.0	3001.2
Crude protein (%)	21.06	21.07	21.07	21.07	21.08	21.08
Crude fibre(%)	3.85	4.16	4.48	4.79	5.10	5.42
Calcium (%)	0.63	0.62	0.62	0.61	0.61	0.60
Available phos-phorus(%)	1.13	1.13	1.13	1.14	1.15	1.15
Lysine (%)	0.43	0.42	0.41	0.40	0.39	0.38
Methionine (%)	0.31	0.31	0.30	0.29	0.29	0.28
Cystine (%)	0.74	0.73	0.71	0.69	0.68	0.66
Feed cost/kg (N/kg)	9.99	10.18	10.37	10.57	10.76	10.95

Table 4.4: Effect of Graded Levels of Cassava Peel Meal on Broiler Performance (0-4 weeks)[1]

Treatments (Levels of CPM)	Weight gain (g)	Feed consump-tion (g)	Feed Conversion Ratio	Feed Cost/ kg gain (N/kg)	Mortality (%)
1 (0%)	951.67	1983.33	2.09	21.12	2.22
2 (5%)	1046.67	2064.67	1.98	20.43	0.00
3 (10%)	968.67	2068.67	2.15	22.54	2.22
4 (15%)	998.67	2058.67	2.06	22.15	2.22
5 (20%)	1035.67	2067.33	2.06	21.87	2.22
6 (25%)	1018.00	2033.00	2.06	22.24	0.00
SEM[2]	26.83	27.17	0.06	0.74	1.82

1. Means obtained from 45 broilers in three replicates of 15 broilers each.

2. SEM - Standard Error of the Means.

Table 4.5: Effect of Graded Levels of Cassava Peel Meal on Broiler Performance (4-8 weeks)[1]

Treatment (Levels of CPM)	Weight gain (g)	Feed consump-tion (g)	Feed Conversion Ratio	Feed Cost/ kg gain (N/kg)	Mortality (%)
1 (0%)	1016.67[c]	3469.67	3.43[a]	34.23[b]	0.00
2 (5%)	1198.00[a]	3524.33	2.94[b]	29.95[c]	0.00
3 (10%)	1042.00[bc]	3491.67	3.35[a]	34.44[b]	0.00
4 (15%)	1126.33[abc]	3625.00	3.32[a]	34.03[b]	2.22
5 (20%)	1043.00[bc]	3589.00	3.14[ab]	33.79[b]	4.43
6 (25%)	1041.67[bc]	3544.33	3.41[a]	37.34[a]	0.00
SEM[2]	33.93	68.78	0.086	0.863	2.03

1. Means obtained from 45 broilers in three replicates of 15 broilers each.

2. SEM = Standard Error of the Means.

3. abc Means within each column with different superscript are significantly different ($P < 0.01$).

Table 4.6: Effect of Graded Levels of Cassava Peel on Broiler Performance (0-8 weeks)[1]

Treatments (Levels of CPM)	Weight gain (g)	Feed consumption (g)	Feed Conversion Ratio	Feed cost/kg gain (N/kg)	Serum thiocyanate level (mg/100 ml)	Mortality (%)
1 (0%)	1982.33^{c}	5453.00^{a}	2.76^{ab}	56.59^{a}	1.00^{a}	2.22
2 (5%)	2244.67^{a}	5589.00^{a}	2.49^{c}	50.38^{b}	1.13^{a}	2.22
3 (10%)	2010.67^{c}	5560.33^{a}	2.78^{a}	57.30^{a}	1.13^{a}	2.22
4 (15%)	2125.00^{abc}	5683.67^{a}	2.67^{ab}	56.18^{a}	1.24^{a}	4.56
5 (20%)	2078.67^{bc}	5656.33^{a}	2.60^{bc}	55.66^{a}	1.33^{a}	6.78
6 (25%)	2059.67^{bc}	5577.33^{a}	2.71^{ab}	59.58^{a}	1.31^{a}	0.00
SEM[2]	44.87	72.69	0.051	1.24	0.50	2.92

1. Means obtained from 45 broilers in three replicates of 15 broilers each.

2. SEM = Standard Error of the Means.

3. abc Means within each column with different superscript are significantly different ($P < 0.01$).

CHAPTER 5

Effect of Graded Levels of of Cassava Peel Meal (CPM) on Pullets Chicks and Growers

ABSTRACT

A feeding trial was conducted to investigate the effect of graded levels of sun-dried cassava peel meal (CPM) on the growth rate of pullet chicks and growers. Nine levels of CPM at 0, (control), 5, 10, 15, 25, 30, 35 and 40-percent of the diets were fed during both the chicks' and growers' studies. All diets were iso-nitrogenous containing 20 and 15.55% crude protein (CP) for the chick and grower diets respectively. The trial lasted for a period of eight weeks for the chick phase and twelve weeks for the grower phase.

The results indicated that the chicks fed up to 20% CPM in the diets were not significantly ($P > 0.05$) different from those fed on the control diet in terms of weight gain and feed intake.

Also, feed efficiencies of the chicks fed 5 and 10% CPM diets were not significantly different from that of the control. For the grower phase, weight gains and feed efficiencies of the birds fed up to 25% CPM in the diets were not significantly ($P \geq 0.05$) different from those on the control diet.

It was concluded that chicks could be fed up to 20% CPM in the diet while growers could be fed 25% CPM diet without adverse effect on the performance. For the two phases of the study, mortality rates for the birds fed CPM diets were not significantly different from that

of the control group which indicates the absence of cyanide toxicity.

INTRODUCTION

Cassava (Manihot esculenta Crantz) roots serve as human food in most tropical countries of the world which include Brazil, Thailand, Ghana and Nigeria. The roots in recent times have found a place in animal nutrition due to its high energy content (Phillips, 1974). Most experimental works have been limited to the use of the roots of cassava (Gomez et al., 1983; Ngoka, 1986). Economic consideration led Eshiett and Ademosun (1981); Osei and Duodu (1988) to investigate on the nutritional values of cassava peel for livestock which is the main by-product of cassava processing plants.

Eshiett and Ademosun (1981) fed commercial pullets three iso-nitrogenous diets containing 0, 10 and 20% CPM for twelve weeks. Their results showed that during the growing stage, birds fed 0% CPM consumed less feed ($P \leq 0.01$) and were more efficient ($P \leq 0.01$) in their feed utilization than the other treatment groups. Osei and Duodu (1988) fed 5, 10 and 15%) CPM and a high level of fishmeal to day-old broiler chicks with satisfactory results. In their study, feed consumption was significantly ($P < 0.05$) increased with the addition of sun-dried CPM. Live weights were significantly improved by the 5% CPM diet above the result for the control diet ($P \leq 0.05$) but there were no significant differences in the live weights between those fed on the control diet and those fed on 10 or 15% CPM diets. This study was therefore undertaken to investigate the effect of feeding graded levels of CPM in diets devoid of animal protein source on pullet chicks from one day old up to point of lay (0-20 weeks).

MATERIALS AND METHODS

The cassava peel used for this study was obtained from the tubers of composite of local Nigerian varieties. About 0.25cm of the pulp was removed with the outer rind during peeling with knives. The peel was sun-dried on concrete floors until the moisture was reduced to between 8 and 10% in an atmosphere of 14.5% humidity at 21°C for 14 days and then milled with a hammer mill. The chemical composition of the CPM was determined by methods of A.O.A.C. (1980). Diets 1-9 were compounded to contain 0, 5, 10, 15, 20, 25, 30, 35 and 40% CPM respectively for both the chick (0-8 weeks) and grower (8-20 weeks) stages. These dietary levels of CPM replaced quantitatively the maize components of the diets. The diets were iso-nitrogenous (20% CP for the chick diets and 15.55% CP for the grower diets) but not isocaloric. These diets and their calculated composition are presented in Tables 5.1 and 5.2.

One thousand and eighty day-old pullet chicks were used for this study. Each treatment consisted of three replicates of 40 chicks each. Complete randomized block design was used for this study. Standard brooding procedures were used. Feed and water were available ad libitum. Body weights of replicate groups were taken at the beginning of the study and forthnightly. Feed consumption was recorded every two weeks and mortality rates were recorded as they occurred. At the 20th week, faeces were collected from each replicate and the free HCN content of the faeces were determined (Bowler, 1944).

