Sucrose Analysis and Chipping Ability of Twenty Alaska Grown Potato varieties

Cooperator:

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Significance of Project to Alaskan Agriculture:

Alaska potato growers are currently supplying 75% of the fresh market potatoes sold in Alaska. Alaskan potatoes are used in less than 1% of the processed potato products sold in Alaska. In the 1988 marketing season for Alaska potatoes, approximately 400 tons of potatoes were dumped that may have been utilized for processing if reliable baseline data were available. This project has attempted to provide an initial step in that direction.

Objective:

Establish baseline data on 20 potato varieties grown in Alaska and evaluate their performance under storage conditions that are standard in the processing industry. Data correlation was established between specific gravity, maturity (sucrose rating - SR), fry color of the 20 varieties tested. Remarkable differences have been demonstrated in data from Alaska grown varieties compared to similar data from the lower 48 states.

Methods:

Research plan was implemented to evaluate specific gravity, chemical maturity (sucrose rating - SR), fry color, fertility factors of six plots of five cooperating growers and the Plant Materials Center. Twenty varieties were to be tested.

An unexpected event altered the project somewhat. Bacterial Ring Rot was detected on several farms around the test plots. Due to the significant risk of contamination of seed stocks at the PMC where the laboratory work would be done, the decision was made to abandon the grower plots and continue the project using the largest plot at the PMC.

The plots at the Plant Materials Center were harvested September 13, 1988. Sixty pound sacks were collected of the 20 varieties and placed into a constant temperature at 600 F storage. Sampling began September 26, 1988 and continued every two weeks until December 3, 1988.

Procedure:

Specific gravity - determined by using this formula: dry weight/dry weight-wet weight = specific gravity

Fry color - determined by cooking a .063 inch chip slice *@375 degrees* for three minutes and matching the color to the standard pc/sfa chart. Temperature drop of the fryer was never below 355 °. Chip slices were taken to include the apical and basal ends of the tuber. Slices were blotted dry and not washed or leached. Ten sample slices were tested per variety. Vegetable cooking oil was used.

SR (sucrose rating) - Van Handel method was used, as published in Ohio State University Research Bulletin #1172.

200 gram samples were taken from variety samples at two week intervals beginning September 26. Samples were juicerated using an Acme juicerator, placed in a zip-lock sample bag, and quickly frozen for later analysis. Later, the frozen samples were partially thawed in a microwave, transferred to a 500 ml graduated cylinder, and volume of the sample brought to 430 ml with distilled water. The mixture was placed in a flask and allowed to settle for one hour. A portion was drawn from each flask (0.1 ml) and diluted with four parts distilled water and placed in a test tube. To each tube was added 0.1 30% KOH reagent. Each test tube was covered, mixed, and heated at 1000 C for 15 minutes.

Three test tubes were made up with 0.1 ml sucrose reagent. Sucrose reagent is one gram sucrose diluted in 1,000 ml water. Three test tubes were made up with 0.1 ml distilled water. Sample tubes were allowed to cool to room temperature and 3 ml Anthone reagent was added. Anthrone reagent is mixed by combining 76
ml sulfuric acid to 30 ml distilled water, then adding .15 gram Anthrone. Test tubes were incubated for 30 minutes at 400 C. Test tube samples were transferred to smaller 1/2 inch diameter tubes that fit the Spectronic 20 spectrophotometer. The instrument was set to zero with the lowest reagent blank at 620 nm. Standard sugar solution and unknown sample solutions were analyzed for their optical density (OD) at 620 nm in comparison to the known sugar.

Calculation to determine sucrose rating (SR):
OD (unknown) x 0.1 x 107.5 (factor)/OD (standard) x gr. tuber = mg sucrose/gr tuber = tuber SR

Alaska grown potatoes are commonly referred to as being sweet. Attempts to utilize the commonly grown varieties 'Bakeking' and 'Green Mountain' for chipping have resulted in an unacceptably dark colored chip. Dark chip color results from the accumulated reducing sugars reacting with free amino acids during the frying process. This reaction called the non-enzymatic browning reaction, can be manipulated when the amount of sucrose is known.

The amount of sucrose found in potatoes at harvest is influenced by many factors. These factors include variety, planting date, growing location, soil fertility, water availability, and any stress-inducing event. Sucrose is the major free sugar present in all growing potato plants. It moves from the foliage to the tubers where the sucrose is channeled into cellular growth processes rather than accumulating as reducing sugars
(i.e. glucose and fructose). Sucrose, being a non-reducing sugar, does not directly affect the non-enzyumatic reaction which causes browning. This is the reason that immature potatoes with high sucrose levels can be chipped directly from the field. Once potatoes are placed in storage, the sucrose is rapidly hydrolized into glucose and fructose which do participate in the non-enzymatic reaction. Potatoes with high sucrose levels at harvest tend to accumulate more reducing sugars and are therefore not suitable for processing out of storage.

