Cassava Root and Foliage Meals in Laying Hen Diets

Author: J.J. Montilla, Facultad Ciencias Veterinarias, Univ. Central de Venezuela, Apartado Correo 4563, Maracay 2101A, Venezuela.

ABSTRACT

Two experiments were carried out on the use of cassava foliage flour, particularly in combination with root flour. In experiment I, two main energy sources, maize and cassava root flour dried above 100°C (HRYT), in combination with five levels of cassava foliage flour (HFY): 0, 5, 10, 15, and 20%, were evaluated in a 5x2 factorial arrangement. Leghorn hens were used (4 groups of 12 pullets and 10 layers assigned to each treatment). In experiment II, three main energy sources, maize, HRYT, and sun-dried cassava root flour (HRYS), in combination with three levels of HFY: 0, 10 and 20%, were evaluated. Black Sex Link hens were used (4 groups of 15 pullets and 12 layers assigned to each treatment). Hens were placed in individual metal cages and daily records were made of feed consumption and egg production. The results indicate a) with HRTY and HRYS satisfactory body weights at 50% egg production were obtained, though inferior as compared to maize; b) rations based on HRYT adversely affected egg production; c) a slight decrease of egg production observed with HRYS may be due to the deterioration of the cassava quality caused by the long-drying period; d) with HFY egg production was normal up to 20% level combined with maize, and only up to 10% with HRYS; e) a strong root-foliage interaction was observed that adversely affected the productive performance when the foliage flour level was increased--this may be due to the increase in HCN concentration.

Cereals as a source of energy and soy as a source of protein constitute the fundamental ingredients of the classical pelleted feeds for poultry. As much the first (with the exception of rice) as the second, do not give good results in tropical ecosystems means that of countries in these areas, only those with considerable importing capacity have been able to develop a prosperous poultry production industry.

The search for substitutes for cereals to make up the energy component has made possible the use of rice, cassava, root meal and sugar cane products and by-products as excellent energy sources for poultry. With these, cereal grains (maize, wheat, sorghum) can be substituted partially completely in the feeds.

With reference to the utilization of cassava root meal in feeds for laying hens, the known results are conclusive in the sense that cereals can be completely substituted for by cassava root meal without affecting the laying percentage, the feed efficiency and the internal egg quality (Enriquez y Roos, 1972; Montilla et al., 1973; Portal et al, 1977 and Eshiett and Ademasun, 1978).

In relation to the protein components, advances have been slower and more limited. However, many research workers are convinced there are various ways to achieve substitution of imported soy meal in poultry feeds, one of these being the use of leaf proteins.

As Oke (1973) affirms, green plants represent the most economical and abundant potential source of protein by the synthesis of amino acids through photosynthesis from primary elements available in almost unlimited quantities: solar energy carbon dioxide, water and nitrogen (atmospheric in the case of leguminoses and other plants). The amino acids in a more stable form -proteins- are stored in the leaves. The cassava plant has an exceptional value as much for the quantity as for the quality of its foliage proteins (Montilla, 1982).

Portal et al., (1972), report that cassava leaf meal supplies pigments capable of producing a good color of the egg yolk and they can completely substitute alfalfa meal in feeds for laying hens, without adverse effect at the levels studied (10% being the greatest) with respect to the percentage laying, weight of the egg and feed efficiency. According to the results of Montilla et al., (1982), laying hens utilize well up to 20% cassava leaf meal, especially if this is provided from birth, which probably is due to a conditioning of the digestive tract to feeds with a relatively high fiber content.

The purpose of this paper is to study effect of combining cassava root meal (two methods of preparation) with different levels of cassava foliage meal in laying hen diets.

Materials and Methods

Two experiments were conducted, the first of 510 days and the second, 400 days. In experiment I, the effect was studied of substituting completely in feed for laying hens, corn meal for cassava root meal dried mechanically at 120°C, (two sources of energy), combined with five levels of cassava foliage meal: 0%, 5%, 10%, 15% and 20%, resulting in a factorial 2x5. Composition of feeds for the laying period is in Table 1.

