NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION
PROJECT OUTLINE

Project No. S149
Date
Submitted 9-21-53
Approved 9-28-53
Revised

1. Title: The Effect of Length of Cure, Temperature and Duration of Storage Upon The Physical and Chemical Quality of Sweet Potatoes.

2. Objective (s): 1. To determine the effects of short (4 days) and regular (10 days) curing periods, the subsequent storage temperatures, and duration of storage on certain physical and chemical components of quality of sweet potatoes.

2. To compare the extent of suberization and wound periderm formation after the short and regular curing periods and relate these findings to subsequent storageability of the roots.

3. To investigate the possible change in ascorbic acid from the reduced form to dehydro form, and, if so, the extent of change under the curing and storage variations.

3. Reasons for undertaking Investigations* Large shipments of sweet potatoes are made for a period immediately following harvest. A portion of the crop, however, is generally stored during the winter and spring and sold before the warm temperatures of late spring develop. The roots sprout rapidly during March and April, become pithy, and the culinary quality is greatly reduced if the roots are held at warm temperatures for an extended period of time. If the quality of sweet potatoes could be maintained by the use of refrigeration, the marketing period could be lengthened and sales and consumption possibly increased. One purpose of this study is to determine the minimum amount of refrigeration necessary to maintain quality in storage until the mid-summer following the previous fall harvest.

Another purpose of this investigation is to study the effects of a shorter curing time than is usually used. Presently it is recommended that sweet potatoes be cured by holding them at temperatures of 80-85° F. and relative humidity of 85-90 per cent for a 10-14 day period. Under these conditions the rate of physiological activity is accelerated, resulting in a weight loss of from five to seven per cent as well as considerable change in both sugar content and culinary quality. A shorter curing time would reduce this weight loss and be desirable economically. However, it should be determined whether roots given a short length of cure will compare favorably in quality, degree of suberization and wound periderm formation with roots given the longer cure.

Still another portion of this study is concerned with the nutritional value of the sweet potato and involves a fundamental question that to date has not been elucidated for many stored vegetables. It is known that the content of ascorbic acid (reduced form) of sweet potatoes diminishes in storage. There is a possibility that this loss

(Con'd. on back of sheet)

*Including economic justification

may represent merely a transformation to the dehydro form, which can be utilized efficiently by the human body but has largely been ignored in past work in view of the lengthy and somewhat complicated chemical determination involved. The sweet potato is now considered a good source of ascorbic acid, but if it can be demonstrated that reasonable amounts of the dehydro form are present, additional emphasis could be placed on the nutritional value of this crop.

Project No. .....

4. Previous work and present status of investigations in the field of this project:

The majority of the early work on the effects of curing and storage of sweet potatoes was evaluated only by weight loss and incidence of decay (7, 8, 11, 12). Hasselbring and Hawkins (4, 5, 6) have reported the most extensive studies of carbohydrate changes, but the storage periods used were only of about a month's duration, temperatures fluctuated considerably, and comparable conditions among treatments were lacking. Culpepper and Magoon (2), reporting on the effect of storage on the canning quality of sweet potatoes, included a study on the sugar content before and after curing, and following storage. Here again, however, the storage period was for only one month. Speirs, Peterson et al (10) followed changes in ascorbic acid and carotene content of the Unit I Porto Rico during curing and a subsequent six months storage at 50-55° F. Bzell and Wilcox (3) determined the effect of storage temperature and duration upon the carotene, total carotenoid and ascorbic acid contents (storage temperatures of 50°, 55°, 60° and 70°). Both of these studies showed that ascorbic acid content decreases considerably in storage. However, in regards to the carotene content, the former workers report very little change in storage, but the data of the latter show an increase between one and two months of storage followed by a decrease for the remainder of the storage period. In the literature to date there are no reports of the effect of length of cure on physical and chemical factors of quality nor any work on the dehydro-ascorbic acid content of sweet potatoes. In regards to loss in prolonged storage under refrigerated conditions (55-60° F.), preliminary work at this station agrees with a recent progress report from Texas (9) in that weight loss, incidence of rotting, and the rate of sprouting is kept to a minimum. That a shorter curing time may be feasible is supported by the work of Artschwager and Starret (1) wherein it is shown that under conditions of 92 per cent relative humidity and 83° F. temperature suberization and wound periderm formation has taken place at the beginning of the third day.

5. Outline of Procedure:

This investigation will consist of two lengths of curing, and of storage at three temperatures, with samples to be withdrawn from storage at bi-monthly intervals from January through July. In addition to this, a number of roots will be given a uniform "wound" and cured for the two lengths of time. A histological study will be made to determine the actual amount of suberization and wound periderm formation that has taken place.