The data collected were subjected to the analysis of variance and statistical significant differences between treatment means were assessed by the application of Duncans Multiple Range Test (Steel and Torrie, 1960).

RESULTS AND DISCUSSION

The results are presented in Tables 5.3, 5.4 and 5.5. The chick study (Table 5.4) showed that there were no significant differences ($P \geq 0.05$) between birds fed 20% and those on 0% CPM diets in terms of weight gain and feed consumption. Beyond 20% CPM in the diet, the birds were not able to efficiently convert their feed into weight gain. The inability of CPM beyond 20% in the diet to support desirable gain could be due to cyanide, fibre or energy contents of the iso-nitrogenous diets offered to the birds.

The free cyanide content of the cassava peel meal is 45.75 mg/kg as shown in Table 5.3. The level of cyanide is very low since the peels were sun-dried. Sun-drying reduces the cyanide in peels by over 80% (Larsen and Amaning-Kwarteng, 1976). Hence the cyanide content of the highest inclusion rate of 40% CPM was 1831.50 mg/100/kg diet or 18.32 mg/kg diet as shown in Table 5.1. This is lower than 156.80 mg/kg regarded as a toxic level (Larsen and Amaning-Kwarteng, 1976). Also, the mortality rate was very low (Table 5.4) indicating absence of cyanide toxicity.

The fibre content of cassava peel is 9.26% as shown in Table 5.3. The highest fibre content of the diets in Table 5.1 is 7.16% for 40% CPM diet and this is lower than 8-9% found to have desirable effect on chick growth, mortality and feed consumption (Din et al., 1979).

The energy content was the limiting factor to the usage of CPM. Energy content of CPM was 2324 kcal/kg ME (Table 5.3) compared to maize (3432 kcal/kg ME). The NRC (1977) gave 2650 kcal/kg diet as the energy requirement for chicks from day-old to 20 weeks of age. This requirement was met for diets with CPM levels of 0-10% (Table 5.1) but the birds were able to grow satisfactorily on the energy level lower than the NRC requirement down to

2,484.82 kcal/kg in the diet. Below this energy level the birds were not able to grow satisfactorily. The ability of the birds to grow well on lower energy level (2484.82 kcal/kg diet) could be due to the tropical environment with higher environmental temperatures. Consequently, less energy was needed by the birds as compared with those reared in the temperate countries (Olomu, 1976). Beyond 20% CPM inclusion in the diet, the energy content of the feed was limiting and was unable to support satisfactory growth of the chicks. Hence for this study the minimum dietary energy required for satisfactory performance was 2,484.82 kcal/kg of diet which was the energy level of the diet containing 20% CPM (Table 5.1).

Feed intake of the birds fed diets higher than 20% CPM was significantly ($P \leq 0.05$) higher than the control. This is expected since the energy levels of these diets were lower than the adequate energy required for their optimum growth. At low energy concentration, the birds may not consume enough feed to meet their energy requirement for maximum growth rate and hence, significant reduced weight gain was observed. The work of Osei and Duodu (1988) showed a limit of 15% CPM for broilers while this work shows a limit of 20% CPM for chicks. This is because the energy requirement for pullet chicks is lower than that for broilers. The lower energy of the diets above 20% CPM makes the birds increase their feed consumption in an attempt to meet their energy requirement (Summers and Leeson, 1993).

Some essential amino acids such as lysine, methionine and methioine + cystine become limiting (below NRC requirement for pullets) as the levels of CPM approached 40% in the diet (see Table 5.1). This could contribute to low performance of the pullet chicks.

Mortality rate for this study was not significant, it ranges between 0-5% (Table 5.4). This is in agreement with the results of Osei and Duodu (1988a&b) who did not observe any

significant effect on the mortality rate of broilers fed up to 15% CPM. This indicated the absence of cyanide poisoning due to consumption of CPM.

For the grower study, the birds used in the chick study were made to continue with their corresponding levels of CPM in the grower stage. The results of the grower study are presented in Table 5.5. The nutrient requirements of growers (except for the energy requirement) are lower than those for the chicks (NRC, 1977). Hence for this phase of the study, the replacement pullets were grown successfully on 25% CPM diet as there were no significant differences ($P > 0.05$) between birds fed on 25% CPM diet and those on 0% CPM in terms of weight gain, feed consumption and feed efficiency. There was no evidence of cyanide poisoning during this phase of the study. The levels of HCN in the diets were lower than 156.8 mg/kg regarded as HCN toxic level for animals (Larsen and Amaning-Kwarteng, 1976). In addition, the % HCN in the samples of faeces (3.03-5.33%) analysed for the nine treatments was not significantly affected by treatment which further indicated that cyanide present in the feed was not at a toxic level (Table 5.5). The mortality rate which ranges between 13.62-18.59% was not significantly affected by the levels of CPM in the different diets consumed by the birds.

The crude fibre content of the diets was within the recommendation of the NRC (1977), hence crude fibre may not be the limiting factor in the usage of CPM. The energy content of the diets as shown in Table 5.2 may be the limiting factor in the usage of CPM beyond 25% inclusion rate. The energy content of diets 7, 8 and 9 fell below the 2,400 kcal/kg diet recommended by Olomu (1976) for birds grown in the tropics. This would explain the low weight gains by birds on 30, 35 and 40% CPM diets.

These results were similar to the study of Eshiett and Ademosun (1981). They fed a maximum level of 20% CPM to pullets and found that this level of CPM did not restrict energy consumption of the birds, since they increased their feed intake to compensate for the lower energy content of the CPM diets. This is not the case for diets containing more than 25% CPM. The diets contain less than the energy required for optimum growth of the birds and hence the birds fed these diets were not able to grow optimally. In the study of Summers et al. (1987) energy and not protein was identified as the critical nutrient required for a good body conformation at point of lay. This energy becomes limiting as the inclusion rate of CPM goes beyond 25%.

In conclusion, this study shows that cyanide and crude-fibre contents of CPM did not limit its usage for both chicks and growing birds. The main limiting factor was the low energy content of the meal which limits its usage up to 20% for chicks and 25% for growing pullets.

Table 5.1: Graded Levels of Sun-dried Cassava Peel Meal (CPM) in Chick Diet

	DIETS								
	1	2	3	4	5	6	7	8	9
	CPM Level								
Ingredients	**0**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**
Maize	50.00	45.45	40.00	34.55	29.10	23.65	18.20	12.70	7.25
Groundnut cake	14.05	14.45	14.95	15.40	15.85	16.30	16.75	16.25	17.70
Soya bean cake	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Rice bran	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Cassava Peel Meal (CPM)	0.00	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00
Bone meal	3.00	3.00	3.00	3.000	3.00	3.00	3.00	3.00	3.00
Lime stone	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated Analysis									
Crude Protein (%)	20.01	20.01	20.01	20.01	20.00	20.00	20.00	20.00	20.00
Metabolizable Energy (kcal/kg)	2722.65	2667.19	2624.34	2544.28	2484.82	2425.36	2365.90	2305.99	2246.53
Crude fibre (%)	4.50	4.83	5.17	5.50	5.83	6.16	6.50	6.83	7.16
Calcium (%)	1.75	1.75	1.74	1.74	1.74	1.74	1.74	1.74	1.74
Available phosphorus %	0.92	0.91	0.91	0.91	0.90	0.90	0.89	0.89	0.88
Lysine %	0.93	0.92	0.91	0.91	0.91	0.90	0.89	0.89	0.88
Methionine %	0.34	0.34	0.33	0.32	0.31	0.30	0.29	0.28	0.27
Methionine + Cystine %	0.63	0.63	0.62	0.61	0.60	0.59	0.57	0.55	0.54
Feed Cost N/kg	**7.64**	**8.53**	**8.45**	**8.34**	**8.25**	**8.15**	**8.04**	**7.95**	**7.84**
Free HCN mg/kg diet	**0.00**	**2.29**	**4.57**	**6.86**	**9.15**	**11.43**	**13.74**	**16.03**	**18.321**

