BREEDING FOR PROTEIN ENHANCEMENT IN CASSAVA

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SUMMARY

An intraspecific cross in *Manihot esculenta* between a Madagascar clone and a clone from Malaysia has a protein content of 7.9% but a low yield potential. In interspecific crosses between *M. saxicola* and *M. esculenta* there was a higher protein content in the roots of seedlings than in the parents, but the protein content reverted to normal levels in the clonal offspring of the hybrid seedlings. Tetraploids were produced from Malayan 4 and the protein content of these was increased by 42% over the level in the diploid and this was stable under vegetative propagation. Mutation breeding is also being undertaken.

RESUME

Un croisement intraspécifique dans *Manihot esculenta* entre un clône malgache et un clone de Malaisie a une teneur en protéine de 7.9%, mais le potentiel de rendement est bas. Dans des croisements interspécifiques entre *M. saxicola* et *M. esculenta*, la teneur en protéine est plus élevée dans les racines et les plantules que dans les parents, mais la teneur en protéine redevient normale dans les descendants des plantules hybrides. Des trétraploides ont été créés a partir du Malayan 4 avec un accroissement de 42% de leur teneur en protéine au dessus du niveau observé dans le diploide; l'enrichissement acquis s'est maintenu lors de la multiplication végétative. La sélection de mutations est également en cours.

RESUMEN

El contenido de proteína de una cruza intraespecífica en *Manihot esculenta* es de 7.9%, pero su rendimiento potencial es bajo. En cruzas interespecificas entre *M. saxicola* y *M. esculenta*, hubo un contenido más alto de proteína en las raíces de la progenie que en los padres; revirtiendo, sin embargo, a niveles normales en la progenie clonal de los híbridos. Se produjeron tetraploídes a partir de Malayan 4, con un contenido de proteína incrementado en un 42% sobre el nivel encontrado en los diploídes y estable bajo propagación vegetativa. Seintenta también la hibridación por mutaciones.

INTRODUCTION

The diet in the developing regions in the world is deficient in protein. It is desirable to develop strains of food crops having higher protein content, as one means of combating malnutrition. Cassava (*Manihot esculenta*) is biologically a highly efficient producer of calories, and if it could be made a more efficient producer of protein, it could make a greater contribution to nutrition in the tropics.

Protein malnutrition is prevalent particularly among low-income families where cassava is an important food. In cultivars presently grown the tubers generally contain about 1.8% protein (Coursey and Haynes[4]), and the protein is also poor in essential amino-acids, and especially in the sulphur-containing amino-acids (Jones[7]).

We have attempted to improve the protein content of cassava through conventional breeding methods involving selection and hybridization at both intra- and inter-specific level. Breeding by induced polyploidy and mutation have also been found to hold promise. We present the results obtained so far and discuss the future approach to the enhancement of protein in cassava.

RESULTS AND DISCUSSION

Germplasm evaluation

The total germplasm collection of clones comprises about 1,400 entries, of which 250 are exotics. Screening for quality characteristics did not reveal any significant variability in protein content of the tubers. This supports the findings of Bolhuis[2]. However, a clone recently received from Colombia has been claimed to contain about 8% protein and this is being multiplied.

Intervarietal hybridization

Though a break-through has been achieved in yield (Magoon *et al.*[10]) by hybridization, quality im-

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provement has received little attention. Superior genotypes have been crossed and desirable recombinants have been selected and maintained clonally. In a population of 54 segregants derived from a cross between a Madagascar and a Malayan stock, there appeared to be continuous variation from 2.08 to 7.99% protein content on a dry weight basis. Selections 1579(1), 1586(3) and 602(3) had 6.2%, 6.3% and 7.99% respectively. However, these had very poor yields and indicate a negative correlation between protein and yield.

'Interspecific' hybridization

Manihot saxicola is a wild species reported to contain 11% protein. However, Bolhius[2] questioned the validity of classifying *M. saxicola* as a separate species since seed set in the 'interspecific' cross with *M. esculenta* often exceeded the seed set in cassava x cassava crosses. Crosses made between *M. esculenta* and *M. saxicola* yielded a few seedlings with comparatively high protein in the tubers but when these selections were propagated clonally the protein content fell back to typical levels (Jones[7]). A new attempt seemed worthwhile to transfer the protein productivity of *M. saxicola* to cassava, avoiding the breakdown of this character associated with clonal propagation. It is also important to collect other species to intensify the breeding programme in this direction.

Polyploidy

Polyploidy has been successfully used for improvement in rye, turnips, clover, berseem etc. (Mehta & Swaminathan[11], Allard[1]). Recently, polyploidy has been found effective in improving quality in root crops (Gaul[6]).

Cultivated cultivars of cassava are diploids with 2n = 36 chromosomes. Auto-tetraploidy was induced in Malayan–4 by treating the sprouts of stem cuttings with 0.5% colchicine solution (Magoon *et al.*[9]). Clones raised from treated shoots showed the usual gigas characters associated with polyploidy, but no significant difference in yield potential or in dry matter content was found between 'tetraploid' and the parental clones.

The average crude protein content in the diploid was found to be 2.79% while tetraploid has as high as 3.97% on a dry weight basis, representing an increase of 42.3%. Tubers of diploid parents showed a range of 2.26 to 3.30% crude protein, while in the corresponding tetraploids, the range was found to be 3.30% to 4.86%. The increase in protein content was consistent in tubers of different individual tetraploid plants of a particular clone (Jos, *et al.*[8]).

Tubers of tetraploid and diploid plants did not differ significantly in shape or size, so that the variation in protein content is not merely a characteristic related to the overall size of the tubers. Rather, it seems that protein *per se* had increased in the tubers. This is in contrast to the situation in crops like rye, where increase in protein at the tetraploid level is attributable to the small seed size and lower seed setting in the tetraploid plants (Frost & Ellerstrom[5]). Tetraploidy in cassava appears to persist and be stable through vegetative propagation.

Mutation

Developing crop cultivars having either higher protein content or enhancing the content of certain essential amino-acids in their protein through mutation, has opened new vistas in breeding for quality, particularly in cereals. Using a wide variety of mutagens, a mutation breeding programme in cassava has been initiated for protein enhancement. Though significant improvement could be achieved for the increase in starch content and decrease in rind thickness (Vasudevan *et al*[12]), further detailed analysis is underway to screen the irradiated population for protein characteristics. Also, mutation breeding may be of further help in breaking undesirable linkages.

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