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## Leaf area in relation to petiole length in cassava

**Resumen.** Se encontró una correlación positiva entre la longitud del pecíolo y el área foliar de la yuca. Se propone un método simple y rápido para estimar el área foliar cuando se efectúan evaluaciones genéticas de nuevos especímenes

Total leaf area exposed by a plant determines largely its capacity for photosynthesis and transpiration. Hence leaf area index is gaining more importance while assessing the productivity of crop plants. Attempts were made in the present study to work out the relationship between petiole length and leaf area in order to develop a simple method for measurement of leaf area particularly for larger population of cassava as the linear measurement methods developed for this crop (1, 2) are more time consuming.

Fully expanded leaves were marked at random separately for 1) broad and medium leaf type and 2) for narrow leaf type. The leaves were collected at monthly intervals between second to eighth month stages and their actual leaf area with the corresponding petiole length were measured separately for both the leaf types. The petiole length of fully expanded leaves varies from 15 to 40 cm and their leaf area ranges from 130 to 540 $cm^2$ (Fig. 1). Maximum values were recorded during the active period of plant growth (2 to 6 months) which normally coincides with the rainy seasons. More reduction in leaf and petiole length were noticed during dry period. Following the regression equations, it would be interesting to see the prediction equations of the areas, on the basis of petiole length, both for the strains of wide and narrow lobed

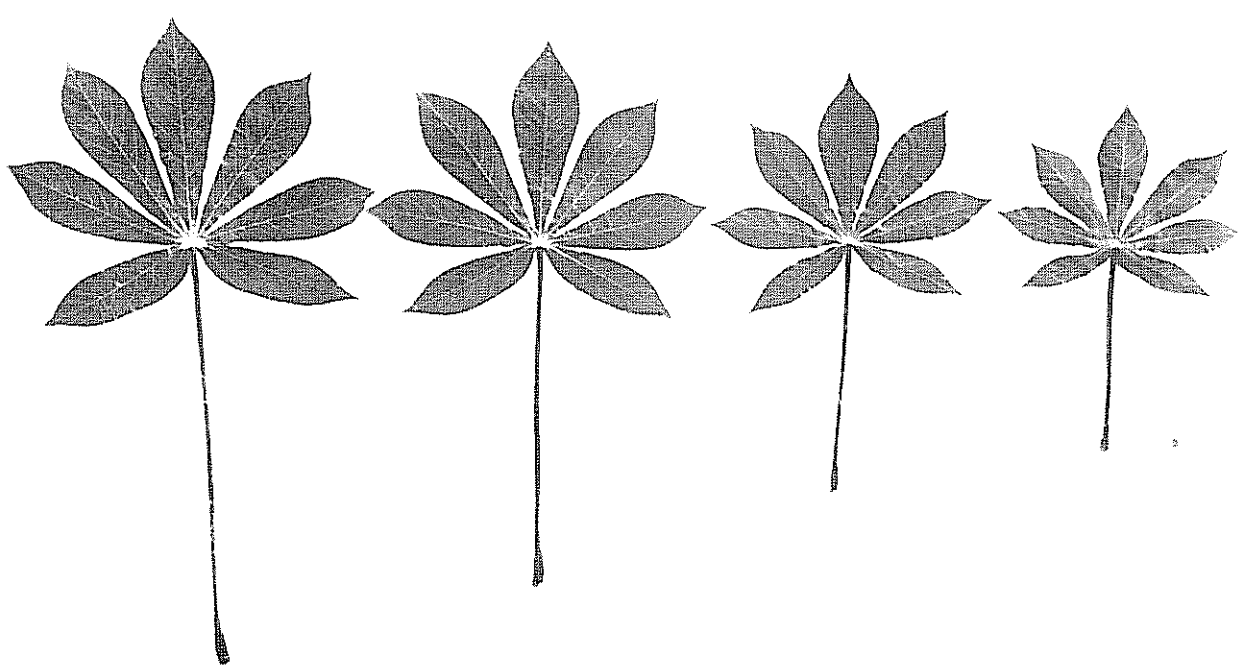

Fig. 1. Variation in petiole length and leaf in fully expanded leaves of cassava (Var H–2304)