Table 5.2: Graded Levels of Sun-dried Cassava Peel Meal (CPM) in Grower Diet

		D I E T S								
		1	2	3	4	5	6	7	8	9
		CPM Levels								
Ingredients		***0***	***5***	***10***	***15***	***20***	***25***	***30***	***35***	***40***
Cassava Peel		0.00	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00
Maize		58.45	52.90	47.35	41.80	16.25	30.7	25.15	19.60	14.05
Groundnut cake		11.50	12.05	12.60	13.15	13.70	14.25	14.60	15.35	15.90
Soya bean cake		10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Rice offal		15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Lime stone		1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Bone meal		3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Premix		0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Salt		0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
	Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated Analysis										
Crude Protein (%)		15.56	15.56	15.56	15.56	15.55	15.55	15.55	15.55	15.55
Metabolizable Energy (kcal/kg)		2736.80	2676.44	2616.08	2555.72	2498.79	2435.00	2369.58	2314.28	2253.92
Crude fibre (%)		4.34	4.78	4.98	5.32	5.65	5.99	6.31	6.66	6.99
Calcium (%)		1.73	1.73	1.73	1.73	1.73	1.73	1.73	1.73	1.73
Available phosphorus %		0.58	0.58	0.58	0.59	0.59	0.59	0.60	0.60	0.60
Lysine %		0.64	0.64	0.63	0.63	0.62	0.62	0.61	0.61	0.60
Methionine + Cystine %		0.57	0.57	0.56	0.56	0.55	0.55	0.54	0.54	0.53
Feed Cost(N/kg)		**7.74**	**7.63**	**7.54**	**7.43**	**7.33**	**7.24**	**7.14**	**7.05**	**6.95**
Free HCN(mg/kg diet)		**0.00**	**2.29**	**4.57**	**6.86**	**9.15**	**11.43**	**13.74**	**16.03**	**18.32**

Table 5.3: Chemical composition of sun-dried cassava peel meal

Fraction	Composition*
Dry matter (%)	94.30
Crude protein (%)	5.70
Crude fibre (%)	9.26
Ether extract (%)	0.71
Ash (%)	8.30
Nitrogen free extract (%)	69.30
Free HCN (mg/kg)	45.75
Gross energy (kcal/kg)	3990
Metabolizable Energy (kcal/kg)	2324
Calcium (%)	0.075
Phosphorus (%)	0.12

***Mean of 3 determinations.**

Table 5.4: Performance of Pullet Chicks Fed Graded Levels of Cassava Peel Meal (0-8 weeks)[1]

	T R E A T M E N T S									
	1	2	3	4	5	6	7	8	9	
	Levels of CPM									
Parameters	**0**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**SEM[2]**
Initial weight (g)	42.58	42.75	42.67	42.92	42.75	42.83	42.50	42.75	42.83	0.13
Weight gain (g)	513.76^{a}	492.47^{ab}	490.39^{ab}	496.44^{ab}	495.34^{ab}	445.73^{b}	481.67^{b}	482.98^{b}	479.71^{b}	4.35
Feed intake (g/bird)	1303.28^{d}	1281.43^{d}	1298.65^{d}	1325.84^{cd}	1301.59^{d}	1374.19^{bc}	1411.17^{ab}	1438.92^{a}	1466.25^{a}	10.44
Feed conversion ratio	2.54^{c}	2.66^{bc}	2.65^{bc}	2.67^{b}	2.78^{b}	3.00^{a}	2.93^{a}	2.98^{a}	3.05^{a}	0.02
Mortality %	0.83	1.67	1.67	2.50	1.67	5.00	0.00	0.00	1.67	0.77

[1]Means within each row with different superscripts are significantly different ($P<0.05$)

[2]Standard Error of the means.

Table 5.5: **Performance of growers on graded levels of cassava peel meal (8-20 weeks)[1]**

	TREATMENTS									
	1	2	3	4	5	6	7	8	9	
	Levels of CPM									
Parameters	0	5	10	15	20	25	30	35	40	SEM
Initial weight (g)	612.80[a]	611.43[a]	607.58[abc]	610.98[ab]	600.96[abc]	590.58[bc]	577.303[dc]	562.07[d]	556.12[d]	12.35
Weight gain (g)	954.32[a]	956.17[a]	944.06[ab]	934.65[ab]	942.90[ab]	935.06[ab]	866.90[c]	812.103[d]	806.40[d]	4.20
Feed intake (g/bird)	6616.43[a]	6653.07[a]	6673.31[a]	6674.44[a]	6654.71[a]	6646.14[a]	6870.91[b]	7116.43[c]	7133.07[c]	27.53
Feed Conversion ratio	7.08[a]	6.98[a]	7.14[a]	7.23[a]	7.09[a]	7.12[a]	7.12[a]	8.78[b]	8.86[b]	0.04
Mortality (%)	16.03	16.60	14.40	18.54	13.62	15.03	15.25	15.82	18.59	4.33
% HCN in feaces	3.03	4.50	4.45	4.70	4.33	4.60	4.17	5.13	5.33	2.36

[1]Means within each row with different superscripts are significantly different ($P \leq 0.05$).

[2]SEM = Standard Error of the means.

CHAPTER 6

AFTERMATH EFFECT OF CASSAVA PEEL MEAL IN GROWER DIETS ON LAYER PERFORMANCE

ABSTRACT

A feeding trial was conducted to investigate the aftermath effect of cassava peel meal in grower diets on layer performance. At 20 weeks of age, birds raised on graded levels of CPM during the chick and grower stages were fed layer's diet devoid of CPM and which contained 16.6% crude protein and metabolizable energy value of 2595 kcal/kg diet.

The results showed that dietary levels of CPM fed during the grower stage significantly ($P<0.01$) affected laying house performance as regards hen weight at first egg, age at first egg, age at 50% production, age at peak production, percentage production at peak,hen-day and hen-housed egg productions and the initial weight of birds at 20 weeks. However, feed intake, egg weight, feed/kg egg, weight of birds at 60 weeks and mortality rate were not significantly affected by the graded levels of CPM fed during the growing phase.

In addition, up to 30% CPM in the grower diet did not have any significant effect on hen-day egg production, hen-housed egg production, age at 1st egg, age at 50% egg production and age at peak of egg production during the laying phase.

In conclusion the dietary level of CPM in grower diets up to 30% did not have significant effect on the subsequent laying performance of the layers fed diets devoid of CPM.

INTRODUCTION

A number of factors can have marked effect on the performance and profitability of a laying flock. The ultimate goal of a good rearing programme is to slow down the physiological development of the pullets in order to delay sexual maturity which leads to higher rate of production, larger eggs and less mortality in the laying house when compared with early maturing birds (Carlson and Nelson 1981; Robinson and Sheridan 1982).

In the studies of Summers and Leeson (1978) and Leeson and Summers (1979) pullets were allowed a choice of protein or energy, the result was a delayed sexual maturity and reduced body weight compared with birds reared on conventional growing programme. The performance of these birds in the laying house equalled that of conventionally reared birds (Leeson and Summers 1980; Doran et al, 1983; Bish et al, 1984; Robinson et al. 1986). Also, body size of the birds influences egg-size, laying house mortality and feed intake (Robinson and Sheridan 1982; Summers and Leeson 1983; Balnave 1984).

The inclusion of cassava peel meal (CPM) in chicken diets was of recent development (Eshiett and Ademosun 1981; Osei and Duodu 1988). This study was undertaken to see the effect of graded levels of CPM grower diets on subsequent laying performance of hens.

MATERIALS AND METHODS

The cassava peel meal used for this study was obtained from the tubers of a composite of local Nigerian varieties. About 0.25cm of the pulp was removed with the outer rind during peeling with knives. The peels were sun-dried on concrete floor until the moisture was reduced to between 8 and 10% in an atmosphere of 14.5% humidity at 21°C for 14 days. The dried

peels were milled with a hammer mill. The chemical composition of the CPM was determined by the A.O.A.C (1980) methods as shown in Table 6.3. Diets 1 to 9 were compounded to contain 0, 5, 10, 15, 20, 25, 30, 35 and 40% CPM for grower (8-20 weeks) stage as shown in Tables 6.1. The dietary levels of CPM replaced quantitatively the maize components of the grower diets. When the birds were 20 weeks old they were placed on a standard layer's diet devoid of CPM. The ingredient composition and the calculated analysis of the layer diet is presented in Table 6.2. Complete randomised block design was used for this study. Feed and water were provided ad libitum. Body weight of replicate groups were taken at the beginning and at the end of the experiment while the feed consumption was recorded every 28-day period. Egg production was recorded daily and mortality recorded as it occurred.

Eggs were weighed for 3 consecutive days every fourth-night. The experiment lasted for 40 weeks. The data collected were subjected to the analysis of variance while significant differences between treatment means were assessed by the application of Duncan's Multiple Range Test (Steel and Torrie, 1960).