These were isoproteic but not isoenergetic, although a brisk fall in the caloric value was avoided by addition of small quantities of animal fat for each increase in the level of foliage. Each hen received 100 gm/day. During the brooding and growing periods, the feed with the same energy sources and same percentages of foliage, was administered at libitum, both in Experiment I and in Experiment II. The foliage meal was prepared from green material cut at intevals of approximately 90 days and of different varieties; drying was in the sun on a cement floor. A total of 480 white Leghorn birds was used, giving each treatment four groups of 12 birds each, during the brooding and growing periods and of 10 birds each group in the laying period.

In experiment II, three energy sources were studied: corn meal, cassava root meal, prepared by means of sun drying (on a cement floor) and cassava root meal dried mechanically at a temperature of approximately 120°C. Each energy source was combined with three levels of cassava foliage meal, of the same type as that used in Experiment I: 0%, 10% and 20% resulting a factorial 3x3. The feeds were prepared with a formula similar to those of the corresponding levels of foliage used in Experiment I. A total of 540 commercial red Sex Link birds was used in each treatment, four groups of 15 birds in the brooding and growing periods which were reduced to 12 birds in the laying period.

Table 1. Experimental diets for laying hen levels of cassava foliage meal.

Ingredients	CRM 0%	CRM 5%	CRM 10%	CRM 15%	CRM 20%	C 5%
Corn meal	64.00	57.25	53.75	50.25		
Soybean meal	13.50	12.00	10.50	9.00	7.50	22.50
Wheat bran	4.00	4.00	4.00	4.00	4.00	
Cotton seed meal	4.00	3.50	3.00	2.50	2.00	3.50
Meat and bone meal	2.00	2.00	2.00	2.00	2.00	2.00
Fish meal	3.50	3.50	3.50	3.50	4.50	
Blood meal	1.00	1.00	1.00	1.00	1.00	1.00
Calcium carbonate	6.00	6.00	6.00	6.00	6.00	6.00
Bone meal	1.50	1.50	1.50	1.50	1.50	
Animal fat		0.25	0.75	1.25	1.75	1.50
Cassava foliage meal		5.00	10.00	15.00	20.00	5.00
Minerals	0.25	0.25	0.25	0.25	0.25	
Vitamins	0.25	0.25	0.25	0.25	0.25	
Cassava root meal						52.00

CRM = Cassava root meal;
C = Corn meal.

After observing the daily feed consumption of the hens, the amount of feed was adjusted to 112, 117 and 122 gm/hen/day.

Results and Discussion

Experiment I:

In Table 2 are body weights at different ages and the feed conversion at the 10th and 21st week of age, at the later age of which the birds reached 50% laying. In Table 3 the F values are given for the data presented in Table 2. Tables 4 and 5 present the mean values for laying percentage in the 4 trimesters and the corresponding F values respectively.

For the body weight increase at the 10th week, a highly significant difference ($P<0.01$) is seen for cassava root meal (R); this is probably explained by the uniformity of the data, since the values are very similar both for the birds which received corn meal (681 g) and those which received R (668 g) respectively; a similar explanation can be given to the highly significant difference for lineal foliage (FI) at the same age although a slight fall in the weight increase appears, relatively pronounced with the higher level of foliage studied. When the birds reach 50% laying (21 weeks of age) no significant differences between treatments exist (see Tables 2 and 3). In the same tables, note that the body weights at 6 months and at the year of laying are lower for the birds which consumed cassava root meal ($P<0.01$). The high significance for Fc, Fcu and R x Fcu does not appear to be of great importance.

For the feed efficiencies at the 10th and 21st weeks, highly significant differences ($P<0.01$) for FI, only appear at the earliest age, which is not of great importance since, as can be seen at 50% laying, the feed conversion indices are little affected (see Tables 2 and 3).

Table 2. Experiment I. Average values for body weights and feed efficiencies at different ages.

