GLUCOSINOLATES IN THE GROWING AND FLOWERING PLANTS OF BRASSICA NAPUS AND BRASSICA CAMPESTRIS

Von Klaus Jürges
Institute of Agronomy and Plant breeding
University Goettingen, D 3400 Goettingen, Germany

Whereas in countries like Canada or France the utilization of rapeseed is restricted to seed, the German farmers have a great interest in using green parts of rapeseed too. In Germany an area of 200.000 ha of rapeseed is used for the production of green material whereas an area of 100.000 ha is used for the production of seed. The glucosinolates, however, not only those found in the seed but also all over the whole plant, cause a restriction of the utilization of rapeseed as a plant for fodder purposes. We started to work on this problem, the glucosinolates in green material, because in this field only a few experiments are known to have been carried out.

ANALYTICAL ASPECTS

In the genus Brassica we have two main groups of glucosinolates. Five aliphatic glucosinolates called sinigrin, gluconapin, glucobrassicanapin, progoitrin respectively glucorapiferin and 2-OH-4-pentenylglucosinolate, and two indole-glucosinolates called glucobrassicin and neoglucobrassicin. In the following, the glucosinolates of the first group are named aliphatic glucosinolates whereas the glucosinolates of the second group are named indole-glucosinolates. In order to analyse these two groups of glucosinolates, we used two different methods: The analysis of the aliphatic glucosinolates was performed by GLC (Thies, 1977), whereas for the analysis of indole-glucosinolates a new method, based on the method of Aldridge (1944, 1945) was developed. In contrast to the GLC-method, where the whole molecule is analysed, the estimation of indole-glucosinolates was done by a split-product of the glucosinolate, the thiocyanate ion. Both methods, however, were disturbed by other chemical compounds of the plant-material. The GLC-method was mainly disturbed by sulfate-ions in the plant-extract and by those sulfate-ions that the glucosinolate-molecules set free during a derivatisation-step. The indole-glucosinolate-method was mainly disturbed by proteins. Therefore for both methods a step for cleaning the samples from such disturbing compounds was necessary. In both cases ion-exchangers were used to eliminate such problems. This ion-exchanger-step not only causes a cleaning of the samples but as a further aspect makes it possible to concentrate the glucosinolates, which is of great interest for the analysis of samples with a low glucosinolate-level. Such methods (Thies, 1978, Jürges) make it possible to select genotypes with a glucosinolate--concentration lower than 10 µmol/g.

RESULTS

In 1977 we took samples of wintertypes of B. napus and B. campestris out of the field. The sampling started at the beginning of the vegetation period and ended in the time of fully ripened seed, a period from February to July. Three varieties were chosen as material for this experiment. Two varieties of B. napus, "Lesira" and "Ledos", and one variety of B. campestris, "Arktus". At each date of sample-drawing we took three plants from each of the three varieties. As early as possible in ontogeny, whole plants exclusive the roots were divided into vegetative and generative parts which were then analysed seperately.

Regarding the aliphatic glucosinolates, each of the three varieties showed

the same trend: Starting with relative high glucosinolate concentrations at the beginning of the vegetation-period, their concentration permanently was reduced in the progress of ontogeny. Regarding the variety "Ledos" during the ontogeny, its highest glucosinolate concentrations of 10 µmol/g DM in vegetative parts came near the glucosinolate-concentration of 13 µmol/g defatted meal in its seed. The comparable concentrations of the vegetative material of "Arktus" resp. "Lesira" we found in much lower concentration regions than the glucosinolate-concentrations in the seed of these two varieties.

A comparison of vegetative material of "Ledos" during ontogeny concerning the concentration of aliphatic and indole-glucosinolates showed higher concentrations of aliphatic glucosinolates than of indole-glucosinolates from the start of the vegetation period up to the start of flowering. After this date the concentrations of both the glucosinolate groups were nearly at the same level.

A comparison of the concentrations of indole-glucosinolates in generative and vegetative parts of the variety "Ledos" during ontogeny showed the following results: In young buds before flowering we found that the concentration of indole-glucosinolates was as high as in the vegetative material at the beginning of the vegetation period. This concentration in the generative material like the concentration in the vegetative material was reduced with the progress in the development of flowers. In contrast to the concentration in the vegetative material, it started rising with the development of siliques. It reached an end point above the concentration in the young plant at the start of the vegetation period.

These results may be of interest for plantbreeders, but of highest interest for these persons is the question of the existence of a correlation between the glucosinolate concentrations in seed and in green material. The existence of such a correlation would make it possible to select seeds for low glucosinolate concentrations in green material. In this context we made an experiment to compare the glucosinolate concentrations in seed and in vegetative material. We took the material from twenty varieties of B. napus. Regarding the aliphatic glucosinolates, we can speak of a correlation between its concentrations in seed and in vegetative material. We were able to detect indole-glucosinolates not only in green material but also seeds. A comparison of the glucosinolate concentration of seed material of the two varieties "Lesira" and "Ledos" gave the following results: "Lesira", which had a high concentration in aliphatic glucosinolates, showed a lower concentration of indole-glucosinolates than "Ledos", which was much lower in aliphatic glucosinolates than "Lesira". In this case it is interesting to note that we have no correlation between the respective concentrations of the two investigated glucosinolate groups. In the circumstances it is not unthinkable that varieties like "Erglu", which are strongly reduced in their aliphatic glucosinolates in seed, may get their rest toxicity partially out of their content of indole-glucosinolates. An interesting aspect which should be kept in view. It seems to be necessary to use two methods for the selection of varieties with low glucosinolate concentrations in seed: One for the analysis of the aliphatic glucosinolates and another one for the analysis of indole-glucosinolates.