RESULTS AND DISCUSSION

The results of the study are presented in Tables 6.3, 6.4 and 6.5. Dietary treatments given to the pullets during the growing phase did not have any significant effect on the subsequent laying house performance of the pullets as regards feed consumption egg weight, feed per kg egg, weight at 60 weeks and mortality rate. The following parameters - weight at first egg, age first egg, age at 50% production, age at peak production, percent production at peak, hen-day egg production, hen-housed egg production and feed per dozen eggs were however

significantly ($P<0.01$) affected by the carry over effect of graded levels of CPM fed during the grower phase.

The inclusion of CPM in the grower diets for the pullets consistently lowered the metabolizable energy concentration of the diets from 2737 to 2254 kcalME/kg diet (Table 6.1). It is a well established fact that to a certain extent, birds fed ad libitum eat to satisfy their energy requirements (Summers and Leeson, 1993).

In this study, feeding 0 to 30% CPM in the diets during the rearing stage supported a good laying house performance as shown in Table 6.4 in terms of weight at first egg, age at first egg, age at 50% production, age at peak production, hen-day egg production and hen-housed egg production. This is an indication that up to 30% CPM in the diet for rearing pullets did not have any detrimental effect on the subsequent egg production. It is also an indication that the fibre, energy and cyanide contents of CPM up to 30% dietary level of inclusion is adequate for a good laying house performance. It is only in terms of percent production at peak that the 20 to 30% CPM diets were significantly inferior to 0% CPM diet. This result is in agreement with the study of Summers et al (1987) who reported that dietary energy appear to be the critical nutrient involved in achieving a certain body weight in order to trigger the onset of egg production. The energy content of the rearing diets up to 30% CPM level contained adequate energy for the onset of egg production.

On the other hand, birds reared on 35 and 40% CPM diets performed poorly in all the parameters measured in Table 6.4. The only explanation to the poor performance of the birds could only be attributed to a deficiency in the rearing diets fed. Thirty-five and 40-percent CPM diets, fed at the grower stage (Tables 6.1) contained lower energy than the 2,400 kcalME/kg diet

recommended by Olomu (1976) for birds reared in the tropics. Although the protein fed were within the recommendations of NRC (1977), the energy levels were far below the recommendations. In addition, the lysine, methionine and cystine levels in these rearing diets were below the NRC recommendations, hence the poor performance of these birds.

The type of diets fed during rearing phases did not affect feed consumption, egg weight, feed/dozen eggs, final body weight of the birds at 60 weeks, weight gained during the laying phase and the mortality rate during lay (Table 6.5). In some studies (Robinson and Sheridan, 1982; Balnave, 1984, Summers and Leeson 1983) body size was found as the main factor that influences egg size, laying house mortality and feed intake, hence the non-significant effect of the diets on these parameters.

It is also interesting to note that the birds had uniform weight at 60 weeks although at 20 weeks there were significant differences in weight (Table 6.5). This observation is in agreement with other reports (Bish et al. 1984, Lillie and Denton 1986) that showed that regardless of the grower phase feeding programme, if pullets had the opportunity to consume a balanced diet a few weeks to the point of lay, they will quickly catch up in body weight so that a uniform weight is obtained at point of lay. A similar situation occurs for the laying hen that may be under-weight at point of lay due to a nutrient-restricted growing feeding programme (as in this study). When given the opportunity to eat, compensatory growth occurs and the layers quickly adjust their body weight to normal levels so that before long, regardless of the previous dietary treatment, most hens will have similar body weights (Lillie and Denton, 1966; Akanbi and Goodman, 1982; Bish et al., 1984).

It can be concluded from this study that pullets could be reared on CPM diets of between 0-30% levels with no adverse effect on the subsequent laying house performance. If the dietary level of CPM is beyond 30%, poor production and low peaks in the laying house may be expected. Furthermore, any savings in feed cost at some stage of the growing and laying period will usually be paid for by greater feed consumption for compensatory growth at a later date or a reduction in egg mass out-put.

Table 6.1: Graded Levels of Sun-dried Cassava Peel Meal (CPM)in Grower Diets Fed

Ingredients	CPM Levels 0	5	10	15	20	25	30	35	40
Maize	58.45	52.90	47.35	41.80	36.25	30.70	25.15	19.60	14.05
Groundnut cake	11.50	12.05	12.60	13.15	13.70	14.25	14.60	15.35	15.90
Soyabean cake	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Rice bran	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Cassava Peel Meal (CPM)	0.00	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00
Bone meal	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Lime stone	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated Analysis									
Crude protein	15.56	15.56	15.56	15.6	15.55	15.55	15.55	15.55	15.55
Metabolizable energy kcal/kg	2737.0	2676.00	2616.00	2556.00	2499.00	2435.00	2370.00	2314.00	2254.00
Crude fibre (%)	4.84	5.28	5.48	5.82	6.15	6.49	6.81	7.16	7.49
Calcium (%)	1.73	1.73	1.73	1.73	1.73	1.73	1.73	1.73	1.73
Lysine (%)	0.64	0.64	0.63	0.63	0.62	0.62	0.61	0.61	0.60
Methionine + Cystine (%)	0.57	0.57	0.56	0.56	0.55	0.55	0.54	0.54	0.53
Available phosphorus (%)	0.58	0.58	0.58	0.59	0.59	0.59	0.60	0.60	0.60
Free HCN (mg/kg diet)	0.00	2.29	4.57	6.86	9.15	11.43	13.74	16.03	18.32

Table 6.2: Layer Diet Fed as from 20 weeks

INGREDIENTS	COMPOSITION (%)
Maize	53.10
Groundnut cake	12.85
Soyabean cake	13.00
Rice offal	10.00
Lime stone	7.50
Bone meal	3.00
Vitamin-mineral Premix	0.25
Salt	0.30
Total	**100.00**
Calculated Analysis	
Crude Protein (%)	16.60
Metabolizable Energy (kcal/kg)	2594.00
Crude fibre (%)	5.97
Calcium (%)	3.99
Available Phosphorus (%)	0.60
Lysine (%)	0.83
Methionine + Cystine	0.63

Table 6.3: Chemical Composition of Sundried Cassava Peel Meal

FRACTION	COMPOSITION*
Dry matter (%)	94.30
Crude protein (%)	5.70
Crude fibre (%)	9.26
Ether Extract (%)	0.71
Ash (%)	8.30
Nitrogen free extract (%)	69.30
Gross Energy (Kcal/kg)	3990
Metabolizable Energy (Kcal/kg)	2324
Calcium (%)	0.075
Phosphorus (%)	0.12
Free HCN (mg/kg)	45.75

Means of 3 determinations.

Table 6.4: Carry-over Effect of Feeding CPM grower diets on subsequent performance of layers

Treatments (levels of CPM fed during rearing)		Weight at 1st egg (kg)	Age at 1st egg (days)	Age at 50% production (days)	Age at peak production (days)	% Production at Peak (%)	Hen-day egg production 20-60 weeks (%)	Hen-housed egg production 20-60 weeks (%)
1	(0%)	1.69^{ab}	157^{bcd}	187^{cd}	209^{bc}	86.38^{ab}	78.65^{a}	79.84^{ab}
2	(5%)	1.64^{ab}	155^{cd}	185^{d}	205^{c}	88.70^{a}	79.28^{a}	79.11^{ab}
3	(10%)	1.65^{ab}	154^{cd}	185^{d}	204^{c}	82.44^{bc}	77.81^{ab}	78.96^{abc}
4	(15%)	1.65^{ab}	152^{d}	183^{d}	203^{c}	82.82^{bc}	78.48^{a}	81.30^{a}
5	(20%)	1.64^{ab}	157^{bcd}	186^{cd}	209^{bc}	81.45^{cd}	76.98^{abc}	77.79^{abc}
6	(25%)	1.63^{bc}	163^{ab}	191^{bc}	211^{ab}	79.45^{d}	74.94^{abc}	75.23^{bcd}
7	(30%)	1.61^{bc}	164^{ab}	192^{abc}	212^{ab}	79.46^{d}	73.38^{abc}	75.94^{bcd}
8	(35%)	1.57^{c}	167^{a}	193^{ab}	217^{a}	79.16^{d}	69.49^{d}	62.34^{d}
9	(40%)	1.51^{cd}	168^{a}	198^{ab}	219^{a}	79.16^{d}	70.59^{cd}	63.12^{cd}
	SEM	0.014	2.26	2.02	2.14	0.86	1.54	1.97

Means within each column with different superscripts are significantly different ($P<0.01$)

SEM = Standard Error of the Means.

