Reprinted from Vol. 103(2), March 1978
Journal of the American Society for Horticultural Science
Mount Vernon, Virginia 22121, USA

J. Amer. Soc. Hort. Sci. 103(2):190–192. 1978.

Changes in Dry Matter, Protein and Non-protein Nitrogen during Storage of Sweet Potatoes[1]

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Additional index words. Ipomoea batatas

Abstract. **The percentages of dry matter (DM), protein (N x 6.25), and nonprotein nitrogen (NPN) were determined periodically during storage for 'Centennial' and 'Jewel', and the selection NC-317 sweet potato (*Ipomoea batatas* (L.) Lam. Percent DM decreased and % protein increased with storage time, but the changes were significant only for 'Centennial' and 'Jewel'. NPN in 'Centennial' and 'Jewel' decreased during the first part of storage (14-15 weeks), then increased. NPN in NC-317 changed more slowly. In a second test with 'Jewel', changes were followed in the amounts of DM and protein, expressed as % of the original amounts. Both dry matter and protein were lost during storage and the rate of loss was about twice as fast for DM as for protein. The apparent increase in % protein during storage in the first test was attributed to a faster rate of loss in DM than in protein.**

Sweet potatoes are usually cured immediately after harvest in the U.S. Curing at temp between 25-30°C and high humidity rapidly heals wounds incurred during harvest and conditions the roots for longer storage life. Optimum storage temp after curing is about 13° (1). During curing and storage, respiration continues and dry matter is lost (1, 2, 3). Presumably, this loss is mainly from the carbohydrate fraction (4), and results in an increased concn of other components, such as β-carotene (1).

Apparently no study has been made to determine whether protein concn in sweet potatoes changes after harvest; thus in this paper we report levels of dry matter and protein (N x 6.25) and non-protein nitrogen (NPN) during storage.

Methods and Materials

Sweet potatoes and sampling, 1974 crop. Roots 'Centennial' and 'Jewel', and an experimental selection, NC-317, were obtained from the North Carolina Agricultural Experiment Station near Clayton. Roots were placed in a curing room within 6 hr of harvest and held at 29°C and 90% relative humidity for 1 week; then they were stored at 13° and 50–80% humidity.

One sample of each line was taken at harvest, after curing and periodically during storage for 26 weeks (25 weeks for NC-317). Samples consisted of 6 roots, 1 from each of 6 designated boxes. The selected roots in each sample were washed, allowed to dry at ambient temp for 2 hr. and sliced into strips 3 mm thick. Strips were mixed and a portion was grated for dry matter and non-protein nitrogen (NPN) determinations; another portion, 500 g, was dried to constant wt at 75°C in a forced-air oven and then ground to pass a 24 mesh screen for protein analysis.

Protein analysis. Duplicate 3 g samples of ground sweet potatoes were weighed to 0.1 mg and assayed by the Kjeldahl method, using copper and selenium catalysts during digestion. Protein was calculated as 6.25 x Kjeldahl N, and reported as % protein (dry basis).

Dry matter determination. About 20 g of the grated, raw material was weighed to 0.01 g into a Petri dish and dried at 100°C for 16 hr and reweighed.

Non-protein nitrogen determination. A 20 g sample of grated material weighed to 0.01 g was blended for 3 min at high speed with 40 ml 13% trichloroacetic acid in a semi-micro Waring blender jar (7). The slurry was transferred to centrifuge tubes with an additional 20 ml TCA solution and centrifuged at 20,000 x g for 10 min. Supernatants were filtered with a Whatman no. 1 paper into a Kjeldahl flask. Pellets and material on the filter were transferred to another Kjeldahl flask. N content of each flask was determined and % NPN was calculated as:

$$\frac{\text{N supernatant}}{\text{N supernatant + N Pellet}} \times 100 = \% \text{ NPN}$$

Sweet potatoes and sampling, 1975 crop. Three boxes of freshly dug 'Jewel' roots were obtained from a commercial packer near Wilson, North Carolina. Roots were washed and allowed to dry for 2 hr at room temp. Each root was individually weighed to 0.01 g and the wt recorded on the root. At each sampling period, once every month for 1 year, 30 sound roots were randomly selected and weighed. Original wt of the 30 roots was determined by summation; final wt was determined as the sum of the weights at sampling. Six of the 30 roots were randomly selected for analysis, and the remaining roots were returned to storage.

Data from this test permitted calculation of the percentages of original dry matter (DM) and protein remaining at each sampling date. Thus, for example:

g original fresh wt x original % DM = g original DM
g fresh wt at sampling x % DM at sampling = g DM at sampling

$$\frac{\text{g DM at sampling}}{\text{g original DM}} \times 100 = \% \text{ DM remaining}$$

Similar calculations were made for % protein remaining.

Statistical analysis. Data were analyzed by multiple regression analysis. For statistical analysis of the 1974 data, the curing period, namely the first week after harvest, was considered as 1 wk of storage.

[1]Received for publication September 6, 1977. Paper No. 5380 of the Journal Series of the North Carolina Agricultural Experiment Station, Raleigh. Mention of a trademark or proprietary product does not constitute a guarantee or warranty of the product by the U. S. Department of Agriculture or North Carolina State University, nor does it imply approval to the exclusion of other products that may be suitable.

Results and Discussion

1974 test. Dry matter concn decreased linearly while protein concn increased, but only the change for 'Jewel' and 'Centennial' was significant. The changes are expressed as regression equations.