Treatments*		Body Weights (g)				Feed Conversion	
		10th week	21st week (50% laying)	6th month laying	1 year laying	10th week	21st week
CRM-CFM	0%	689	1301	1323	1313	4.93	6.23
CRM-CFM	5%	683	1302	1277	1268	5.01	6.22
CRM-CFM	10%	696	1321	1303	1291	5.03	6.14
CRM-CFM	15%	691	1291	1250	1218	5.13	6.27
CRM-CFM	20%	645	1272	1261	1320	5.59	6.38
CM-CFM	0%	695	1318	1476	1491	4.89	6.16
CM-CFM	5%	678	1315	1348	1296	5.02	6.17
CM-CFM	10%	663	1291	1416	1375	5.20	6.28
CM-CFM	15%	660	1335	1411	1474	5.30	6.19
CM-CFM	20%	629	1265	1343	1407	5.48	6.49

*CRM = Cassava root meal; CFM = Cassava foliage meal.

Table 3. Experiment I. Weight increments, body weights and feed conversion at different ages.

	Weight Increments		Body Weights		Feed Conversion	
	10th week	21st week	6 month laying	1 year laying	10th week	21st week
R	7.94 **	1 NS	59.41 **	71.79 **	1.36 NS	1 NS
Fl	31.57 **	2.09 NS	7.70 **	1 NS	117.01 **	4.12 NS
Fc	5.93 *	1.52 NS	2.00 NS	11.22 **	7.52 **	1.91 NS
Fcu	4.11 NS	1.04 NS	5.41 *	9.47 **	2.55 NS	1 NS
R x Fl	2.94 NS	1 NS	1.50 NS	1 NS	1 NS	1 NS
R x Fc	1 NS	1 NS	1 NS	1 NS	6.27 *	1 NS
R x Fcu	1 NS	1 NS	8.56 **	26.78 **	2.23 NS	1 NS

R = Cassava root meal; F = Cassava foliage meal.

The laying percentage (Tables 4 and 5) was reduced in the birds which received cassava root feeds without, apparently, any effects due to different levels of foliage.

With respect to the levels of foliage, only a cuadratic effect (Fc) is observed in the first trimester and a cubic effect in the second trimester, both of which are highly significant ($P<0.01$), probably due to the poor behavior of the birds with the 5% foliage feed and the unequal behavior of all the treatments in

Table 4. Experiment I. Percentage Laying in the Four Trimester and Total Laying Period.

	TRIMESTERS				
	1	2	3	4	Year
CRM - CMF* 0%	45.8	41.2	48.2	53.4	47.2
CRM - CMF 5%	44.6	36.4	45.4	47.9	43.6
CRM - CMF 10%	41.2	33.7	48.1	53.8	44.2
CRM - CMF 15%	41.1	35.4	44.8	44.7	41.5
CRM - CMF 20%	39.4	42.5	54.0	50.2	46.5
C - CFM 0%	74.3	61.2	64.2	65.0	66.2
C - CFM 5%	38.9	52.0	66.2	66.4	55.9
C - CFM 10%	68.7	50.9	62.6	66.2	62.0
C - CFM 15%	64.3	48.2	64.9	62.1	59.9
C - CFM 20%	73.8	54.5	66.5	59.6	63.6

*CRM = Cassava root meal; CFM = Cassava foliage meal; C = Corn meal.

Table 5. Experiment I. Percentage laying: F values.

	% Laying TRIMESTERS			
Source	1	2	3	4
R	143.29 **	41.04 **	89.12 **	66.27 **
Fl	1 NS	1 NS	1.35 NS	4.33 NS
Fc	13.48 **	8.29 **	2.32 NS	1 NS
Fcu	16.10 **	1 NS	1 NS	1 NS
R x Fl	10.61 *	1.23 NS	1 NS	1 NS
R x Fc	14.36 *	1 NS	1 NS	1.77 NS
R x Fcu	20.01 *	1 NS	1 NS	1 NS

R = Cassava root meal; F = Cassava foliage meal.

the second period, when there was a marked reduction in laying which may have been caused by bad weather. For the other periods, the foliage level does not affect laying. It is important to emphasize that the body weight of the chickens at the end of the laying period did not reach the normal level for the race even in those birds which received a corn meal feed without foliage; this seems to indicate that the 100 g of feed/bird/day were not sufficient and may have also affected the laying percentage which was lower than that expected even for those birds which received the feed with corn meal without foliage.