Table 6.5: Carry-over effect of feeding CPM grower diets on subsequent performance of layers

Treatment (levels of CPM fed during rearing)	Initial weight of birds at 20 wks (kg)	Hen-day egg production 20-60 wks (%)	Hen-Housed egg production (20-60 wks) (%)	Feed con-sumption (20-60 wks) kg/bird/day	Egg weight (g)	Feed/doz eggs (kg)	Feed/kg eggs (kg)	Weight at 60 wks (kg)	Gain in weight during lay (g)	Mortality rate (%)
1 (0%)	1.61^{ab}	69.67^{a}	69.86^{ab}	122.40	60.72	2.11^{c}	2.93	2.43	816.67	7.22
2 (5%)	1.59^{ab}	68.82^{a}	69.11^{ab}	123.43	60.49	2.16^{bc}	2.97	2.38	810.00	6.67
3 (10%)	1.57^{ab}	67.22^{ab}	68.69^{bc}	121.47	59.45	2.17^{bc}	3.12	2.44	900.00	8.87
4 (15%)	1.56^{ab}	68.84^{a}	71.33^{a}	123.08	59.71	2.15^{c}	3.00	2.50	923.33	11.11
5 (20%)	1.57^{ab}	66.89^{abc}	67.97^{abc}	125.82	60.15	2.31^{abc}	3.21	2.50	970.00	11.11
6 (25%)	1.54^{bc}	64.28^{abc}	66.23^{abc}	119.83	60.86	2.31^{abc}	3.11	2.52	1094.33	13.33
7 (30%)	1.53^{bc}	64.23^{abc}	66.49^{abc}	124.84	60.00	2.32^{abc}	3.13	2.44	1015.33	11.11
8 (35%)	1.40^{c}	59.99^{d}	62.43^{d}	125.84	58.81	2.52^{a}	3.18	2.46	1055.67	13.33
9 (40%)	1.39^{cd}	61.03^{cd}	63.21^{cd}	123.68	60.12	2.43^{a}	3.33	2.43	1038.67	8.96
SEM	0.023	1.45	1.79	2.67	0.87	0.065	0.18	0.064	66.94	4.26

Means within each column with different superscripts are significantly different ($P<0.01$).

SEM = Standard Error of the Means.

CHAPTER 7

Effect of Long-Time Feeding of Graded Levels of Cassava Peel Meal (CPM) on Laying Birds

ABSTRACT

A feeding trial was conducted to investigate the chronic effect of graded levels of CPM on laying performance of pullets reared on graded levels of CPM (0, 5, 10, 15, 20, 25, 30, 35 and 40% levels) in chick and grower diets from 0-20 weeks. At 20 weeks of age, the pullets were fed iso-nitrogenous layer's diet (16.6% crude protein) containing 0, 5, 10, 15, 20, 25, 30, 35 and 40% CPM for another period of 40 weeks, making a total of 60 weeks of feeding on CPM.

The results showed that feeding 5 to 15% graded levels of CPM did not have any significant effect from the control on hen-day egg production, hen-housed egg production, feed consumption, feed/dozen eggs and per cent production at peak. Beyond 15% CPM in the diet, the above mentioned parameters were significantly poorer than the control diet. Other parameters measured which include feed/kg egg, age at peak production and age at 50% production were significantly ($P<0.01$) different from the control when the inclusion rate of CPM was beyond 15% and the energy level lower than 24000 kcal/kg diet. Weight at 1st egg and age at 1st egg were significantly poorer than the control after 20% CPM in the diet.

Also, the results showed that feeding graded levels of CPM for laying phase did not have any significant ($P>0.05$) effect on egg weight, weight gain at 60 weeks, laying house mortality rate, percentage hydrogen cyanide (HCN) in eggs and faeces.

In conclusion, feeding of pullets on diets containing 15% CPM for 60 weeks did not have any significant effect on laying house performance and mortality.

INTRODUCTION

The potential to increase poultry production in most tropical regions of the world is greatly handicapped by the high costs and chronic shortage of conventional concentrate feeds. The long-term growth of poultry farming in tropical countries depend on better utilization of lesser known new feed resources which do not compete as human food. Cassava (Manihot esculenta crantz) peel meal (CPM) is such ingredient that needs full investigation.

CPM which accounts for between 10 and 13 percent of the tuber weight (Tewe et al. 1976) is a moderate energy waste obtained during the processing of cassava roots for both human and animal feeding. In the wet form it contains five to ten times more hydrocyanic acid than the cassava pulp (Wood, 1965). This might be part of the reason why cassava peel has not found much use in animal feeding.

In chronic cyanide toxicity, cyanide is not present in high enough concentrations to cause severe symptoms. Nutrients which otherwise would have gone into body building or maintenance are diverted to the more urgent task of cyanide detoxication.

Foods derived from cassava are often deficient in nutrients such as protein, essential fatty acids and vitamins (Oke, 1968; Osuntokun 1970, 1973; Pitchumuni and Thomas, 1973; Ononogbu, 1980). When such foods are not supplemented with sources of the deficient nutrients, the deficiency symptoms that result are often confused with or mistaken for cyanide toxicity. In most forms of animals husbandry, the rate at whih young animals grow is of the utmost economical importance. Depression of growth rates results from chronic exposure to cyanide. Supplementation with sulphur amino acids or sources of sulphur amino acids alleviate

the condition, thus implicating deficiency of these amino acids in cyanide toxicity (Olson et al., 1969; Maner and Gomez, 1973; Barrett, 1976; Philbric et al., 1979).

When cyanogenic compounds such as KCN were fed to chicks (Carew, 1981), reduced weight gain was observed when fed over prolonged period of time. The cyanide intake reduced the amount of sulphur amino acids available for growth purposes because some of these nutrients were used in detoxication reactions (Carew, 1981). Also, Barrett (1976) observed that supplementing a low protein diet with vitamin B_{12} in the absence of KCN improved weight gains in rats, but in the presence of KCN the B_{12} effect was not significant. The explanation is that in the presence of cyanide, supplementary B_{12} was used to detoxify cyanide and hence was not available for growth promoting functions. When thiocyanate was added to the drinking water of laying birds, thiocyanate contents of eggs were greatly increased in the period immediately following the thiocyanate administration, then the level fell off progressively with time (Carew, 1981).

Enriquez and Ross (1972); Hamid and Jalaludin (1972) reported satisfactory egg production when up to 60% of the maize in the diets were replaced by cassava root meal in layer's diet.

This study was undertaken to investigate the long-time effect of feeding higher graded levels of CPM above what other workers have fed, and to observe the effect on egg production of chickens reared on CPM and fed CPM throughout their laying phase (i.e. 0-60 weeks of age).

MATERIALS AND METHODS

Cassava peel was obtained from the tubers of a composite of local Nigerian varieties. About 0.25 cm of the pulp was removed with the outer rind during peeling with knives. The peel was sun-dried on concrete slabs until the moisture was reduced to between 8 and 10% in

an atmosphere of 14.5% humidity at 21°C for 14 days. It was ground with a hammer mill. Chemical composition was determined by methods of AOAC (1980). Diets 1-9 were compounded to contain 0, 5, 10, 15, 20, 25, 30, 35 and 40% CPM respectively for both chick (0-8 weeks) and grower (8-20 weeks) stages Tables 7.1 and 7.2). These dietary levels of CPM replaced quantitatively the maize components of the diets. At 20 weeks of age 15 birds from each replicate fed the above diets were placed on corresponding 16.6% protein layer's diets containing graded levels of CPM.