Material - U. S. No. 1 sweet potatoes, variety Porto Rico, available from station plantings will be used for this study.

Curing - Curing will be carried out under conditions of 85° F. temperature and 90-92 per cent relative humidity. Samples designated for the short cure will be removed at the end of the fourth day, and for the long cure at the end of the tenth day.

Storage - The samples will be stored in constant temperature chambers at 55°, 60°, and 65° F. A small fan will be installed to insure a uniform temperature throughout each chamber. The samples will be contained in mesh bags or small ventilated crates to facilitate air movement around the roots.

Analyses and Data -

a. Weight loss
b. Sprouting
c. Dry matter
d. Total sugar
e. Ascorbic acid - reduced and dehydro forms.
f. Incidence of rot and internal cork (in cooperation with Plant Pathology).
g. Baking quality and shelf life upon removal from storage.

Sampling - A sample will consist of three replicates of 10 roots each.

Sampling Schedule:	
Before curing	1
After curing	
4 days	1
10 days	1
Removal from storage (3 temperatures x 2 lengths of cure)	
January	6
March	6
May	6
July	6
	27
Replications	3
Total	83

In addition, 24 samples (12 from each length of cure) will be placed in storage for subsequent shelf life and baking quality observations. The samples will be removed on a similar schedule as outlined above, held for one week at room temperature and the weight loss, incidence of rot, extent of sprouting, and condition will be noted. Following this, five roots from each replicate (15 from each sample) will be baked and tested for flavor and texture. The remainer of the samples will be sliced to determine the incidence of internal cork.

6. Probable Duration of Project: Three years.

7. Date of Initiation: July 1, 1953.

8. Personnel:

Name	Department	Relation to Project
C. L. McCombs	Horticulture	Leader
F. D. Cochran	Horticulture	Co-leader
D. T. Pope	Horticulture	Cooperator
L. W. Nielsen	Plant Pathology	Cooperator
W. J. Peterson	Chemistry	Adviser
J. A. Rigney	Statistics	Adviser

9. Coöperation:

a. Interdepartmental

Horticulture, Chemistry, and Plant Pathology.

b. Other Agencies

10. Financial Support:

a. Proposed Budget 7-1-53 .... To 6-30-54 .

Items	ALLOCATION OF FUNDS						
	Bankhead-Jones	R & M	Purnell	Adams	State	Other	Total
1. Salaries					$4611		
2. Labor					00		
3. Travel					125		
4. Equipment & Supplies					600		
5. All Others					162		
Total					$5498		

b. Proposed Future Budgets:

Year	Salaries	Total Expenditures	Estimated Income

11. General Remarks:

SIGNATURES OF APPROVAL

1. Approval of Project Leaders

Date Sept. 21, 1953 C. L. McCombs

Title Res. Instructor

Date Sept. 21, 1953 Fred D. Cochran

Title Head, Veg. Crops Section

Date .....

Title .....

2. Approval of Heads of Departments or Coöperating Agencies

Date 9-21-53 M. E. Gardner

Head, Department of Horticulture

Date .....

Head, ...

Date .....

Head, ...

3. Approval of Director

Date 9/27/53 R. W. Cummings

Director, North Carolina Agricultural Experiment Station

4. Approval of U.S.D.A.

Date .....

Chief, Office of Experiment Stations

Literature Cited

1. Artschwager E. and Starret, R. C. 1931. Suberization and wound periderm formation in sweet potatoes and gladiolus as affected by temperature and relative humidity. J.A.R. 43: 353-364.

2. Culpepper, C. W. and Magoon, C. A. 1926. The relation of storage to the quality of sweet potatoes for canning purposes. J.A.R. 33:627-643.

3. Ezell, B. D. and Wilcox, M. S. 1952. Influence of storage temperature on carotene, total carotenoids, and ascorbic acid content of sweet potatoes. Plant Phys. 28: 70-80.

4. Hasselbring, H. and Hawkins, L. A. Physiological changes in sweet potatoes during storage. Jour. Agr. Res. 3:331-342. 1915.

5. _____ Respiration experiments with sweet potatoes. Jour. Agr. Res. 5:509-520. 1915

6. _____ Carbohydrate transformations in sweet potatoes. Jour. Agr. Res. 5:545-560.

7. Lauritzen, J. I. Some effects of chilling temperatures on sweet potatoes. Jour. Agr. Res. 42: 617-627. 1931.

8. Lutz, J. M. Chilling injury of cured and non-cured Porto Rico sweet potatoes. U.S.D.A. Cir. 729. 1945.

9. Michael, R. and Hollingsworth, J. P. Refrigerated storage of sweet potatoes. Progress Rpt. 1454. Texas Agr. Expt. Sta. 1952.