LITERATURE

Aldridge, W.N., 1944. Analyst. 69, 262.
Aldridge, W.N., 1945. Analyst. 70, 474.
Jürges, K. Z. Pflanzenzüchtung, in preparation.

Thies, W., 1977. Z. Pflanzenzüchtung 79, 331-335.
Thies, W., 1978. Proc. 5th Int. Rapeseed Congr., June 1978, Malmö, Sweden.

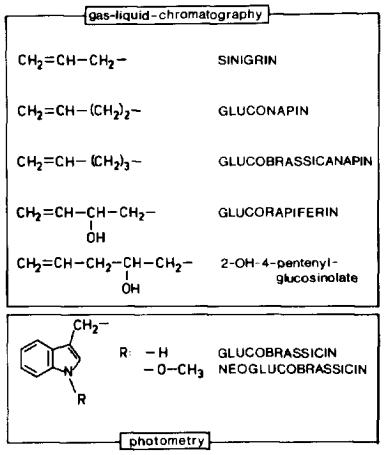

FIG. 1.

THE TWO MAIN GROUPS OF GLUCOSINOLATES IN BRASSICA

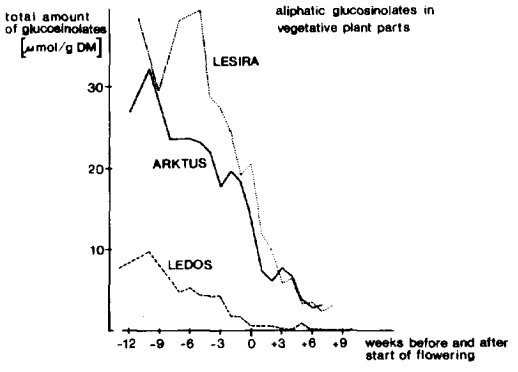

FIG. 2

CONCENTRATIONS OF ALIPHATIC GLUCOSINOLATES IN VEGETATIVE PARTS OF THREE VARIETIES DURING ONTOGENY

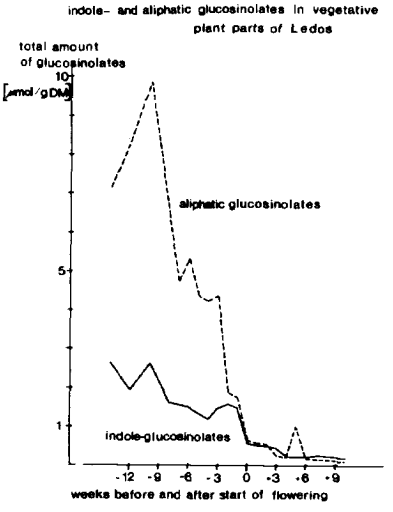

FIG. 3

CONCENTRATIONS OF ALIPHATIC AND INDOLE-GLUCOSINOLATES DURING ONTOGENY IN "LEDOS"

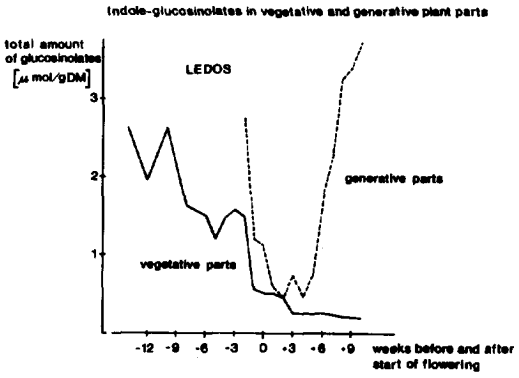

FIG. 4

CONCENTRATIONS OF INDOLE--GLUCOSINOLATES IN GENERATIVE AND VEGETATIVE PARTS OF "LEDOS" DURING ONTOGENY

section	aliphatic glucosinolates ($\bar{x}$-values) in seed [µmol/g def.meal]	in veg.plant parts [µmol/g DM]
A 1-8	3,9	2,5
B 16-27	21	3,3
C 32-76	53	7,3
D >80	90	12,4

FIG. 5

CONCENTRATIONS OF ALIPHATIC GLUCOSINOLATES IN SEED AND VEGETATIVE MATERIAL FROM 20 VARIETIES

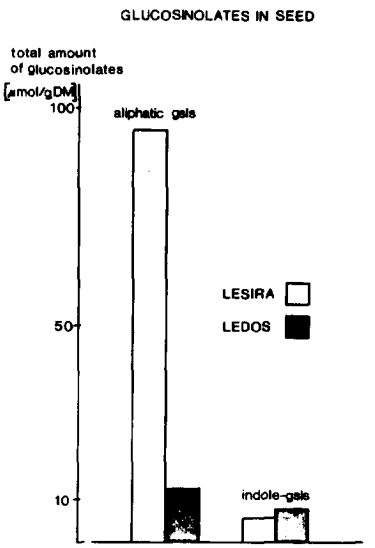

FIG. 6

CONCENTRATION OF ALIPHATIC AND INDOLE-GLUCOSINOLATES IN SEED-MATERIAL OF "LEDOS" AND "LESIRA"