Completely randomised block design were used for this study, the cages were in rows which represent the block in the design. Feed and water were available ad libitum. Body weights of replicate groups were taken at the beginning and at the end of the experiment, while the feed consumption was recorded every 28-day period. Egg production was recorded daily while mortality was recorded as it occured. Free HCN content of the eggs and faeces were determined at the end of the experiment. Eggs were weighed for 3 consecutive days fourthnightly. The experiment lasted for 40 weeks. Data collected in this study were subjected to analysis of variance and the statistical significant differences between treatment means were assessed by the application of Duncan's Multiple Range Test (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

The results of the study are presented in Tables 7.4, 7.5 and 7.6. Feeding up to 15% CPM in the layer's diet gave similar production parameters as the control (0% CPM) diet in terms of hen-day egg-production, hen-housed egg production, feed consumption, feed/dozen eggs and % production at peak (Table 7.5). The implication of this result is that diets containing up to 15% CPM had adequate energy to support production similar to the control diet. Beyond the 15% CPM the above mentioned parameters were significantly poorer than the control diet. The

probable limiting nutrient in diets containing 20-40% CPM is the energy content of the diet as shown in Table 7.3. The metabolizable energy for diets containing 0-15% CPM ranged between 2694 - 2515 kcal/kg diet while for 20-40% CPM ranged between 2455 - 2218 kcal/kg diet. According to Olomu (1976) 2,400 kcal/kg diet was recommended for layers grown under tropical environment and diets of 20-40% CPM contained metabolizable energy that fell below this recommendation. It is also interesting to note that these low metabolizable energy contents of these diets were not able to support up to 60% hen-day egg production and the production % at peak was less than 75% as shown in Table 7.5. The proximate analysis of CPM (Table 7.4) shows that the meal has about 2/3 of the energy value of maize which CPM replaces in the diets. Hence as the inclusion rate increases above 15% CPM, the energy contents of the diets decreases to below 2,400 kcal/kg diet.

Other parameters measured which include weight at 1st egg, feed/kg egg, age at peak production, age at 50% production and age at 1st egg were significantly ($P \leq 0.01$) poorer than the control when the inclusion rate of CPM was beyond 15% CPM at energy level of 2,400 kcal/kg diet. This result further buttress the fact that energy is the limiting factor to the use of CPM. The energy limitation of diets that contained 20-40% CPM was responsible for the significantly lower production in parameters listed above.

Feeding CPM throughout the life of the chicken has no detrimental effect on the liveability of the birds as shown by the laying house mortality (Table 7.6). The lowest mortality was with the hens fed 0 and 25% CPM (14.44 and 14.45% respectively). While the highest mortality was with the birds fed 30% CPM with mortality of 19.22%. This is an indication that feeding CPM was not detrimental to the liveability of the birds and that there was no indication of cyanide poisoning. These results agree with the works of Eshiett and Ademosun (1981), Gomez et al (1987); Osei and Duodu (1988a). These workers fed CPM to pullets and broilers

respectively without observing significant mortality. Table 7.6 shows that % free HCN in faeces and eggs of the hens did not show any significant differences in cyanide content ($P > 0.05$) even at the highest CPM level of 40%. In the report of Panigrahi et al. (1992), slower rates of drying cassava roots produced meals with lower cyanogen concentration that are consequently less toxic to broiler chicks. The sun-drying of CPM used in this study did reduce the cyanogen content of the peel, hence the absence of cyanide poisoning in the experimental hens.

In conclusion, the limitation to the use of CPM is the energy of the diet and not cyanide toxicity, if birds were to be raised on CPM from day-old to end of lay the inclusion rate of CPM should not exceed 15% because of the energy limitation.

Table 7.1: Graded Levels of Sun-dried Cassava Peel Meal (CPM) in Chick Diet

Ingredients	CPM Levels 0	5	10	15	20	25	30	35	40
-Maize	50.90	45.45	40.00	34.55	29.10	23.65	18.20	12.70	7.25
Groundnut cake	14.05	14.45	14.95	15.40	15.85	16.30	16.75	16.25	17.70
Soyabean cake	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Rice bran	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Cassava Peel Meal (CPM)	0.00	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00
Bone meal	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Lime stone	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
*Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Calculated Analysis									
Crude protein (%)	20.01	20.01	20.01	20.01	20.00	20.00	20.00	20.00	20.00
Metabolism energy kcal/kg	2722.65	2667.19	2624.34	2544.28	2484.82	2425.36	2365.90	2305.99	2246.53
Crude fibre	4.50	4.83	5.17	5.50	5.83	6.16	6.50	6.83	7.16
Calcium (%)	1.75	1.75	1.74	1.74	1.74	1.74	1.74	1.74	1.74
Available Phosphorus %	0.92	0.91	0.91	0.91	0.90	0.90	0.89	0.89	0.88
Lysine %	0.93	0.92	0.91	0.91	0.91	0.91	0.89	0.89	0.88
Methionine	0.34	0.34	0.33	0.32	0.31	0.30	0.29	0.28	0.27
Methionine Cystine %	0.63	0.63	0.62	0.61	0.60	0.58	0.57	0.55	0.54
-Feed Cost N/Kg	8.64	8.53	8.45	8.34	8.25	8.15	8.04	7.95	7.84
HCN (Mg/Kg diet)	0.00	2.29	4.57	6.86	9.15	11.44	13.74	16.03	18.32

*Premix used supplied the following per kg of diet.
Vitamin A (stabilized) 10,0005 I.U.; Vitamin D_3 (stabilized) 2,250 I.U.; Vitamin E (stabilized) 5.01 I.U., Vitamin K (stabilized) 2.01mg; Vitamin B_2 4.50mg; Vitamin B_6 3.0mg; Nictoninic acid 22.005mg; Calcium D-Pantothenate 6.0mg; Vitamin B_{12} 0.012mg; Choline chloride 200.10mg; D.O.T. (3,5-dinitro-orthotoluamide) 100.05mg; Manganese 80.01mg; Iron 50.01mg; Zinc 40.005mg; Copper 2.4mg; Iodine 1.401mg; Cobalt 0.201mg; Selenium 0.051mg.

Table 7.2: Graded Levels of Sun-dried Cassava Peel Meal (CPM) in Gower Die

Ingredients	CPM Levels 0	5	10	15	20	25	30	35	40
Cassava Peel	0.00	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00
Maize	58.43	52.90	47.35	41.80	36.25	30.70	25.15	19.60	14.05
Groundnut cake	11.50	12.05	12.60	13.15	13.70	14.25	14.60	15.35	15.90
Soya bean cake	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Rice offal	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Lime Stone	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Bone Meal	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
[a]Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Calculated Analysis									
Crude protein (%)	15.56	15.56	15.56	15.56	15.55	15.55	15.55	15.55	15.55
Metabolism energy kcal/kg	2736.80	2676.44	2616.08	2555.72	2498.79	2435.00	2369.58	2314.28	2253.92
Crude fibre	4.34	4.78	4.98	5.32	5.65	5.99	6.31	6.66	6.99
Calcium (%)	1.73	1.73	1.73	1.73	1.73	1.73	1.73	1.73	1.73
Available Phosphorus %	0.58	0.58	0.58	0.59	0.58	0.60	0.60	0.60	0.60
Lycrine %	0.64	0.64	0.63	0.63	0.62	0.62	0.61	0.61	0.60
Methionine Cystine %	0.57	0.57	0.56	0.56	0.55	0.55	0.54	0.54	0.53
Feed Cost N/Kg	7.74	7.63	7.54	7.43	7.33	7.24	7.14	7.05	6.95
HCN (Mg/Kg diet)	0.00	2.29	4.57	6.86	9.15	11.44	13.74	16.03	18.32

[a]Premix used same as in Table 7.1.

