MEASUREMENT OF CHIPPING QUALITIES IN MANITOBA-GROWN POTATOES¹

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ABSTRACT

Of ten varieties of potatoes from three major producing areas of Manitoba, Cherokee, Irish Cobbler, Norland and Netted Gem each produced high quality chips in at least one area. Variations in chipping qualities occurred between localities. Reducing sugar and specific gravity were reliable indexes of chip quality. A simplified method for measuring chip colour is outlined.

INTRODUCTION

The potato processing industry has rapidly gained in importance during the past decade. In the United States this industry now uses about one-fifth of all potatoes produced for food (10). The same trend has been evident in Canada.

The role of sugars in determining the quality of potato chips has been extensively studied since the initial work of Sweetman (9). The level of reducing sugars in potatoes has been reported to be the most important single factor influencing the colour of the chips (2-5, 11). The accumulation of these reducing sugars in potatoes during storage depends largely on variety and temperature (2, 8, 9). A Hunter colour and colour difference meter has been used recently (3, 4, 7) to measure potato chip colour objectively and thus provide an index of chip quality. High specific gravity has been reported to be associated with frying quality (6) and high chip yield (11).

This is a study of the measurement of chipping qualities of several varieties grown in major potato-producing areas of Manitoba. Special emphasis was given to the measurement of chip colour. Other quality factors included were reducing sugar content and specific gravity of the raw tubers and yield of the processed chips.

MATERIALS AND METHODS

Ten varieties of potatoes were grown at three localities in Manitoba during 1958. These included: Cherokee, Columbia Russet, Huron, Irish Cobbler, Keswick, Manota, Netted Gem, Norland, Pontiac and Waseca. The localities and soil types were: *Carman*, light sandy loam; *Fort Garry*, heavy clay; and *Poplar Point*, medium clay loam. The same source of seed was used for each variety at all the localities.

Chipping qualities of the potatoes were determined after 3 months of storage at 40°F. and again after 6 months.

The tubers were conditioned for 10 days at 65°F. prior to testing. Fifteen-pound lots of each variety from each locality were then immersed in succession in a series of seven brine solutions varying in specific gravity from 1.058 to 1.106. The floating tubers were removed from each brine

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tank and weighed. From these data the mean specific gravity of each lot was calculated. Only the potatoes in the median range of specific gravity were used for chemical analysis and chip preparation. This was desirable because of the heterogeneity of specific gravity found in each lot. Reducing sugar content was ascertained by a Lane-Eynon volumetric method (1).

The chips were prepared as follows: The tubers were washed, peeled and cut into 1/16-inch slices. Quadruplicate 100-gram portions of slices were prepared from each sample lot. Each 100-gram portion was rinsed in cold water to remove the surface starch and then placed between cotton towels to absorb the excess moisture. The raw slices were then immersed in a high grade of hydrogenated vegetable shortening previously heated to 375°F. and fried for 2½ minutes. The chips were placed in an oven at 80°F. for 2 minutes to drain off the excess oil; then they were weighed and the chip yield was calculated in terms of the original weight of the slices.

The chips obtained from each 100-gram portion of slices were prepared for colour determination by blending with a 100-ml. aliquot of ethanol in a Waring blender for 30 seconds. The mixture was filtered through No. 1 Whatman paper and the moist residue transferred to a viewing cell 2½ inches in diameter and 1½ inches high, with an optical glass bottom. The residue was mixed thoroughly with a wooden spatula to remove bubbles

TABLE 1. — CHIPPING QUALITIES OF 10 VARIETIES OF POTATOES
(Means for three localities and two storage periods)

Variety	Specific gravity	Reducing sugar, %	Chip yield %	Hunter L value
Cherokee	1.089	.70	31.8	41.8
Columbia Russet	1.082	1.19	31.2	34.0
Huron	1.084	.92	29.2	24.7
Irish Cobbler	1.094	.56	33.9	47.4
Keswick	1.086	1.23	29.6	28.6
Manota	1.089	.66	32.2	40.2
Netted Gem	1.086	.60	33.1	44.6
Norland	1.084	.39	32.0	49.1
Pontiac	1.076	.94	28.0	33.3
Waseca	1.084	.69	30.5	34.0
Difference necessary for significance at 5% level	.005	.11	1.2	5.5

TABLE 2. — CHIPPING QUALITIES OF POTATOES FROM THREE GROWING AREAS IN MANITOBA
(Means for ten varieties and two storage periods)

Locality	Specific gravity	Reducing sugar, %	Chip yield %	Hunter L value
Carman	1.087	.69	31.3	41.3
Fort Garry	1.089	.71	31.9	41.8
Poplar Point	1.080	.96	30.2	33.3
Difference necessary for significance at 5% level	.003	.06	.7	3.0

TABLE 3. — CHIPPING QUALITIES OF POTATOES AFTER STORAGE FOR TWO PERIODS AT 40°F.
(Means for ten varieties and three localities)

Storage period	Specific gravity	Reducing sugar, %	Chip yield %	Hunter L value
3 months	1.088	.73	31.2	39.2
6 months	1.082	.84	31.1	38.3
Difference necessary for significance at 5% level	.002	.05	—	—

and fine settlings from the viewing surface. Lightness of chip colour was determined on a Hunter colour and colour difference meter, the L circuit being used.