10. Speirs, M., Peterson, W. J. et al. The effects of fertilizer treatments, curing, storage, and cooking on the carotene and ascorbic acid content of sweet potatoes. Southern Cooperative Series, Bul. 3. Dec. 1945.

11. Thompson, H. C. Sweet potato storage studies. U.S.D.A. Bul. No. 1036, 1922.

12. Whiteman, T. M., and Wright, R. C. The effects of temperature on losses in sweet potatoes. Amer. Soc. Hort. Sci. Proc. 48:437-442. 1946.

September 21, 1953

Dr. R. W. Cummings
Director of Research
Patterson Hall
Campus

Dear Dr. Cummings:

We are transmitting herewith a new project entitled "The Effect of Length of Cure, Temperature, and Duration of Storage on the Physical and Chemical Quality of Sweet Potatoes". You will remember that this project has been in the mill a long time and has undergone several revisions. I am advised that the project has been cleared according to instructions given in your memorandum of June 18, 1953.

For your information, I am attaching a memorandum from Dr. Jensen explaining the participation of the pathologist in this project. If you think other signatures are necessary on the project, please let us know, and we will have them attached.

With best wishes.

Sincerely yours,

M. E. Gardner, Head
Department of Horticulture

MEG/S
Attachment

North Carolina State College

Raleigh

Division of Biological Sciences
Plant Pathology

September 1, 1953

Memorandum to: Dr. Fred Cochran

From: James H. Jensen

I have had an opportunity to read your proposed project outline on the sweet potato storage problem. I have also asked Dr. Nielsen to read it and he has done so. This project seems to us to be satisfactory. As I understand it, Nielsen's activities would consist of acting in an advisory capacity and being in position to cooperate with respect to the fungi and other rot producing organisms encountered by the investigator. This would assume, I presume, that studies on the activities of the rot-producing organisms, their life histories and etc. would be within the province of the plant pathologist.

Best wishes for success in the prosecution of this project.

JHJ/f

cc: Dr. L. W. Nielsen

Sent to McCombs and Cochran for signatures
9-16-53-

Office of the Director of Research
North Carolina Agricultural Experiment Station

MEMORANDUM

To Prof. M. E. Gardner

Here is Dr. Peterson's letter which should have been attached to the sweet potato project. I am sorry I overlooked attaching it.

ATTACHED PAPERS

____Please note and return.
____Please note, do not return.
____File.
____For your information.
____For your records.
____Hold for conference.
____Speak to me concerning.
____Please handle.
____Please answer.
____Note opinion and return.
____Needs your signature.
____Please give me all data.

Signed: K. M'Kinnon

Date 6-22-53

North Carolina State College of Agriculture and Engineering
of the
University of North Carolina
Raleigh
DEPARTMENT OF CHEMISTRY

June 2, 1953

Also work effect

Dr. R. W. Cummings
Director of Research
Patterson Hall
Campus

Dear Dr. Cummings:

I am returning the project proposal "Effect of Length of Cure, Temperature, and Duration of Storage Upon the Physical and Chemical Quality of Sweet Potatoes", which was submitted by Mr. C. L. McCombs. I delayed in providing you with my appraisal until I had had an opportunity to see the tentative project proposal of the Southern Cooperative Group. It now appears that the regional project does not have very much in common with this project and I recommend that it be approved as an independent project of this station. I would suggest, however, that the first year's findings may well develop in such a way that final clarification would be expedited by regional effort. Should this prove to be the case, it would be desirable to discuss the first year's results with the folks in the Institute of Statistics before attending the next meeting of the Southern Cooperative Group. There is also a real chance that the regional project, in its first year, will determine the optimum curing time (since this is one of its objectives) and that Mr. McCombs may want to modify his experiment slightly in the second year so as to make best use of this information.

I have made a few minor corrections on the manuscript. This project begins to make practical use of the many splendid facilities the Department of Horticulture now has available for this type of work.

Incidentally, the Chemistry Department contemplates active cooperation in the regional project which is now being prepared. Dr. Cochran has assured me that the Horticulture Department will also cooperate in providing the crop as well as in other areas where they have special facilities.

Sincerely,

Walter J. Peterson.

Walter J. Peterson, Head
Department of Chemistry

Encl: 1 project, McCombs.
WJP:jam

North Carolina State College of Agriculture and Engineering
of the
University of North Carolina
Raleigh
STATE COLLEGE STATION

SCHOOL OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION
AGRICULTURAL EXTENSION SERVICE
RESIDENT TEACHING

DEPARTMENT OF HORTICULTURE

July 8, 1953

MEMORANDUM TO MR. C. L. McCOMBS:

I am returning herewith your project "The Effect of Length of Cure, Temperature, and Duration of Storage Upon the Physical and Chemical Quality of Sweet Potatoes". You will also find attached letters from Dr. Peterson and Dr. Cummings, making certain suggestions which should be complied with before final revisions are made.