Table 7.3: Graded Levels of Sun-Dried Cassava Peel Meal (CPM) in Layer Diets

Ingredients	DIETS 1	2	3	4	5	6	7	8	9
Cassava Peel Meal	*0.00*	*5.00*	*10.00*	*15.00*	*20.00*	*25.00*	*30.00*	*35.00*	*40.00*
Maize	53.10	47.55	42.15	36.65	31.20	25.80	20.30	14.85	9.40
Groundnut Cake	12.85	13.40	13.80	14.30	14.75	15.15	15.65	16.10	16.65
Soya bean cake	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00
Rice offal	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Limestone	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
Bone meal	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
*Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated Analysis									
Crude Protein (%)	16.60	16.63	16.61	16.63	16.63	16.61	16.62	16.62	16.62
Metabolizable Energy (kcal/kg)	2694.00	2634.00	2575.00	2515.00	2455.00	2397.00	2337.00	2277.00	2218.00
Crude fibre (%)	5.97	6.30	6.63	6.97	7.30	7.63	7.97	8.30	8.63
Calcium (%)	3.99	3.99	3.99	3.98	3.98	3.98	3.97	3.97	3.97
Available Phosphorus %	0.60	0.60	0.60	0.61	0.61	0.61	0.62	0.62	0.62
Lysine (%)	0.83	0.83	0.83	0.82	0.82	0.82	0.81	0.81	0.80
Methionine + Cystine %	0.63	0.63	0.63	0.62	0.62	0.62	0.61	0.61	0.61
Free HCN (mg/kg diet)	0.00	2.29	4.57	6.86	9.15	11.94	13.74	16.03	18.32

*Premix used supplied the following per kg of diet. Vitamin A (stabilized) 10,005 I.U.; Vitamin D_3 (stabilized) 2010 I.U.; **Vitamin E (stabilized) 10.005 I.U.; Vitamin K 2.01mg; Vitamin B_2** 4.5mg; Vitamin B_6 3.0mg; Nicotinic Acid 25.005mg; Calcium D-Pantothenate 8.01mg; Vitamin B_{12} 0.012mg; Vitamin C 20.01mg; Choline chloride 200.1mg; Manganese 100.005m; **Iron 50.01mg; Zinc 40.005mg; Copper 2.4mg; Iodine 1.401mg; Cobalt 0.201mg; Selenium 0.051mg.**

Table 7.4: Chemical Composition of Cassava Peel Meal

Fraction	Composition*
Dry matter (%)	94.30
Crude protein (%)	5.70
Crude fibre (%)	9.26
Ether extract (%)	0.71
Ash (%)	8.30
Nitrogen free extract (%)	69.30
Free HCN (mg/kg)	45.75
Gross energy (kcal/kg)	3990
Metabolizable Energy (kcal/kg)	2324
Calcium (%)	0.075
Phosphorus (%)	0.12

***Mean of 3 dterminations.**

Table 7.5: The Effect of long-time Feeding of CPM on Performance of Layers

Treatment (level of CPM)	Henday egg production (%)	Hen-housed egg production (%)	Feed consump. (kg/bird/day)	Fee/doz egg (kg)	% Produc- at peak (%)
1 (0%)	68.95^{ab}	68.60^{a}	120.00^{e}	2.05^{d}	87.60^{a}
2 (5%)	71.83^{a}	66.82^{ab}	120.10^{e}	2.16^{cd}	84.44^{ab}
3 (10%)	68.19^{ab}	65.26^{ab}	120.92^{de}	2.23^{cd}	84.81^{ab}
4 (15%)	68.55^{ab}	66.70^{ab}	121.23^{de}	2.19^{cd}	84.81^{ab}
5 (20%)	59.66^{c}	58.98^{c}	124.08^{bc}	2.38^{bc}	74.11^{c}
6 (25%)	58.01^{c}	52.29^{cd}	125.60^{bc}	2.57^{ab}	71.89^{cd}
7 (30%)	53.58^{d}	50.82^{d}	126.83^{ab}	2.59^{ab}	70.60^{cd}
8 (35%)	52.88^{d}	48.21^{dc}	126.37^{ab}	2.61^{a}	69.14^{d}
9 (40%)	48.07^{e}	47.86^{e}	129.10^{a}	2.63^{a}	68.58^{d}
SEM[1]	2.22	2.01	1.08	0.069	2.05

SEM - Standard Error of Means.

abc - Means within each column with different superscripts are significantly different ($P < 0.01$).

Table 7.6: The Effect of Long-time Feeding of CPM on the Performance of Layers

-Treatment (level of CPM)	% HCN in faeces ($\%x10^{-3}$)	% HCN in eggs ($\%x10^{-2}$)	Laying house mortality (%)	Gain in weight (g)	Egg weight (g)	Wt at 1st egg (kg)	Feed/ kg egg (kg)	wt at 60 wks (kg)	Age at peak prod. (day)	Age at 50% Prod. (day)	Age at 1st egg (day)
1 (0%)	6.00	1.05	14.44	777.67	61.23	1.66^{a}	2.93^{d}	2.41	214^{f}	184^{d}	155^{c}
2 (5%)	6.67	1.16	13.33	888.00	58.91	1.68^{a}	3.05^{d}	2.52	214^{f}	183^{d}	155^{c}
3 (10%)	4.53	1.12	16.67	902.33	59.17	1.61^{ab}	3.19^{cd}	2.48	216^{ef}	184^{d}	155^{c}
4 (15%)	6.67	1.00	16.67	851.67	59.96	1.58^{abc}	3.04^{d}	2.31	$22o^{cde}$	186^{cd}	157^{bc}
5 (20%)	5.97	1.12	18.89	942.33	58.62	1.58^{abc}	3.39^{bc}	2.44	223^{cd}	190^{bc}	159^{abc}
6 (25%)	6.88	1.36	14.45	994.33	58.01	1.56^{bc}	3.55^{b}	2.45	225^{bc}	190^{bc}	160^{ab}
7 (30%)	6.79	1.35	19.22	962.67	58.81	1.50^{d}	3.64^{ab}	2.40	229^{bc}	194^{ab}	162^{ab}
8 (35%)	6.79	1.12	15.55	989.00	58.54	1.53^{cd}	3.86^{a}	2.43	235^{a}	198^{a}	162^{ab}
9 (40%)	6.92	1.47	18.00	914.33	58.00	1.53^{cd}	3.88^{a}	2.29	238^{a}	196^{a}	162^{ab}
SEM[1]	0.56	0.45	4.57	61.24	0.78	0.014	0.089	0.056	1.58	1.51	1.76

SEM = Standard Error of Means.

Means within each column with different superscripts are significantly different ($P \leq 0.01$).

CHAPTER 8

THE EFFECT OF GRADED LEVELS OF CASSAVA PEEL MEAL ON LAYING HENS

ABSTRACT

A feeding trial was conducted to investigate the effect of graded levels of sun-dried cassava peel meal (CPM) on the performance of laying hens. Five levels of CPM containing 0, (control), 10, 20, 30 and 40% of the ration were used. All rations were iso-nitrogenous at 16.5% crude protein. The trial lasted for four 28-day periods or approximately 16 weeks.

The results of the study indicated that the performance of the hens fed 20% CPM diet was comparable to those on the control diet in terms of total number of eggs, % hen-day production and feed consumed per dozen eggs produced. Average daily feed intake, egg weight and the serum thiocyanate level were not significantly ($P>0.05$) affected by dietary treatments. Based on these results it is suggested that CPM may be incorporated into layer diets up to 20% level with no adverse effect on the performance of the birds. This level of CPM replaces about 50% of the maize in the control diet.

INTRODUCTION

Cassava peel is a low energy waste by-product obtained from the peeling of cassava tubers for human and animal feeding. Until recently not much attention has been paid to this main by-product of cassava. The peels are readily available from starch, cassava chips, fermented cassava and "gari" processing industries in Nigeria. They are generally thrown away into rubbish dumps although small fractions may be fed fresh to sheep and goats or cooked and fed to pigs on small holdings. With prices of conventional feedstuffs escalating, the need to

source for alternative feed resources cannot be over-emphasized.

Eshiett and Ademosun (1981) fed commercial pullets three iso-nitrogenous diets containing 0, 10 and 20% CPM for twelve weeks. Their results showed that during the growing stage, birds fed 0% CPM consumed less feed ($P<0.01$) and were more efficient ($P<0.01$) in their feed utilization than the other treatment groups. There was no difference between the other two treatments in their efficiency of feed conversion and feed intake. During the laying stage, feed consumption, egg production, efficiency of feed conversion and egg weight were not significantly ($P>0.05$) affected by the level of CPM fed during the growing stage.

Tewe and Kasali (1986) fed four diets prepared to contain 31.12% of either corn (control) or processed cassava peel (sun-dried, oven-dried or fermented). These diets were fed to weanling giant rats in a 42-day trial. Performance was best for those on the control diet and poorest on the oven-dried CPM. Metabolizable energy and nitrogen retention were poorer in giant rats fed the cassava peel rations.

Osei and Duodu (1988a) fed 5, 10 and 15% CPM to day old broiler chicks. In this study consumption significantly ($P<0.05$) increased with the addition of sun-dried CPM. Live weights were significantly improved by the 5% CPM diet above the result for the control diet ($P<0.05$) but there were no significant differences in the live weights for the control diet and those for 10 or 15% CPM diets.