RESULTS AND DISCUSSION

The Hunter L values obtained on the chips were indicative of visual lightness of colour and were easily reproduced. A Hunter L value of over 50 was considered as good to excellent, 40 to 50 as fair, and under 40 as poor.

The varieties Cherokee, Irish Cobbler, Norland and Netted Gem each produced good-coloured chips (Hunter L value over 50) from at least one of the localities studied. Norland, Irish Cobbler and Netted Gem gave the best average chip colour (Table 1). Manota and Cherokee were intermediate in this regard. Norland had the lowest reducing sugar level and was the only variety averaging below the critical 0.4 per cent level reported by Hawkins *et al.* (5). Columbia Russet, Huron, Keswick, Pontiac and Waseca all produced chips with poor colour readings at each locality; reducing sugars were generally high for these varieties. Irish Cobbler had the highest average specific gravity and also the highest chip yield.

The chips produced from potatoes grown at Carman and Fort Garry were similar, on the average, in all qualities though the soil types were very different (Table 2). Poplar Point yielded tubers that were lower in specific gravity and higher in reducing sugar; and chips inferior in colour.

In storage, the specific gravity of the potatoes decreased significantly, the reducing sugar increased significantly, and the chip yield and chip colour remained practically constant (Table 3). The small but significant decrease in specific gravity during storage was attributed to loss of solids by respiration which apparently exceeded any dehydration effect. As the potatoes had been stored for 3 months at 40°F. before the tests, the rapid increase in reducing sugars generally occurring during initial storage at this temperature (8) was not apparent in these results.

The correlation coefficients for characteristics of the raw potatoes and chips for the two periods of storage at 40°F. were:

	After 3 months	After 6 months
Reducing sugar vs. Hunter L value	— .73**	— .87**
Specific gravity vs. chip yield	+ .78**	+ .78**
Specific gravity vs. reducing sugar	— .49**	— .52**

** Significant at 1% level

The correlation coefficients between reducing sugar and chip colour as determined by the Hunter L values agree favourably with that of Habib and Brown (3), who reported a coefficient of -0.85 for the two factors. Specific gravity was a reliable index of chip yield; this supports the findings of Wright and Whiteman (11). The correlation between specific gravity and reducing sugar was negative and highly significant. In the present tests both the specific gravity of the tubers and their reducing sugar level were key factors influencing chip quality.

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REFERENCES

1. Association of Official Agricultural Chemists. Official methods of analysis. 8th ed. Washington, D.C. 1955.
2. Denny, F. E., and N. C. Thornton. Factors for colour in the production of potato chips. *Contribs. Boyce Thompson Inst.* 11:291-303. 1940.
3. Habib, A. T., and H. D. Brown. Factors influencing the colour of potato chips. *Food Technol.* 10:332-335. 1956.
4. Habib, A. T., and H. D. Brown. Role of reducing sugars and amino acids in the browning of potato chips. *Food Technol.* 11:85-89. 1957.
5. Hawkins, W. W., M. Black, and C. M. Dicks. Some biochemical changes on storage in potatoes from Prince Edward Island, and their relation to the quality of chips. *Can. J. Plant Sci.* 38:457-463. 1958.
6. Kirkpatrick, M. E., P. H. Heinze, C. C. Craft, B. M. Mountjoy, and C. E. Falatko. French frying quality of potatoes as influenced by cooking methods, storage conditions, and specific gravity. U.S. Dept. Agr. Tech. Bull. 1142. 1956.
7. Shallenberger, R. S., O. Smith, and R. H. Treadway. Role of the sugars in the browning reaction in potato chips. *J. Agr. Food Chem.* 7:274-277. 1959.
8. Schwimmer, S., A. Bevenue, W. J. Weston, and A. L. Potter. Survey of major and minor sugar and starch components of the white potato. *J. Agr. Food Chem.* 2:1284-1290. 1954.
9. Sweetman, M. D. Colour of potato chips as influenced by storage temperatures of the tubers and other factors. *J. Agr. Research* 41:479-490. 1930.
10. Talburt, W. F., and O. Smith. Potato processing. Avi Publishing Co., Westport, Conn. 1959.
11. Wright, R. C., and T. M. Whiteman. Chipping quality of eight potato varieties as affected by source and by storage treatment. U.S. Dept. Agr. Circ. 936. 1954.