DISCUSSION

Dr. Magoon :

I wish to make the following comments:—

1. You have indicated in your paper that cassava is definitely of South American origin, but have given no data to support your conclusion. On the other hand, Rogers (1963) proposed that cassava first became an important element in the diet of lowland tropical people, somewhere in the Meso-American complex, and was distributed from there to other parts of its present day range. This proposal is well supported by sound arguments.

2. You have pointed out that the genus **Manihot** contains over 150 species. I do not know what makes you so sure that each one of them deserves the rank of a species. Although there are certain 'species' groups in the genus, the species are very difficult to delimit taxonomically, because, as pointed out by Rogers, hybridization occurs and recombination of characteristics destroys sharp delimitations among many of the so-called species. The progress of speciation among forms of the same group, is comparatively weak, so that related species are connected by intergrades. Considerable amount of work will be required in this genus, before one is in a position to categorically state the number of species it contains. Only a few 'species' have so far been used in the breeding programme, and, in fact, very little is known to the breeder concerning the various other wild forms, in spite of the fact that the genus is a large one.

3. You have emphasised that cassava tubers contain a highly poisonous prussic acid in the free state. What evidence do you have, if any, to support this statement? As far as I know, the living plant probably contains no free prussic acid, but like other members of the Euphorbiaceae, it exudes latex from small sacs beneath the peel or bark, when it is cut or bruised. The latex contains a cyanogenetic glucoside that begins to break down into prussic acid, acetone, and glucose, once the plant is harvested. The prussic acid is present in roots, branches, and leaves of the plant, after they are harvested in quantities that vary from harmless to lethal. It is highly soluble in water, and is reported to get decomposed when heated to a temperature of 150°C. The freeing of prussic acid from the glucoside appears to be accomplished by the action of linase — an enzyme which is present in the growing plant — and hydrolysis, under the influence of linase can be speeded up by soaking the roots in water, by heating, by cutting or grafting them, since it facilitates contact between enzyme and cyanogenic glucoside. The enzyme, linase, has been shown to get destroyed above the temperature of 75°C. and therefore, great care must be exercised in keeping the temperature below 75°C, in preparing cassava products. Hardly anything definite is known regarding the toxicity of cassava roots, and the influence of external factors on it, and much more critical work will have to be done before the effect of soil, climate, age of the plant, moisture, temperature, altitude, potassium deficiency etc., which have been shown to influence prussic acid content, by different workers, can be fully acceptable to all.

4. The next point is optimum starch content. If the graph shown here is taken into consideration, it appears that no consideration is made of the time whereby the maximum period of starch content will be available in the tuber. Actually experience has shown that there is a considerable variation in the starch content at various stages of the tuber and the maximum period of starch content is really from variety to variety. Apart from this, potassium has shown to have considerable effects on the formation of carbohydrates. Even though potassium is not a constituent of carbohydrates, it appears to play a part in the creation of tubers, starches and cellulose. So such factors have not been taken into consideration in drawing this graph. Probably it has been taken only on one variety.

Dr. Ghosh :

I am indeed thankful to Dr. Magoon for pointing out these various things. As I do not profess to be an expert on cassava, by any means. We have had discussions on the subject, and what I have tried to do here is to show what we are doing in the industrial stage. I take his criticism about the number of species with an open mind. My knowledge is on the books I have read or which I have available, and if that is wrong there is no question asked about it.

Going back to the graph showing the optimum age and the effect of maturity of cassava on starch, I think if the graph is looked at carefully it is self-explanatory. It does not refer to any particular variety, but I think that I am right in saying that it applies to a large number of varieties. Similar studies, if carried out, will show that as you move away from the optimum stage, either minus or plus, you will lose in the yield. Therefore, this graph is only an indication as to the importance of establishing the optimum age of the varieties which are under consideration. It is not for a particular variety.

Mr. Doku :

Could you describe the peeling unit in a bit more detail, because I believe that peeling could affect the efficiency of production of starch?

Dr. Ghosh :

Unfortunately I forgot to mention this, but I have a few photographs with me of the plant. Most of the photographs were not very successful, and if you are interested, I can show them in much more detail to you.

Mr. Kennard :

The information you gave concerning this plant is of considerable interest to us, because we were looking into the possibility of manufacturing cassava starch as a substitute in the refining process in bauxite. What is of interest to me is the fact that the plant will operate for six to seven years at a loss. Could you give me some information as to the cost of establishing such a plant?

Dr. Ghosh :

I am afraid that this is going to be a very tricky question to answer, because the Uganda government, who is responsible for it is not particularly keen to show how much they are losing. I think that this is more of a political project than an economic one, and it is difficult to answer this question.

Dr. Maner :

Just one comment. In Colombia there is a pilot plant being run by the United Starch Company from the United States, and I understand that they did not decide to go into commerical production because of the excessive cost of producing starch.

Prof. El Mohandes :

Going back to the project, it would be successful to establish a plant in your country, providing that you do not import starch from outside. In other words, you have to have protective measures because the competitive prices between corn starch and other starches are very high, and tuber starches cannot compete with the modified starches of corn, so before you think, you have to take these protective measures. One statement in that paper said that they had to have protective measures in Uganda, because the South East Asian production is so deep that nobody can compete with it. Corn starch is cheaper because it is produced for five cents a pound. The cost of production is five cents a pound and that is very cheap.