Accumulation of Crude Protein and Oil Contents

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ABSTRACT AND SUMMARY

The crude fat content of whole seed and the crude protein level of defatted embryos were monitored on successive days after pollination. Seed of Buffalo gourd, *Curcurbita foetidissima* HBK, harvested during September-October, 1976, obtained a maximum oil and protein level in 38 to 42 days after pollination. Maximum protein and oil accumulation in seeds of the *Cucurbita digitata* group (sample period June-July, 1976) and *Apodanthera undulata* (sample period August-September, 1976) occurred between 34 and 38 days and 30 and 34 days after pollination, respectively. Variability within sample periods was attributed to the heterogeneity of the populations.

INTRODUCTION

The agronomic potential of xerophytic curcubits as cultivated crops has been considered for over 30 years. Curtis (1) summarized the attributes of *Cucurbita foetidissima* HBK and *C. digitata* Gray as: perennial plants, possessing the ability to grow in regions of low rainfall, producing mechanically harvestable fruit, and bearing seed rich in protein and oil. Estimates of seed yields from single or few plant populations ranged from 2607 lbs/acre (2928 kgs/ha) to 4664 lbs/acre (5241 kgs/ha) (2).

The chemical composition of Buffalo gourd, *C. foetidissima,* has been extensively studied by Berry et al. (3). These authors reported values of 33.0% crude fat and 32.9% crude protein in ground whole seed and a content of 75.0% crude protein in the defatted embryo. Bolley et al. (4) determined the oil content of whole seed from *C. foetidissima* (28.0%) and *C. digitata* (25.0%). Shahani et al. (5) described the protein and oil content of Buffalo gourds as 31.7% and 24.3% of whole seed, respectively. Hensarling et al. (6) assessed the nutritive value of globulins isolated from Buffalo gourd seeds. Weber et al. (7) evaluated the defatted protein meal of the three xerophytic cucurbits using weanling mice. The fatty acid profiles of various cucurbit seed oils were characterized by Bemis et al. (8). The oil composition of *Apodanthera undulata,* a soft-fruited xerophytic cucurbit, has been described by Bemis et al. (9).

Little has been published regarding the cultural parameters of these species. However, the seed maturity of Buffalo gourd in relation to percent germination and seed weight per 100 seeds has been investigated by Ba-Amer and Bemis (10). Costa and Bemis (11) expanded this investigation by including seed viability. In reference to the above-mentioned parameters, the two studies indicated seed maturity at 32 to 34 days after pollination (DAP), and at 34 to 38 DAP, respectively. After-ripening effects upon percent seed germination were also discussed. The DAP required for seed maturity in the *C. digitata* group and *A. undulata* have not been heretofore examined.

The objective of the present study was to observe the economically important parameters of crude fat and crude protein accumulation in seeds of *C. foetidissima, C. digitata* group, and *A. undulata* with respect to days after pollination.

[1]Arizona Agricultural Experiment Station number 2773.

MATERIALS AND METHODS

Plant Materials

Plant materials were obtained from the germplasm nursery of native cucurbits grown on the University of Arizona Experimental Farms. Pepos of *C. foetidissima* were collected during September-October, 1976, from first-season plants established from feral seed collected in Arizona. Fruit of *C. digitata* group were harvested during July-August, 1976, from first-season plants of a synthetic population derived from a composite cross of three subspecies: *C. digitata, C. palmata,* and *C. cylindrata. A. undulata* fruits were gathered during August-September, 1976, from first-season plants grown from feral seed collected in Arizona.

Sample Cultivation Collection and Preparation

To begin each sample period, female flowers were tagged at anthesis. Open pollination was facilitated by native bees. Furrow irrigation was administered on a monthly basis. Three developing fruits were harvested on each DAP studied. Following harvest, seeds were manually extracted from the fruits, washed, dried at 60 C for 24 hr, then ground in a Wiley mill to pass through a 10-mesh screen in preparation for laboratory analyses.

Laboratory Analyses

For each DAP, duplicate 5 g samples of ground whole seed were dried in a vacuum oven at 50 C overnight. After dry weights were obtained, the samples were extracted with hexane in a Soxhlet apparatus for 12 hr. After the samples were redried, the percentage crude fat of each replicate was determined by the loss in meal weight. Replicate values were averaged.

A crude protein analysis of the dried defatted embryo was performed in triplicate for each DAP, using the micro-Kjeldahl technique. The defatted embryo powder was obtained by sifting the extracted seed meal through a 115-mesh screen. Differences in particle size facilitated the collection of material free of seed coat. Triplicate values were averaged.

RESULTS AND DISCUSSION

The accumulation of oil content in whole seed and protein content in defatted embryo for the three species studied are represented graphically in Figures 1 and 2.

Cucurbita foetidissima

The crude fat content of seeds ranged from 3.6% (DAP 22) to 33.9% (DAP 40). Protein levels in extracted embryo extended from 36.7% (DAP 22) to 70.1% (DAP 40). The maximum levels of oil and protein closely resembled values reported for these parameters by Berry et al. (3). The most notable fluctuations in protein and oil content appeared between DAP 28 and DAP 30. The crude fat content of whole seeds rose from 5.9% to 19.6%, while extracted embryo protein levels rose from 39.9% to 53.5%.