This study was therefore undertaken to investigate the effect of feeding graded levels of CPM on laying hens using rations devoid of animal protein.

MATERIALS AND METHODS

The cassava peel meal used for this study was obtained from the tubers of a composite of local Nigerian varieties. About 0.25cm of the pulp was removed with the outer rind during

the peeling process. The peel was sun-dried on concrete floors until the moisture was reduced to between 8 and 10% in an atmosphere of 14.5% humidity at 21°C for 14 days and then milled with a hammer mill. The chemical composition of the CPM was determined by methods of A.O.A.C (1980). The results of the proximate analysis are presented in Table 8.1. Rations 1-5 were compounded to contain 0, 10, 20, 30 and 40% CPM respectively. These dietary levels of CPM replaced quantitatively the maize components of the rations. The diets were iso-nitrogenous but not iso-caloric. These rations and their calculated % composition are presented in Table 8.2. Two hundred and twenty-five layers that have been in lay for six months were used for this study. Each treatment consisted of three replicates of 15 birds each. Complete randomized block design was used for this study. Feed and water were available ad libitum. Body weights of replicate groups were taken at the beginning and at the end of the experiment while the feed consumption was recorded every 28-day period. Egg production and mortality rates were recorded daily.

Eggs were weighed for 3 consecutive days every fortnight. The experiment lasted for 112 days. At the end of the experiment six birds were randomly selected from each treatment and bled. The serum thiocyanate levels were determined using the method of Bowler (1944).

The data collection in this study were subjected to the anlaysis of variance and the statistical significance differences between treatments means were assessed by the application of Duncan Multiple Range Test (Steel and Torrie, 1960).

RESULTS AND DISCUSSION

The performance data of the laying hens were presented in Table 8.3. The result indicate significantly lower values ($P<0.05$) for hen-day production for birds fed 30 and 40% CPM when compared with the control ration that contained 0% CPM. The egg production of birds

fed 10 and 20% CPM were not significantly different from those fed the control ration. This result is in agreement with the study of Eshiett and Ademosun (1981) who found no significant difference in subsequent laying performance of pullets reared on the control and on 20% CPM diets between 8-20 weeks of age. This result showed that behond 20% CPM inclusion, the energy level of the ration becomes limiting (energy requirement of laying hens is 2,400-2,600 Kcal/kg ME of diet NRC, 1984). In addition, at 30 and 40% CPM in the diet, methionine plus cystine were limiting by 0.04 and 0.05g respectively.

Feed conversion ration (kg feed/dozen eggs) of the birds did not show any significant difference up to 20% CPM inclusion while kg feed per kg egg showed a significant difference ($P<0.05$) beyond 10% CPM inclusion. The implication of this is that for a situation where the eggs are not graded as in Nigeria, inclusion of CPM up to 20% will still result in economic gains. While inclusion of 10% will be the optimum if premium is given for bigger sized eggs.

Average feed intake and egg weight did not show significant differences ($P>0.05$) although there was the tendency for birds on higher levels of CPM to consume more feed.

The graded levels of CPM did not affect both the internal quality of the egg and the level of the serum thiocyanate (Table 8.3). These results clearly show that cyanide poisoning is not the limiting factor in the usage of cassava peel meal in laying birds. The probable limiting factor in its usage is the low energy content. Beyond 20% CPM inclusion in the diets, the metabolisable energy content of the ration fell below 2680 Kcals/kg diet (Table 8.2) and the egg production level became significantly lower when compared with the control diet.

The hens used in this study did not show any evidence of cyanide poisoning because the cassava peel used in this study was sun-dried thereby reducing its HCN content and enhancing the utilization of the nutrients in the peel (Tewe et al 1976).

In conclusion, laying hens can tolerate sun-dried cassava peel ration up to 20% inclusion rate; with no adverse effects on percentage hen-day production and feed conversion ration (kg feed/dozen eggs). At higher inclusion rates, energy, methionine and cystine now become limiting.

Table 8.1: Chemical Composition of Cassava Peel Meal*

Fraction	Composition*
Dry matter (%)	94.30
Crude protein (%)	5.70
Crude fibre (%)	9.26
Ether extract (%)	0.71
Ash (%)	8.30
Nitrogen free extract (%)	69.30
Gross energy (Kcal/kg)	3990
Metabolizable Energy (Kcal/kg)	2324

*Mean of 3 determinations.

Table 8.2: Composition and Calculated Analysis of Experimental Diets

Ingredients %	RATIONS 1	2	3	4	5
Maize	45.35	34.30	23.30	12.10	0.00
Cassava Peel Meal (CPM)	0.00	10.00	20.00	30.00	40.90
Roasted fullfat soya-bean	21.60	22.65	23.75	24.85	26.05
Palm kernel meal (PKM)	20.00	20.00	20.00	20.00	20.00
Sesame seed	2.00	2.00	2.00	2.00	2.00
Limestone	7.50	7.50	7.50	7.50	7.50
Bone meal	3.00	3.00	3.00	3.00	3.00
Salt	0.30	0.30	0.30	0.30	0.30
Vitamin premix	0.25	0.25	0.25	0.25	0.25
TOTAL	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
CALCULATED ANALYSIS					
Crude protein (%)	16.54	16.54	16.52	16.50	16.50
Metabolizable Energy (Kcal/kg)	2909	2796	2684	2572	2450
Crude fibres (%)	4.63	5.31	6.00	6.80	7.42
Calcium (%)	2.78	2.78	2.77	2.77	2.77
Available phosphorus(%)	0.68	0.67	0.66	0.65	0.63
Lysine (%)	0.66	0.66	0.66	0.65	0.65
Methionine (%)	0.32	0.30	0.29	0.28	0.26
Methionine + Cystine(%)	0.55	0.53	0.51	0.49	0.48

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GENERAL SUMMARY

In these studies sun-dried cassava peel meal (CPM) was fed to various classes of birds namely broilers, chicks growers and layers for varied lengths of time. In all the studies conducted no class of birds had high mortality records during the feeding of cassava peel meal even at the highest level of 40% CPM.

In the first study with broilers, effect of graded levels of cassava peel meal and methionine supplementation was investigated. The results of this study showed that 15% CPM and 0.35% methionine were adequate for the starter phase and 20% CPM and 0.10% methionine for the finisher phase. The second study on broiler investigated the supplementary effect of palm oil on graded levels of cassava peel meal. The results of this study showed that energy was the limitation in its usage in broiler diets. A cheap source of fat or oil will promote the usage of the CPM up to 25% for both the starter and finisher phases without any detrimental effect. Feeding CPM to broilers did not result in any detrimental effect on the birds a level as high as 25% could be fed provided the nutrient (especially energy) requirements of the birds are met. This could only be met by the addition of fats or oils to the diets.

In the four studies with egg-type birds higher levels of CPM were used because of the lower energy requirements of the this class of birds. The CPM levels used were above the 25% used for broilers, levels of up to 40% were used for chicks, growers and layers. For the chick study 20% CPM was found to be adequate for good performance, beyond this level some nutrients such as energy, lysine and methionine become limiting. To be able to feed higher CPM levels these limiting nutrients will have to be provided in form of fat or oil and synthetic lysine and methionine which are very expensive and thus will make the feed more expensive. This is contrary to the aim of this study which is to reduce feed cost. The level of CPM could be increased to 25% during the growing stage since the nutrient requirements of growers are

lower than those of chicks, beyond this level (25% CPM) the nutrients available in the diets become limiting as in the case of the chicks mentioned above.

The effect of graded levels of cassava peel meal in grower diet on subsequent laying house performance of pullets was studied in another experiment. In this study pullets could be reared on CPM diets of 0-30% levels with no adverse effect on laying house performance. Beyond this level poor production and low peaks in the laying house production may be expected.

The chronic effect of graded levels of cassava peel meal on laying birds was also investigated. The feeding of CPM throughout the life of the chicken has no detrimental effect on the liveability of the birds as shown by the low laying house mortality of the birds. This is an indication that feeding CPM was not detrimental to the liveability of the birds and that there was no indication of cyanide poisoning. The limitation to the use of CPM is the energy. If birds were to be raised on CPM from day-old to end of lay the inclusion rate should not exceed 15% in practical diets because of the energy limitation.

In conclusion, cassava peel meal can be included in diets of all classes of birds and the inclusion level will depend on the type of bird, the age of the birds, the duration for which the peel will be fed and supplementation of oil for energy.

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