Alaska's short, cool growing season does not allow potato plants to physically mature. Senescent vines and firm skins which occur in other growing areas, do not occur in Alaska. Factors which indicate physical maturity, dead foliage, high solids content, tuber size, and high specific gravity, do not necessarily indicate the chemical maturity of the crop. Knowledge of the chemical maturity of the field would allow management decisions to be made concerning the suitability of the crop for processing.

A relatively simple method to determine the chemical maturity of a potato crop has been developed by Dr. Joe Sowokinos working with potatoes grown in the Red River Valley. He has determined that an excellent correlation exists between sucrose content (SR) at harvest and the length of time in which undesirable levels of reducing sugars accumulate in intermediate temperature *(50°)* storage.

Potatoes with a SR level below 1.5 with good chip color should retain good chip color seven to ten months. Those with a SR level greater than 1.5 with good chip color should be warmed to 60-70° for two to four weeks, then held at intermediate temperatures, should hold color four to six
months. Potatoes having a SR below 1.5 with poor color should be warmed to 60-70° F for two to four weeks then held at intermediate temperature. These potatoes may then chip for five to six months. Potatoes with a SR
greater than 1.5 and with poor chip color, have as their only possibility for chipping use, warming to 60-70° F for two to four weeks, then chipping immediately if the preconditioning works.

The model developed to estimate sucrose levels and subsequent chip color was applied to Alaskan grown potatoes. Twenty varieties were selected based on physical maturity characteristics (early, medium, late) and/or known processing potential.

It was believed that all varieties would have a chip color rating (CCR) of three or less, which is the desirable range of the color chart during the first few weeks after harvest. Varieties having a SR value greater than 1.5 should have a rapid accumulation of reducing sugars which would lead to dark chip color (greater than three) within the first few weeks after harvest.

The varieties 'Alaska Russet', 'Campbell 13', 'Denali', 'Katahdin', 'Lemhi', "Monona', 'Norchip', 'Yukon Gold', and 'Snowchip' had sucrose levels above 1.5 at harvest. Acceptable chip color was found for all varieties except 'Lemhi' and 'Green Mountain'. The remaining varieties had sucrose levels below 1.5 at harvest and acceptable chip color, except for 'Bake king', ‘Butte', and 'Russet Burbank'. The varieties 'Alaska 114', 'Allagash', 'Atlantic', 'Kennebec', 'Norland', 'Shepody', and 'Superior', having a low SR and good chip color at harvest, should have retained their chip color for seven to ten months; however, only the variety 'Allagash' retained good chip color throughout the test period. 'Superior', known as a chipper, was the first to lose acceptable color.

The project was able to determine the sucrose level, chip color and specific gravity of twenty varieties held at GO°F on a bi-weekly basis for approximately a three month time span. This data will assist the Alaska potato industry in gaining a better understanding of the chemical maturity levels of the crop and its relationship to processing potential.

HARVEST CONDITION		DATE CHIP COLOR IS UNACCEPTABLE					
		9/26	10/12	10/25	11/8	11/19	12/3
SR	AK 114					XXX	XXX
LESS THEN 1.5	ALLAGASH						
	ATLANTIC						XXX
	KENNEBEC						XXX
	NORLAND			XXX	XXX		
	SHEPODY				XXX		
	SUPERIOR		XXX		XXX	XXX	XXX
SR	AK RUSSSET						XXX
GREATER THEN 1.5	CAMPBELL 13					XXX	
	DENALI						
	KATAHDIN			XXX	XXX	XXX	XXX
	MONONA						
	NORCHIP			XXX	XXX	XXX	XXX
	SNOWCHIP						
	YUKON GOLD			XXX	XXX		XXX
SR	BAKEKING	XXX	XXX	XXX	XXX	XXX	XXX
LESS THEN 1.5	BUTTE	XXX	XXX	XXX	XXX	XXX	XXX
	RUS BURBANK	XXX	XXX	XXX	XXX	XXX	XXX
SR	GREEN MTN	XXX	XXX	XXX	XXX	XXX	XXX
GREATER THEN 1.5	LEMHI	XXX		XXX	XXX	XXX	XXX

XXX DENOTES CHIP COLOR ABOVE 3 AND UNACCEPTABLE ACCORDING TO POTATO CHIP/SNACK FOOD ASSOCIATION

COLOR CHART

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