Cucurbita digitata Group

The crude fat content of seeds ranged from 4.8% (DAP 20) to 29.9% (DAP 46). The maximum percentage of oil

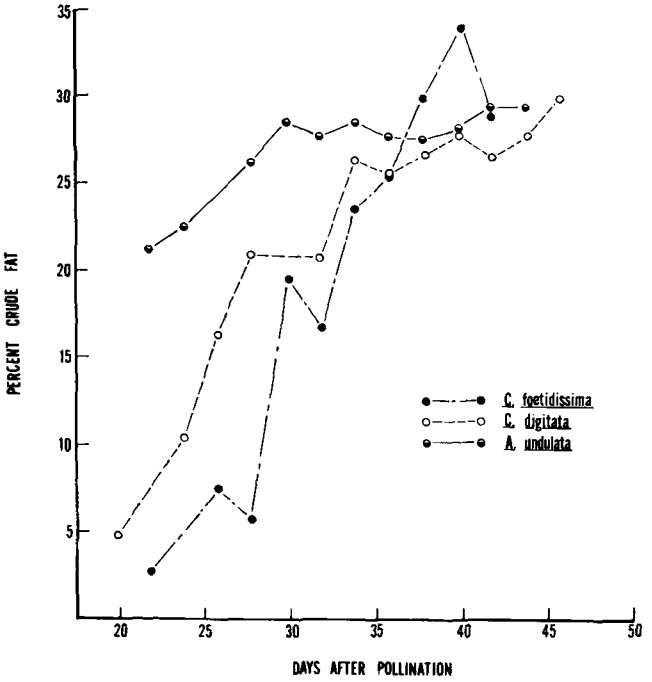

FIG. 1. The crude fat content of three xerophytic cucurbits on successive days after pollination.

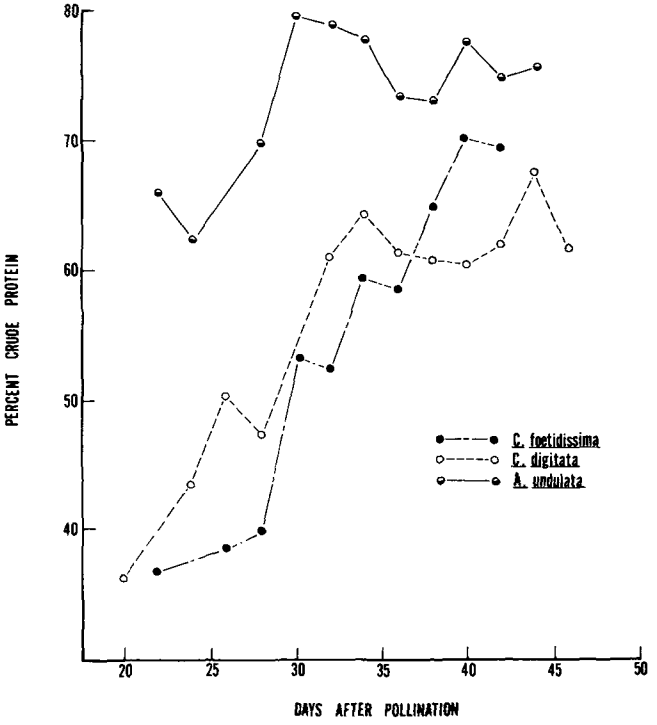

FIG. 2. The crude protein content of three xerophytic cucurbits on successive days after pollination.

reported herein is slightly higher than that described by Bolley et al. (4). The oil content accumulated in relatively uniform increments. Crude protein levels rose from 36.1% (DAP 20) to 67.2% (DAP 44). The largest fluctuation in protein content appeared between DAP 28 (47.2%) and DAP 32 (60.6%).

Apodanthera undulata

In this species, significant protein and oil synthesis in seeds occurred before DAP 20. The conclusion of the accumulation process is displayed in the graphs. Crude fat values ranged from 21.2% (DAP 20) to 29.4% (DAP 44). Defatted embryo protein levels rose from 62.1% (DAP 24) to 79.3% (DAP 30). No significant fluctuations between successive days after pollination were observed.

The Accumulation Process

Sample variability with respect to the accumulation process was observed within sample periods. Decreases in the percentage level of oil and protein between successive days after pollination (i.e., the negative slope of the line) reflected the heterogeneity of the open-pollinated populations sampled. Larger sample sizes might have minimized the effects of this source of variation.

Within a sample period, the defatted embryo protein content and the crude fat value of whole seeds generally approached optimum levels simultaneously. *C. foetidissima, C. digitata* group, and *A. undulata* display optimum accumulation dates of 38 to 42, 34 to 38, and 30 to 34 days after pollination, respectively. However, the time period required for optimum accumulation may fluctuate with respect to genetic and environmental conditions, making exact determination of dates difficult.

Ba-Amer and Bemis (10), and Costa and Bemis (11), using seed weight and percent germination as maturity parameters in *C. foetidissima,* assigned maturity dates as much as 8 days earlier than the optimum accumulation dates assigned by this study. Seed weight and percent germination, as measures of seed maturity, may not reflect optimum protein and oil levels.

The Importance of Optimum Accumulation Dates

The potentially economically important parameters of xerophytic cucurbits are the protein and oil contents. In species producing hard shelled fruits (*C. foetidissima, C. digita* group), where storage on the vine is possible, optimum accumulation dates are of importance near the end of the growing season. This is especially true of first season Buffalo gourd plants, which develop female flowers late in the season (12). In *A. undulata,* the melon-like fruit soften and rot as they reach full maturity, making optimum accumulation dates extremely important.

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