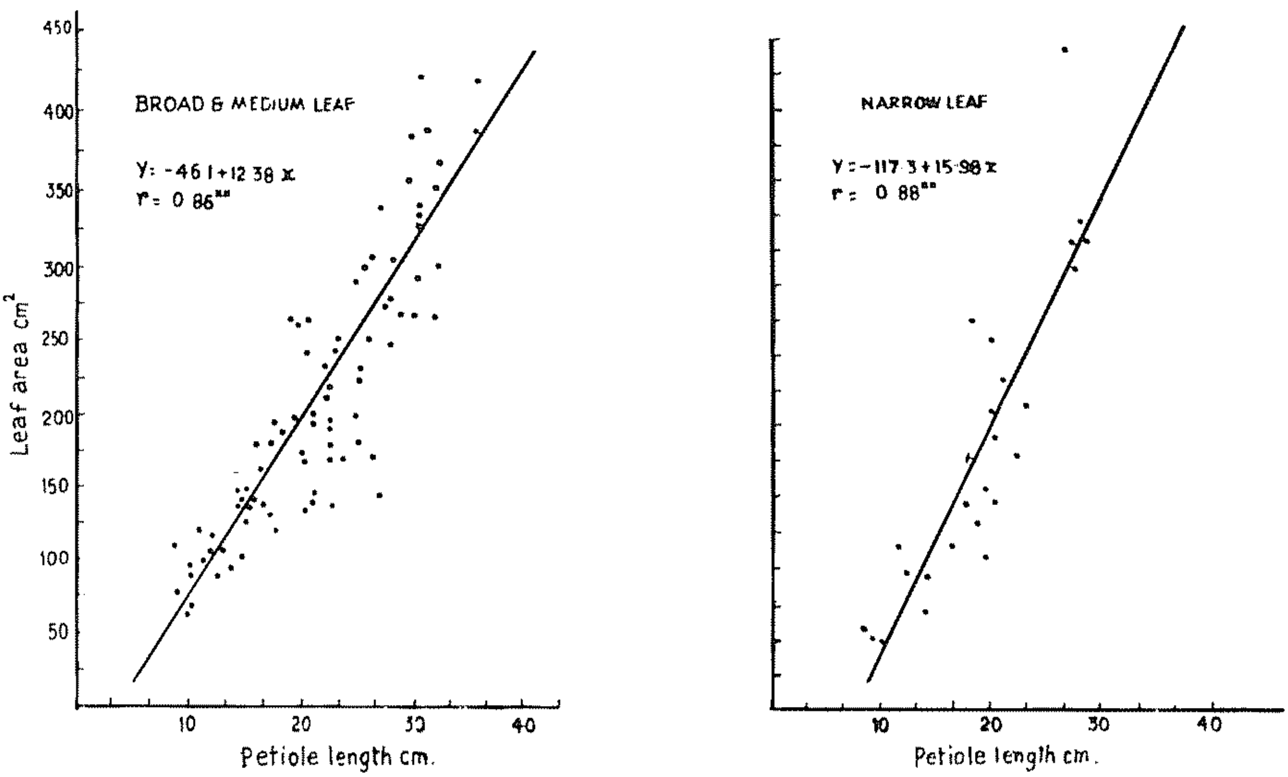


Fig 2 Relationship between petiole length and leaf area in cassava

leaves (Fig. 2). The calculated values of leaf area based on the regression equations were tested with actual leaf area traced on graph paper and the differences were found to be not significant.

Several methods were suggested to measure the leaf area (3). The present report suggests that petiole length can be taken as an index to measure the leaf area for large number of genetic stocks of cassava.

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### Summary

Positive correlations were observed between the petiole length and leaf area of cassava. A simple and rapid method is suggested to measure the leaf area while evaluating more number of genetic stocks.

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Studies on the use of cocoa by-products in animal feed. I. Responses of weanling rats to various levels of cocoa pod husk.

**Resumen.** Treinta ratas de laboratorio destetadas se usaron en un ensayo para determinar el nivel óptimo de inclusión de cáscara de cacao en la dieta. La cáscara de cacao se incluyó a 5 niveles: 0, 10, 20, 30 y 40 por ciento de la dieta.

El óptimo nivel de inclusión (tomando como base la tasa de crecimiento y la eficiencia alimenticia) fue el tratamiento con un 20 por ciento de cáscara de cacao. No se observó ningún efecto tóxico debido al uso de cáscara de cacao en la dieta.

Feeding costs remains the largest limitation to animal production in most parts of the tropics. This is especially so for nonruminant animal production. To reduce the feeding costs, the search for cheap, non-traditional feed sources must be intensified. One such feed source is cocoa pod husk (CPH).