Experiment II:

In Table 6 are given the age, body weight and feed conversion at 50% laying. Age was not affected by the energy sources, but was affected by the foliage level, this effect being small with corn, average with cassava root dried in the sun (CRS) and marked with cassava meal dried at high temperatures (CRT). Something similar is observed for body weight, but with the difference that CRS and CRT (without foliage) also affected this, being 93.4% in the first and 89.0% in the second of the weight obtained with corn meal; a similar situation occurred with reference to the feed conversion index. In all the cases, the marked deterioration which occurs when 20% foliage is combined with CRT, can be seen. As much for age, body weight and feed index conversion significant differences ($P<0.05$) appear, some of which are highly significant ($P<0.01$).

Table 6. Experiment II. Age, body weight and feed conversion at 50% laying.

Treatments	Age (days)	Body weight (kg)	Feed conversion
C - CFM* 0%	193	2.088	5.34
C - CFM 10%	180	1.986	4.95
C - CFM 20%	198	1.932	6.16
CRMS - CFM 0%	195	1.942	5.83
CRMS - CFM 10%	198	1.917	5.92
CRMS - CFM 20%	205	1.817	6.91
CRMT - CFM 0%	192	1.859	6.00
CRMT - CFM 10%	206	1.846	6.71
CRMT - CFM 20%	218	1.681	8.04
Differences (P 0,01)	24	0,166	0.92
Differences (P 0,05)	18	0,123	0.68

*C = Corn meal; CFM = Cassava foliage meal; CRM = Cassava root meal.

The laying percentage for the semester (Table 7) decreases from 76.4% with the feed containing corn meal without foliage to 70.3% and 65.5% when the sources of energy were CRS and CRT (also without foliage). Those differences are highly significant ($P<0.01$) for CRT and not significant but important from the practical point of view for CRS. Significant differences ($P<0.05$) also exist between CRS and CRT. When foliage is incorporated into feeds based on corn, although the laying percentage falls slightly, these differences do not reach a point where they become significant; when foliage is incorporated into feeds with CRS, the laying improves slightly with 10% and a drastic fall is observed with 20% ($P<0.01$). With CRT only small reductions are observed when each level of foliage is added, probably due to the fact that the laying was already reduced, affected by CRT.

The small differences occurring in the weight of the eggs are not important. The weight of the hens at the 6th month of laying was severely influenced by cassava root, with a fall of 10.6% for CRS and of 13.9% for CRT, with respect to the weight of the hens which consumed the feed based on corn without foliage. In almost all cases, a fall in the body weight occurs with each increment in the foliage with differences which vary from significant ($P<0.05$) to highly significant ($P<0.01$); this does not occur for 10% foliage with CRS nor on passing from 10% to 20% foliage for CRT which represents the lowest body weight.

Table 7. Experiment II. Percentage laying, egg weight and body weight at 6 months of laying.

Treatments	% Laying			Egg weight		Body weight at 6 months of laying (kg)
	1st trimester	2nd trimester	6 month period	First	Second	
C - CFM* 0%	71.3	81.5	76.4	59.3	60.5	2,135
C - CFM 10%	71.3	78.3	74.8	58.5	61.8	1,990
C - CFM 20%	68.0	78.5	73.3	60.3	62.0	1,895
CRMS - CFM 0%	65.8	75.3	70.3	57.8	60.5	1,908
CRMS - CFM 10%	65.5	78.0	71.8	58.0	61.3	1,942
CRMS - CFM 20%	58.3	69.0	63.5	58.8	61.5	1,773
CRMT - CFM 0%	60.0	71.3	65.5	57.8	58.5	1,839
CRMT - CFM 10%	58.0	68.8	63.3	59.0	61.5	1,755
CRMT - CFM 20%	55.0	68.3	61.3	56.8	61.3	1,742
Differences (P 0.01)	8.5	7.6	6.7	3.7	3.0	0,130
Differences (P 0.05)	6.3	6.9	4.9	2.8	2.2	0,096

*C = Corn meal; CFM = Cassava foliage meal; CRM = Cassava root meal.

