

STUDIES IN MANIOC & LIMA-BEANS WITH SPECIAL REFERENCE TO THEIR UTILIZATION AS HARMLESS FOOD

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SUMMARY

THE cyanogenetic glucoside in manioc and lima-beans has been isolated and demonstrated to be poisonous. Suitable methods have been worked out to reduce the cyanogenetic glucoside content to a safe limit. Methods are described for the utilization of these as harmless food.

INTRODUCTION

Manioc (*Manihot utilissima*) and lima-beans (*Phaseolus lunatus*) are both known to contain a cyanogenetic glucoside called "linamarin" and an enzyme called "linase". When the enzyme is brought into intimate contact with the cyanogenetic glucoside as a result of injury or decay, prussic acid is liberated. Since prussic acid is a poison, these foods are potentially harmful.

Prussic acid is a very volatile gas and is easily removed during cooking. The enzyme is inactivated at temperatures above 72°C and is therefore not responsible for further liberation of prussic acid, after cooking. This indicates that the cyanogenetic glucoside which is the parent substance of the prussic acid, is responsible for the toxic effects caused by eating these foods, after cooking.

EXPERIMENTAL

The cyanogenetic glucoside was isolated from manioc tubers, and an aqueous solution (free from the enzyme) was administered orally to young rabbits. It was observed that 1½ grammes of the cyanogenetic glucoside containing 10 milli-grammes of prussic acid in the bound form, can kill a rabbit one month old and weighing ¼ lb. in about 3 hours. This proves that the cyanogenetic glucoside is also poisonous.

The above findings indicate that both the free and the bound prussic acid as cyanogenetic glucoside should be removed before these foods are consumed. It was found that the last traces of the cyanogenetic glucoside are difficult to remove without rendering these foods unfit for consumption. Hence it is very necessary that a maximum safe limit should be arrived at for the bound prussic acid content of cooked foods.

Monier-Williams, (1), has suggested in his public health report a maximum of 2 milli-grammes of prussic acid per 100 grammes for foods which are eaten raw. But, he states that in the case of foods treated with prussic acid as an insecticide, e.g., dried fruits, the limit may be higher. In the latter case, the prussic acid is expelled during cooking, and therefore there is no danger.

In view of the above considerations it is suggested that the limit be assumed as 5 milli-grammes per 100 grammes, for the bound prussic acid content of cooked foods. The traces of bound prussic acid so consumed, can be assumed to be detoxified in a mixed diet containing fish, meat, eggs or milk. For, it is reported that the sulphur proteins present in such a diet, have a detoxifying action on the prussic acid, which is converted into sulphocyanates and excreted with the urine, (2).

Experiments on manioc and lima-beans to reduce the prussic acid content to a safe limit are described below.

Manioc Tubers.

The sweet varieties of manioc are cultivated for food, as they contain less prussic acid than the bitter varieties. The prussic acid content is considerably influenced by environmental factors, (3). A number of sweet varieties of manioc analysed by the writer indicates a variation from about 8 to 25 milli-grammes of total prussic acid in 100 grammes of the flesh and 40 to 60 milli-grammes per 100 grammes of the thick white portion of the skin called the cortex.

The tubers on lifting from the soil, remain fresh for about 24 hours. Thereafter respiration ceases and physiological breakdown sets in rapidly with the liberation of prussic acid. It was observed that the free prussic acid in the flesh increases from about 1 milli-gramme per 100 grammes soon after lifting from the soil, to about 2 milli-grammes per 100 grammes in about 24 hours. The free prussic acid content was found to increase at this rate for about 72 hours. The presence of considerable amounts of free prussic acid in stale manioc indicates that manioc is more poisonous when stale. This is confirmed by the observation that manioc tubers three days old have been fatal to hogs, while the fresh tubers have no apparent ill-effects, (4).

Staleness in manioc tubers is accompanied by discolouration of the flesh. This occurs first below the cortex and continues inwards towards the centre of the tuber. The streaks of "blue" seen on peeling stale manioc tubers are due to internal bruises which render that part of the tuber more susceptible to oxidation and decay.

Manioc tubers can be kept fresh for longer than 24 hours and up to 48 hours by placing them immersed in fresh water. The tissue begins to perish after about 48 hours, losing its firmness and is rendered unsuitable for ordinary culinary purposes. On the other hand the tubers can be kept fresh for periods longer than 48 hours and up to even one week by storing them in an atmosphere of carbon dioxide.

The peeled tubers, chopped into pieces, and boiled in a large excess of water for about one hour till well cooked, give less than 5 milli-grammes per 100 grammes as bound prussic acid in the final product, after the water is thrown away.

Manioc tubers on peeling and drying in the ordinary way, after slicing or rasping, normally contain above 5 milli-grammes per 100 grammes of bound prussic acid. If the drying is carried out at temperatures much above 72°C, the enzyme that liberates the prussic acid is quickly inactivated, and the product may contain as much as 25 milli-grammes per 100 grammes as bound

prussic acid. These amounts of bound prussic acid are potentially dangerous. Experiments conducted to reduce the bound prussic content by suitable per-treatment have yielded the following results.