It is estimated that from the annual output of 400,000 tons of dry cocoa beans in Ghana, a leading cocoa producer, 636,157 tons of dry cocoa pod husk may be obtained (Adomako, 3). The husk is largely discarded on cocoa plantations. Earlier reports (de Alba and Basadre 4; Adeyanju 1; Bateman and Larragan 6) indicate that this by-product has potential for livestock feeding. Its nutrient content is similar to high quality forage. Its use in traditional livestock feeding, especially for non-ruminants is limited by the high crude fibre and theobromine contents (Owusu-Domfeh, 9). Nevertheless, where optimum levels are established, its inclusion could lower feed cost.

This experiment was undertaken with a view to establish optimum levels of CPH in monogastric diets using laboratory rats as the test animals.

## Materials and methods

### Animals and diets

Thirty weanling laboratory rats (half male and half female) aged 3-4 weeks, were used in a completely Randomised Design (CRD) experiment to study the effect of five levels of CPH inclusion, viz, 0, 10, 20, 30 and 40 per cent in the test diets (Table 1). The diets were isonitrogenous but energy (TDN) was allowed to fluctuate among diets.

The CPH was obtained from the Plantation Section of the Faculty of Agriculture, University of Science and Technology, Kumasi. The fresh CPH was crushed manually with wooden mallets, dried over a mechanical grain dryer and later milled through a 1 mm mesh size sieve prior to inclusion in the experimental diets. The chemical composition of the cocoa husk was determined according to AOAC (5) procedures. However, theobromine level in the husk was determined according to Boie's methods as reported by Chatt (7).

### Housing and management

All rats were fed individually in 25 x 15 cm metal cages. Each cage was bedded wood shavings which were changed daily. Feed and water were given *ad lib.* Daily feed intake records were kept. All rats were weighed prior to and at the end of three week feeding trial. All rats were sacrificed at the end of the trial by ether asphyxiation and the liver, heart and kidneys examined for gross tissue changes which might be indicative of toxicity.

## Results and discussion

### Feed intake

There was an increase in feed intake with increase in CPH up to a level of 30 percent CPH inclusion and a decrease thereafter (Table 2). The general increase

Table 1: Dietary composition (air dry basis).

| | Level of husk (%) | | | | |
|---|---|---|---|---|---|
| | 0 | 10 | 20 | 30 | 40 |
| **Ingredients** | | | | | |
| Cocoa Pod Husk | 0 | 10 | 20 | 30 | 40 |
| Maize | 52 | 48 | 42 | 35 | 29 |
| Rice Bran | 10 | 7 | 5 | 3 | 1 |
| Copra Cake | 13 | 9 | 6 | 4 | 1 |
| Fish Meal | 23 | 24 | 25 | 26 | 27 |
| Bone Meal | 1 | 1 | 1 | 1 | 1 |
| Common Salt | 1 | 1 | 1 | 1 | 1 |
| **Chemical composition (%)[a]** | | | | | |
| Dry matter | 89.1 | 89.1 | 89.0 | 89.0 | 89.1 |
| Crude Protein | 22.1 | 22.8 | 22.2 | 22.2 | 22.8 |
| Ether Extract | 6.0 | 5.7 | 4.9 | 4.5 | 4.0 |
| Crude Fibre | 7.6 | 11.2 | 13.3 | 15.5 | 17.5 |
| Calculated TDN | 72.3 | 70.6 | 68.4 | 66.0 | 63.8 |

a From Laboratory Analysis except TDN. Values expressed on Dry Matter Basis.

Table 2: Performance of rats on various levels of cocoa husk

| Criteria | Level of cocoa husk (%) 0 | 10 | 20 | 30 | 40 |
|---|---|---|---|---|---|
| Initial body weight (g) | 84.9 | 84.2 | 82.7 | 84.2 | 76.8 |
| Average daily feed intake (g) | 8.6[ab]* | 8.1[b] | 10.3[ab] | 11.3[a] | 10.3[ab] |
| Average daily gain (g) | 1.68[ab] | 1.20[ab] | 1.80[b] | 1.78[ab] | 1.00[a] |
| Feed efficiency gain/feed | 0.19 | 0.15 | 0.17 | 0.16 | 0.09 |

* Means in a row with different superscripts are significantly different (P = 0.05).

in feed intake with increased level of CPH by the rats could be due to an increase in the palatability of the diet or to an increase in feed intake in an attempt to balance their energy requirement. There was a progressive decrease in energy density of the diet with increasing CPH level (Table 1). The presence of volatile compounds in CPH believed to enchance palatability has earlier been reported (Willians, 10). Owing to the high crude fibre content of cocoa husk (Table 3) the 30 percent CPH could be the limit in intake imposed by the physical capacity of the gut. The pattern of feed intake observed is in agreement with the work on CPH in broiler chicks by Ougutuga *et al* (1977).