General Discussion

From the analysis and discussion of the experimental data it becomes evident that cassava root meal dried at high temperatures (120°C) is not utilized well by the laying hen, in contrast to what has been reported for broilers (Montilla et al, 1979); in the same way, it performs well to sustain an appropriate growth of chickens in the brooding and growing periods (Experiment I). The fact that in Experiment II the body weight at 50% laying was slightly lower in the hens fed with CRT, is probably explained by the fact that sexual maturity was delayed because the growing period coincided with the period of shortest days (November-December).

The hens which had the greatest delay reached 50% laying after 31 weeks, when the normal is at 23 to 24 weeks. This seems to indicate that CRT only favors the early growth of the birds.

According to Manurung (1974), burning of the cassava during processing is a function not only of temperature but also of the humidity content of the material. In this way, fresh cassava with 66.7% humidity, burns by exposure to 90°C for 5 minutes, but if the initial humidity is reduced to 56.5%, it supports 50 minutes at the same temperature, and with 48.6 humidity it does not burn after 96 hours exposure. In the commercial plant where the cassava was processed, this was added to the dried (at a temperature of approximately 120°C) with its initial humidity. It is quite certain that in addition to the burning, which can be seen by a brown tone in the material, another transformation also occurs in the starches, making them less assimilable for certain species and/or type of animals.

The fact that with cassava root meal dried in the sun, the behavior of the hens was inferior than that of those which consumed corn feed, may have been influenced by the long period of drying (10 days) of fresh material, due to rainy days which, when the humid material has to be collected and covered, gives rise to fermentative processes which diminish it.

The variation in the climatic conditions during processing are probably the cause of differences in the results between more or less similar experiments carried out by different research workers and even by the same research worker.

It is evident that foliage levels of up to 20% are compatible with an efficient production when they are combined with corn (and probably with any cereal). This does not occur when combined with cassava root, when the highest level tolerated would be 10%.

It cannot be maintained that fiber is the limiting factor, because its incorporation is the same with either of the two sources of energy. It is possible that the problem lies in an increase in the HCN content of the feed because even when foliage and root meals prepared from varieties with an HCN content no higher than 300 to 400 ppm (fresh basis), the results are almost always negative or with a very low concentration (lower than 30 ppm), when the HCN is determined by the AOAC method. Gómez et al (1980) report HCN concentrations of between 43 and 162 ppm in meals dried in the sun and prepared from cassava root in which the HCN content (dry base) was between 32 and 265 ppm. These workers carried out an enzimatic determinations according to the method developed by Cooke et al (1978). If levels of these magnitudes persist in foliage and root meals, there could be an additive effect on combining them at high levels in the feed.

On the other hand, it is convenient to emphasize the fact that the feeds could not be pelleted since the necessary equipment for this was not available. This treatment exercises a very favorable effect on poultry feeds, especially when dusty ingredients with a low density are incorporated into them. Montilla (1982) reports that foliage and root meals only weigh, for unit of volume, 25.2% and 79.2%, respectively, of the corresponding weight for corn meal.

From the results it is concluded:

a) with CRS and with CRT satisfactory body weights were obtained at 50% laying although these were lower when compared with the results obtained on a basis of corn based feeds.
b) the feeds based on CRT adversely affected egg production.
c) a slight reduction on laying observed with CRS could have been due to a deterioration in the quality of the cassava for the long period of drying.
d) with cassava foliage meal the laying was normal up to 20% combined with corn and up to only 10% with cassava root meal sun-dried.
e) a strong root x foliage interaction is observed, adversely affecting the productive behavior, on increasing the foliage level, which could be due to the increase in the concentration of HCN in the feeds.

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