I would like to make the following suggestions which I believe will improve the project:

(1) Under "Objectives" - The objectives should be simply and clearly stated. Number 2 seems to be in order, but I believe you have Objective 1 confused with "Procedure", since you refer to this on page 5. I believe it will be best to delete "a" through "g" and incorporate under "Procedure". In this case Objective 1 might be exactly the same as the title.

(2) Under "Procedure", page 5, - Sampling - It would be well if this could be somewhat consolidated, in order that space on the forms might be more efficiently utilized.

After the suggestions made have been complied with, please submit one copy to this office, and we in turn will copy on the regular forms.

MEG/S
Attachments
cc. to: Dr. Fred D. Cochran

M. E. G.

North Carolina State College of Agriculture and Engineering
of the
University of North Carolina
Raleigh

SCHOOL OF AGRICULTURE
RESEARCH EXTENSION
RESIDENT TEACHING

OFFICE OF DEAN AND DIRECTORS

June 18, 1953

MEMORANDUM TO: M. E. Gardner

I am returning herewith the project proposal entitled "Effect of Length of Cure, Temperature, and Duration of Storage Upon the Physical and Chemical Quality of Sweet Potatoes". I have had this proposal reviewed and I am enclosing copy of a letter from Dr. W. J. Peterson who was one of the reviewers, relative to possible relationship of this project to other studies contemplated or underway by the Southern Cooperative Group. I am sure Dr. McCombs will wish to keep informed of the progress of this group and may wish to take advantage of opportunities for cooperation with other stations if his project and the program of work in these stations reach a stage where such cooperation is mutually advantageous.

A factor not covered in the project but which probably should be considered is the relationship of storage conditions to the damage in quality caused by an internal cork virus. I have just been discussing this matter with Dr. C. J. Nusbaum and he feels that this may be of considerable importance in the maintenance of quality of the potatoes carried into the spring and summer season. His experience indicates that the development of cork spots in infected roots is practically arrested at temperatures in the vicinity of 50°F. but may be greatly accelerated as temperatures increase appreciably above this range. I would suggest that Dr. McCombs discuss this matter thoroughly with Dr. Nusbaum and Dr. Nielsen.

You will note that a number of suggested changes in wording and grammatical structure have been indicated on the project statement returned herewith. I will appreciate it if you will have this put on regular project outline forms and returned for approval.

Very truly yours,

R. W. Cummings

R. W. Cummings
Director of Research.

May 13, 1953

Dr. R. W. Cummings
Director of Research
Patterson Hall
Campus

Dear Dr. Cummings:

We are transmitting herewith three copies of a project entitled "The Effect of Length of Cure, Temperature, and Duration of Storage Upon Physical and Chemical Quality of Sweet Potatoes". This project has been cleared by the section involved and has also been processed through our departmental committee.

You may recall that this project was submitted earlier, but you felt that it was too involved and suggested that we simplify by confining our present efforts along one specific line of research. This has been done.

We shall appreciate your cooperation in having this processed for us in order that we might place it on final forms and submit for approval. This is also a new project.

Very truly yours,

M. E. Gardner, Head
Department of Horticulture

MEG/S
Attachment

Department of Experimental Statistics
North Carolina Agricultural Experiment Station

MEMORANDUM

To Fred

This project looks good to me. There are only 2 questions I have. 1) Would it be possible to obtain the potatoes for each of the 3 reps from a different sweet potato area? This would greatly enhance your results by making them more general. 2) This doesn't quite fit the SCG proposed study. Is this by accident or design? If it were made to fit it would remove part of the urgency to spread the reps.

ATTACHED PAPERS

- ____ Please note and return.
- ____ Please note, do not return.
- ____ File.
- ____ For your records.
- ____ Hold for conference.
- ____ Speak to me concerning.
- ____ Please handle.
- ____ Please answer.
- ____ Note opinion and return.
- ____ Needs your signature.
- ____ Please approve.
- ____ Please give me all data.
- ____ Refer to me.
- ____ Please note and pass to next person.

Signed _____

Date _____

JR

May 5, 1953

MEMORANDUM TO: M. E. Gardner

SUBJECT: Project Outline on Vegetable Storing and Handling

Attached are four copies of a vegetable handling project prepared by Mr. C. L. McCombs. A copy of this is currently in Mr. J. A. Rigney's hands, inasmuch as he is listed as adviser. We thought that some time could be saved by circulating these copies within the department and through Mr. Rigney concurrently.

Very truly yours,

Fred

Fred D. Cochran, Head
Vegetable Crops Section

FDC/w

O.K.
E.B.M.
5/9/53