Growth rate and feed efficiency:

The highest rate of gain was recorded for the rats on 20 percent CPH (Table 2). Apart from the 20 percent CPH diet which differed significantly from the 40 percent CPH diet, none of the dietary treatments resulted in significant differences in rate of gain. The poorest rate of gain was recorded for rats on 40 percent CPH. It seems that fairly satisfactory gains can be made by rats on diets containing up to 30 percent CPH; the most optimum level being the 20 percent CPH. This observation is in agreement with work reported by Adeyanju *et al* (1a) on pigs and Ogutuga *et al* (8) in broiler chicks. It is probable that the 20 percent CPH diet presented the right balance in amino acids and minerals.

There were no significant differences in feed efficiency between diets though it appeared the lowest feed efficiency resulted from the 40 percent CPH inclusion (Table 2). The 20 percent CPH inclusion appeared to be the best of all the CPH containing diets with regard to feed efficiency.

Organ weights:

There was a trend in increasing kidney weight per unit body weight with increase in level of CPH (Table 4). However, neither the kidney weight nor weight of the other organs examined differed significantly across treatments. Thus it could be inferred that in general, at the level of CPH inclusion in the present trial, the theobromine levels (0.32% in the husk (Table 3)) were not high enough to cause visible toxicity effects.

## Conclusion

CPH can be used satisfactory in monogastric diets as deduced from rat trials at levels up to 30 percent inclusion in the diet. It seems the 20 percent level of inclusion is, however, the optimum.

Acknowledgment

The authors are grateful to Mr. S. Yambillah for assistance in the laboratory analysis of feed samples. The assistance by Miss Christie Tuzie in the care of the laboratory rats is appreciated.

Table 3: Chemical composition (dry matter basis) of cocoa pod husk

| Component | % |
|---|---|
| Dry Matter | 86.3 |
| Crude Protein | 7.4 |
| Crude Fibre | 26.5 |
| Ether Extract | 1.4 |
| Ash | 9.5 |
| Theobromine | 0.32 |

Table 4: Organ weight per unit live weight (g x $10^{-2}$) of rats on different levels of cocoa husk

| | Level of Husk (%) | | | | |
|---|---|---|---|---|---|
| Organ | 0 | 10 | 20 | 30 | 40 |
| Liver | 4.82 | 4.70 | 5.05 | 4.52 | 4.82 |
| Kidney | 0.82 | 0.88 | 0.88 | 0.91 | 1.03 |
| Heart | 0.45 | 0.42 | 0.45 | 0.45 | 0.42 |


## Summary

Thirty weanling laboratory rats were used in a three-week trial to determine the optimum level of cocoa pod husk (CPH) inclusion in the diet. The CPH was included at 5 levels, viz 0, 10, 20, 30 and 40 percent in the diet.

The most optimum level of inclusion in terms of growth rate and feed efficiency was the 20 percent CPH inclusion. There were no observed toxicity effects due to CPH feeding.



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## Salt effect on *in vivo* activity of nitrate reductase in peanut (*Arachis hypogaea* L.) seedlings.


**Resumen.** Se estudió la actividad de la reductasa de nitratos bajo la influencia del cloruro y el sulfato de sodio. Ambas sales promovieron la actividad de la enzima *in vivo* tanto en los cotiledones como en los ejes embrionarios. El efecto del cloruro fue más pronunciado que el del sulfato.


Inhibition of the activity of nitrate reductase (NADH: Nitrate reductase, EC 1.6.6.1) by water, heat and salt stress (3, 6, 7, 8) and the factors for such decrease were described earlier (2, 8, 12). Sankhla and Huber (10), however, reported a promotion in the *in vivo* activity of nitrate reductase in cotyledons and leaves of 4-day-old *Phaseolus* seedlings treated with salt and ABA. However, the mechanism of action of such stimulation has not been elucidated. Differences in the *in vivo* and *in vitro* activities of the enzyme under the influence of salt (50-150 mM) in *Salicornia* has been reported by Austenfeld (1). Earlier studies indicated that the