Tropical Root Crops

RESEARCH STRATEGIES FOR THE 1980s

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TROPICAL ROOT CROPS: RESEARCH STRATEGIES FOR THE 1980s

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THE ROLE OF PALM OIL IN CASSAVA-BASED RATIONS

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Palm oil retards the decomposition of the intermediate products of linamarin (acetone cyanohydrin) and amygdalin (mandelonitrile); thus, in animals fed cassava-based diets supplemented with palm oil, the delay in decomposition may prevent absorption of the linamarin. A basic medium (pH 8—9) accelerates the breakdown of these compounds.

Cassava is a cheap, digestible source of calories for humans and domestic animals. However, feeding cassava flour to animals for a considerable time depresses their voluntary feed intake and rate of growth (Oyenuga 1961; Enriquez and Ross 1969; Pido and Adeyanju 1978). Some of the reasons postulated for this reaction include the presence of the cyanogenic glucosides linamarin and lotaustralin, which release hydrogen cyanide or hydrocyanic acid, a deadly poison, upon hydrolysis. The detoxification of hydrocyanic acid by the enzyme rhodanase releases thiocyanate, a goitrogen (Oke, 1978). Some other nutritional problems such as the complexing of lysine by aldehydes of cassava carbohydrates, especially when heated, and the low protein, vitamin, and mineral contents of cassava flour also limit the utilization of this feed source by domestic animals (Oke 1978; Hutagalung 1977). Several methods are used to process cassava roots to decrease the level of toxic compounds in the flour. Grinding, frying, fermenting, boiling, sun drying, and soaking are some of the methods in use. However, not all the toxic compounds are removed from the flour. Carmody (1900) observed that successive water extractions remove further quantities of hydrocyanic acid from cassava roots. Joachim and Pandittesekere (1944) found that the amount of hydrocyanic acid released autolytically increased very rapidly as the amount of time allowed for autolysis was increased up to 24 h. Even when autolysis was essentially complete, a further quantity of hydrocyanic acid could be released by acid hydrolysis. Cooke and Maduagwu (1978) showed that free cyanide was rapidly removed from cassava chips but bound cyanide was less readily removed. These workers established that only a third of the bound cyanide is removed by autolysis at 46.5°C. Hill (1977) showed that 50 mg of linamarin given by stomach tube to rats killed them within 4 h and produced abnormal electrocardiogram tracings similar to those found in cyanide poisoning.

Hawksworth, Drasar, and Hill (1971) observed that Escherichia coli produce β-glucuronidases and β-galactosidases; enterococci produce β-glucosidases and β-galactosidases, and nonsporing anaerobes produce small amounts of all these enzymes except β-glucuronidases. These enzymes could hydrolyze linamarin, lotaustralin, and glucuronides.

Sulfur and fats enable better utilization of cassava flour by animals. Fats, especially, have been noted to influence feed intake regardless of the density of the feed (Carew et al. 1963). Hutagalung and Chang (1977) showed that pigs utilized cassava-based diets more efficiently when supplemented with 5—10% palm oil than did controls or pigs fed diets supplemented with lard or tallow. These researchers also stated that palm oil was more digestible than fats of animal origin. Hew (1975) stated that an 8% palm-oil supplementation of a cassava diet enabled faster growth by animals and beyond this level a plateau was reached. Other workers in this field have observed gains in weight when fats as well as methionine (0.2%) are added to cassava diets (Ross and Enriquez 1967; Hew and Hutagalung 1972; Maner 1974). Devendra and Hew (1977) fed pigs up to 30% palm oil in
10–24% cassava rations and observed no effect. In view of this, work at the University of Ife was designed to investigate the role of palm oil in cassava-based rations.

The intermediate products of linamarin and amygdalin (cyanohydrin and mandelonitrile, respectively) were synthesized according to the method of Vogel (1978). Decomposition rates of 0.2 µl aliquots in phosphate buffer (0.05 M) at different pH levels were investigated. The experiment was repeated with palm oil as the medium. The rate of hydrolysis of mandelonitrile was reduced markedly in the palm oil compared with that in aqueous media; the rate of hydrolysis of acetone cyanohydrin was variable. We measured the rate of hydrolysis as liberated hydrogen cyanide at 30°C using a modified recovery method by Gilchrist (1967).

With this approach, we attempted to discover whether palm oil has any effect on the breakdowns shown in the equations:

(1)

\[
\begin{align*}
\text{CH}_2\text{OH} & \quad \text{O} \quad \text{CN} \\
\text{OH} & \quad \text{OH} \\
\text{OH} & \quad \text{CH}_3 \\
\end{align*}
\]

\[\text{B-glucosidase} \quad \text{step A}\]

\[
\begin{align*}
\text{CH}_2\text{OH} & \quad \text{OH} \\
\text{OH} & \quad \text{OH} \\
\text{OH} & \quad \text{CN} \\
\text{CH}_3 & \quad \text{CH}_3 \\
\end{align*}
\]

\[\text{glucose} \quad \text{acetone cyanohydrin}\]

(2)

\[
\begin{align*}
\text{CN} & \quad \text{O} \\
\text{HO} & \quad \text{C} \quad \text{CH}_3 \\
\text{CH}_3 & \quad \text{step B} \\
\text{Prussic acetone acid} \\
\end{align*}
\]

Our preliminary results showed that palm oil does slow down the decomposition of acetone cyanohydrin, which is expected, as cyanohydrins decompose in basic media; for example,

(3)

\[
\begin{align*}
\text{CN} & \quad \text{CN} \\
\text{HO} & \quad \text{HO} \quad \text{C} \quad \text{CH}_3 \\
\text{CH}_3 & \quad \text{H}_2\text{O} \\
\end{align*}
\]

(4)

(5)

We are now working to evaluate the effects of palm oil on the decomposition of linamarin. One possibility is that, during digestion, palm oil prevents absorption and effects subsequent excretion of linamarin; however, Hill (1967) found no linamarin in feces of rats fed linamarin by stomach tube. He suggested that linamarin was either absorbed intact and excreted in the urine or changed to a yet unidentified metabolite and then excreted in the feces. Another possibility is that palm oil or a component of palm oil modifies the enzyme systems that hydrolyze and metabolize linamarin, most probably via glucuronides.