Treatments.	Drying Temperatures.	Prussic Acid in Flesh.	Prussic Acid in dried Product.	Per Cent. Prussic Acid removed.
Sliced and dried immediately ..	60° C ..	12 mg/100 gms..	15 mg/100 gms..	50
" ..	(90-100)° C..	" ..	25 ..	16
Rasped and dried immediately ..	60° C ..	" ..	10 ..	66
" ..	(90-100)° C..	" ..	25 ..	16
Sliced and dried after 24 hours spreading ..	60° C ..	" ..	5 ..	83
" ..	(90-100)° C..	" ..	8 ..	73
Rasped and dried after 24 hours spreading ..	60° C ..	" ..	3 ..	90
" ..	(90-100)° C..	" ..	8 ..	73

The above results show that the best method of removing the maximum amount of prussic acid to give a dried product containing less than 5 milligrammes per 100 grammes, is by spreading the sliced or rasped manioc flesh for 24 hours at room temperature, and then drying at 60°C. Spreading for 24 hours gives sufficient time for the enzyme to liberate most of the prussic acid, while drying at a temperature below 72°C causes the reaction to proceed at an enhanced rate, whereby the final product is deprived of the maximum amount of prussic acid.

Manioc Leaves.

The leaves of the sweet varieties of manioc contain large quantities of prussic acid. A number of samples analysed by the writer indicates a variation from about 40 to 100 milli-grammes per 100 grammes. The tender leaves were found to contain more prussic acid than the mature leaves.

Manioc leaves are reported to be rich in carotenes (precursors of vitamin "A"), vitamin "B1", vitamin "B2", vitamin "C" and mineral matter, (5). But the presence of dangerous amounts of prussic acid has prevented their use as a popular vegetable.

Manioc leaves seem to contain about 5 per cent. of the total prussic acid in the free form. About 75 per cent. of the total prussic acid, however, is liberated as free prussic acid when the leaves are pounded. This is due to the enhanced activity of the enzyme present in the leaves.

Manioc leaves on pounding in a wooden mortar and washing in three changes of hot water give less than 5 milli-grammes per 100 grammes as bound prussic acid in the final product, after the water is thrown away. The leaves prepared in this manner have a poor appearance, and are not quite suitable for culinary purposes. The leaves when chopped and boiled for 15 minutes each time in two changes of water give less than 5 milli-grammes per 100 grammes as bound prussic acid in the final product, after the water is thrown away. The leaves so prepared are quite suitable for culinary purposes.

Lima-beans.

Lima-bean pods are generally not eaten in the tender snap-bean stage as they are known to be bitter even after cooking. The tender beans analysed

by the writer indicate a variation of prussic acid content from about 50 to 75 milli-grammes per 100 grammes. The bitterness can be almost completely removed and the bound prussic acid content can be brought down to below 5 milli-grammes per 100 grammes by boiling the pods for 20 minutes each time in two changes of water. The mature seeds on the other hand, are quite palatable and nutritious, being rich in proteins and mineral matter, (6). The prussic acid content of the seeds is considerably influenced by environmental factors, (7). A number of varieties analysed by the writer indicates a variation from about 20 to 50 milli-grammes per 100 grammes. The seeds when boiled for half an hour each time in two changes of water, give less than 5 milli-grammes per 100 grammes as bound prussic acid in the final product, after the water is thrown away.

UTILIZATION AS FOOD

The prussic acid content of manioc and lima-beans can be reduced to a safe limit by suitable methods of pre-treatment. It is, however, advisable to supplement these foods with even small quantities of fish, meat, eggs or milk to eliminate any risk of cumulative ill-effects that may be caused by traces of prussic acid. Methods are described below for the utilization of these foods.

1. The fresh manioc tubers are peeled, cut into suitable pieces and boiled in a large excess of water in an open vessel, for about one hour, till well cooked. The water is thrown away and the cooked pieces are eaten as a vegetable or made into a curry.

2. The manioc tubers are peeled and the flesh is sliced or rasped and the material is spread out evenly in a thin layer for about 24 hours. It is then dried in the sun or in a drier at 60–70°C. The dried product is converted into flour and is used for making “pittu”, “string-hoppers”, bread, cakes and biscuits. It is useful to add one part of roasted cowpea or green gram flour to four parts of the manioc flour to improve the nutritive value and flavour of the “pittu”. It is necessary to add an equal part of wheat flour to the manioc flour for the preparation of “string-hoppers”, bread, cakes and biscuits.

3. Manioc leaves are picked in the fairly tender stage, chopped into pieces and boiled for about 15 minutes each time in two changes of water. The water is thrown away and the leaves are eaten as a vegetable or converted into a “mallung” or made into a curry.

4. The tender lima-bean pods are boiled for about 20 minutes each time in two changes of water. The water is thrown away and the beans are eaten as a vegetable or made into a curry.

5. The mature lima-bean seeds are boiled for about half an hour each time in two changes of water. The water is thrown away and the beans are eaten as a vegetable or made into a curry. If the mature dry seeds are used they are soaked over-night in water containing about two tea-spoonfuls of sodium carbonate or two table-spoonfuls of wood-ash per pound of the seeds. This water is thrown away and the beans are boiled in two changes of fresh water for 20 minutes each time. The beans so prepared are eaten as a vegetable or made into a curry.

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