COAGULABLE PROTEIN IN POTATO: SCREENING METHOD AND PROSPECTS FOR BREEDING

P. MIEDEMA, W. M. J. VAN GELDER and J. POST

Foundation for Agricultural Plant Breeding, Wageningen, the Netherlands

Received 12 April 1976

INDEX WORDS

Solanum tuberosum, potato, coagulable protein, screening method, breeding

SUMMARY

From tubers of 34 varieties of Solanum tuberosum, extracts were prepared and analysed for crude protein and coagulable protein by the Kjeldahl method. Content of coagulable protein was 0.37–1.24 %. From the same material, juice was prepared with a juice centrifuge and analysed for coagulable protein by the Kjeldahl and microbiuret method. The average amount of coagulable protein in the juice was 81.8 % of the total coagulable protein. The correlation coefficient between coagulable protein in the juice and total coagulable protein was 0.956 **. The correlation coefficient between Kjeldahl and microbiuret data for coagulable protein in the juice was 0.956 **. Analysis of tuber juice by the microbiuret method is recommended as a rapid screening technique for coagulable protein.

Relationships between protein data of the 34 varieties and earliness, yield and content of dry matter were analysed statistically. Content of coagulable protein in fresh material correlated with content of dry matter (r = 0.756 **), yield of fresh potatoes (r = –0.615 **) and earliness (r = –0.361 *), but not significantly with yield of dry matter (r = 0.309). Coagulable protein in dry matter correlated with fresh yield (r = –0.525 **), but not significantly with content of dry matter (r = 0.260), yield of dry matter (r = –0.131) and earliness (r = 0.054). Path coefficient analysis showed that 67 % of the variation in coagulable protein in fresh material was statistically determined by earliness, content of dry matter, fresh yield and content of uncoagulable protein in fresh material, whereas only 34 % of the variation in content of coagulable protein in dry matter was determined by these components. A high content of coagulable protein in fresh or dry matter can be combined with early maturity and with high yield of dry matter. Coagulable protein in dry matter seems to be a more suitable criterion of selection than coagulable protein in fresh material.

INTRODUCTION

Potatoes have long been considered unimportant as a protein source. Potato tubers have a low content of crude protein on a fresh weight basis in comparison with other foodstuffs of plant origin like pulses, cereals and vegetables (BROUK, 1975). On a dry weight basis, however, contents of crude protein of 7–10 % have been reported (SIGLE, 1951), and potatoes produce more crude protein per hectare than beans, peas and wheat (KALDY, 1972).

Crude protein from potatoes consists of a soluble fraction and a small insoluble fraction (MULDER & BAKEMA, 1956). About 40–70 % of the soluble fraction is coagulable protein (REISSIG, 1958). The soluble non-protein nitrogen fraction consists mainly of amides and amino acids (MULDER & BAKEMA, 1956). The biological value

* P ≤ 0.05; ** P ≤ 0.01.
of the coagulable protein is high, while that of the non-protein nitrogen is low. REISSIG (1958) found average essential amino acid indices for crude protein, soluble non-protein nitrogen and soluble true protein of 73, 37 and 91, respectively.

The potato can be improved as a protein source for human nutrition by increase in the content of coagulable protein. In the Netherlands, about 50% of the potato production is used by the potato starch industry. This industry recovers coagulable protein from the waste liquor. The protein is a valuable by-product used in feedstuffs. Increase in the content of coagulable protein in industrial varieties will increase their value for the starch industry.

The feasibility of breeding for coagulable protein in potato depends on (1) genetic variation, (2) availability of a suitable screening technique, and (3) relationships between coagulable protein and other breeding objectives. A large genetic variation has been reported (NEUBERGER & SANGER, 1942; SIGLE, 1951; MöLLER, 1965; FITZ-PATRICK et al., 1969). Estimation of coagulable protein requires extraction of homogenized tuber samples. Such a method is time-consuming. A rapid screening technique was recently developed (VAN GELDER & KRECHTING, 1973). By this method, coagulable protein is estimated in potato juice, which is easily obtained with a juice centrifuge; after coagulation, protein is analysed by the microbiuret method. An investigation among 12 varieties showed a high correlation (r = 0.93) between coagulable protein on whole tuber basis calculated from the percentage in juice, and total coagulable protein. Thus the method can be used to approach total coagulable protein. In the present paper, this relationship was investigated further on 34 varieties with a much wider range in content of coagulable protein. The question was whether data of coagulable protein in the juice are representative for total coagulable protein and whether the protein data of the juice have to be calculated on whole tuber basis, i.e. multiplied by the ratio between juice weight and tuber weight.

In addition, the suitability was tested of the method for screening for true protein. The main nitrogenous fractions were analysed in four varieties to find out what part of the extractable true protein was coagulable, and how much of the crude protein was insoluble.

The main objective was to study the implications for plant breeding. Two questions will be dealt with. First, what is the most suitable breeding criterion: coagulable protein in the fresh or in the dry matter? Secondly, does selection for high content of coagulable protein have consequences for other agronomic characteristics like earliness, tuber yield and dry matter content? Tuber samples of the 34 varieties were analysed for coagulable protein, crude protein, and dry matter. Yield and earliness of the varieties were estimated. The data were statistically analysed for relationships between coagulable protein and the other characteristics.

MATERIALS AND METHODS

Plant material

Thirty-four varieties of Solanum tuberosum, with a wide range in earliness, content of dry matter and of coagulable protein were chosen for study. The varieties had been selected for yield capacity and other agronomic characters but not for protein con-