'Jewel':	% DM	= 25.82 – 0.08*	x week
	% N x 6.25	= 3.96 + 0.052**	x week
'Centennial':	% DM	= 26.70 – 0.07*	x week
	% N x 6.25	= 5.20 + 0.076**	x week
NC-317:	% DM	= 29.86 – 0.006	x week
	% N x 6.25	= 4.73 + 0.009	x week

*P < 5%
**P < 1%

More detailed examination of the data, including plots of residuals from the regression lines, failed to indicate any systematic deviation from the models used.

Regression coefficients for 'Jewel' and 'Centennial' were not significantly different, while the coefficient for NC-317 was significantly lower. The NPN response was non-linear, falling during the early part of the storage period (14-15 weeks) and then increasing. Regression analyses yielded the following:

'Jewel': % NPN = 34.01 – 1.21* x weeks + 0.36* x weeks^2
'Centennial': % NPN = 15.56 – 1.11** x weeks + 0.045** x weeks^2
NC-317: % NPN = 28.69 – 0.20* x weeks + 0.024 x weeks^2

Sweet potato roots lose dry matter in storage (2, 5, 6, 8). Presumably the loss of dry matter results from metabolism of carbohydrates. We postulated that the increases in protein concn were caused by losses of non-nitrogenous DM without changes in the amount of protein. The experimental design permitted measurements of changes in concn of DM and protein but it did not permit measurements of loss of absolute amounts of DM and protein.

1975 test. We had no reason to believe that protein or other nitrogenous compounds would be lost by respiration. Nevertheless, in the 1975 test, we did show that protein was lost during storage. We did so by determining the original fresh wt and final fresh wt (Table 1) and calculating the amount of DM and protein which had been in the sample at the beginning of storage and at the time of sampling. This enabled us to calculate the % original DM and % original protein remaining at the time of sampling.

Table 1. Weight, % dry matter and % protein content of 'Jewel' sweet potatoes before and after storage, 1975 crop.

Months of storage	Original wt[z] (g)	Final wt (g)	% DM final	% Protein final
0	9101	9101	22.93	7.53
1	8977	8326	24.34	7.46
2	9707	8497	22.98	8.74
3	8022	6818	25.56	7.32
4	7755	6498	24.60	8.77
5	9500	7934	21.20	8.17
6	9108	7351	20.88	8.20
7	9187	7216	23.92	8.63
8	9511	6930	24.11	9.53
9	10156	7339	26.04	7.43
10	9799	6599	26.53	8.74
11	10644	6758	25.55	9.30
12	8369	4973	27.17	8.68

[z]Wet weight of 30 roots.

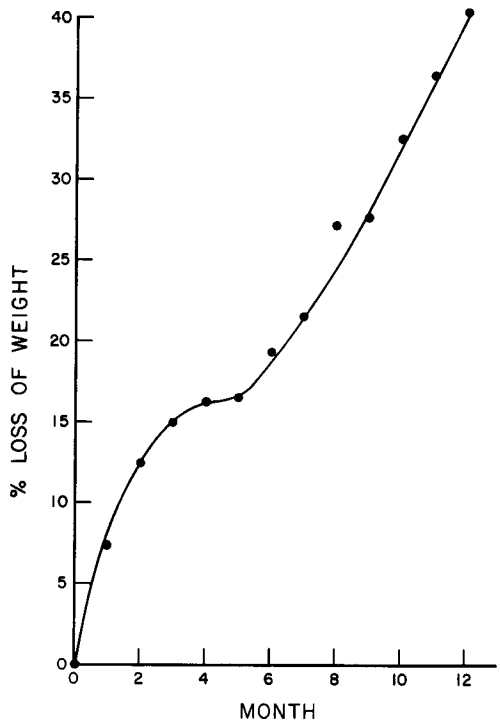

Fig. 1. Change in fresh wt of 'Jewel' sweet potato roots in storage, 1975.

The data show that both dry matter and protein were lost during storage and that the rate of loss was twice as fast for DM as for protein, as follows:

% DM remaining = 97.8 – 2.29** month
% protein remaining = 101.0 – 1.43** month

We therefore attributed the increases in % protein (concn) in the 1974 test to a faster rate of loss in dry matter than in protein.

We do not known the form in which N is lost, but the loss does suggest active N metabolism during storage. N turnover may also be inferred from the observed changes in NPN. A plot of change in fresh wt vs. storage time showed an infelxion (Fig. 1) which coincided with the minimum in NPN. This suggests that the rates of other metabolic activities also vary.

The limit of protein concn during storage is not known, but in our laboratory, some samples which had become pithy after 10 months of storage at room temp contained 20% protein, as compared with 8.9% in samples at harvest. Two roots obtained from a colleague contained 11.9% protein after 2.5 years of storage; protein content at harvest was estimated to be 5.9%. These roots appeared to be in excellent condition, showing no sign of pithiness or other defects. Microscopic examination showed that the starch grains were much smaller than usual and less numerous.

We do not know the composition of the NPN fraction, but it includes all non-precipitable peptides, free amino acids, ammonia, and some of the purine nitrogen. Because the NPN fraction of some cultivars may exceed 30% of the total N depending on time in storage, its nutritional aspects may be of some importance. If most of the NPN is present as peptides and amino acids, protein content estimated from total N determination would be a reliable index of nutritional value, but if considerable amounts are non-amino N, correction would be required.

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