

Determination of Reducing Sugars in French Fried Potatoes by 3,5-Dinitrosalicylic Acid

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ABSTRACT

Determination of reducing sugars in raw potatoes by 3,5-dinitrosalicylic acid is well documented.

For French fried potatoes, especially if prepared in repetitively used frying oil, higher erratic values occurred as compared with standard. These values were related to oil pigmentation interference with reducing sugars.

INTRODUCTION

Several methods have been used for the determination of reducing sugars in potatoes (Mazza, 1983). The method described by Lindsay (1973) for raw potatoes was originated by Summer (1925) and followed by others (Edson & Poe, 1948; Vliet & Muller, 1968). It is based on the color reaction between reducing sugars and 3,5-dinitrosalicylic acid. Lindsay stated that such a procedure is fast, accurate and obeys Beer's law with no inversion of sucrose.

The purpose of this study was to investigate the applicability of this procedure to french fries prepared in oil which had been used repeatedly in deep fat frying.

MATERIALS AND METHODS

Sample preparation

Raw potatoes of the Russet Burbank cultivar with a specific gravity of 1.080 ± 0.001 , grown in the State of Washington, were selected for the study. Tubers were stored for nine months at 7.2°C and reconditioned at room temperature (21.2°C) for 1 week before processing and analyses.

Approximately 10 kg of potato tubers from the same lot were peeled and cut into $13\text{ mm} \times 13\text{ mm} \times 10\text{ cm}$ strips using a french fry cutter. To eliminate unevenly shaped strips, only samples from the core section of the tubers were used. The strips were blanched in water at 82.2°C for 10 min, rinsed with cold water and drained. They were par-fried at 185°C for 90 s in soybean oil and stored at -20°C for 24 h before finish-frying. Approximately 375 g potato strips were finish-fried in soybean oil (ratio, 1:10) for 6 min at 185°C in a Hot Point (Fig. 1) deep fat fryer (General Electric, Chicago Heights, IL). The oil was subjected to twenty-two consecutive fryings and was filtered after every third time of frying. The potato to oil ratio was maintained throughout the process.

Analytical

Moisture content of the potato samples was determined by air drying according to the AOAC method (1980). Reducing sugars in raw potatoes

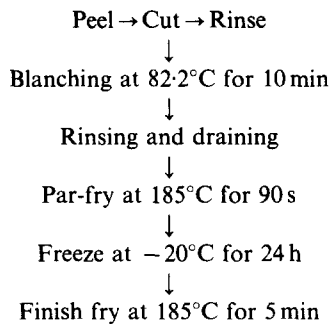


Fig. 1. Unit operations for french fries.

and finished products were determined by the 3,5-dinitrosalicylic acid method of Lindsay (1973) with modification. About 1300–1500 mg sample was thinly cut longitudinally from various strips and thoroughly mixed using a mortar and pestle. After mixing, 300 mg sub-samples were weighed and analyzed. As the reagent (3,5-dinitrosalicylic acid) in a volumetric flask reached half volume, it was discarded and the solution was freshly prepared as the reagent is sensitive to CO₂. The absorbance was determined at 570 nm using a Spectronic 20 spectrophotometer (Bausch and Lomb, NY) with a 1.26 cm path length and plotted against a standard curve.

RESULTS AND DISCUSSION

Reducing sugars accumulate in potato tubers as storage period increases. Long-term stored tubers pose a problem in getting a continuous, adequate supply of high quality fit for processing (Talburtt & Smith, 1967; Weaver & Hautala, 1971).

By applying Lindsay's (1973) method for the determination of reducing sugars in French fried potatoes, it was noted that repetitive use of frying oil resulted in higher erratic values (Fig. 2 and Table 1), especially between the

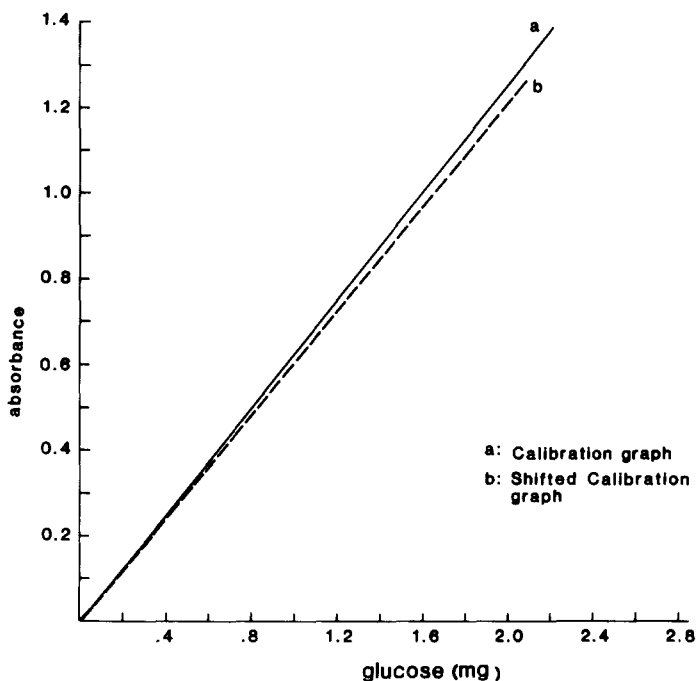


Fig. 2. Calibration graph for reducing sugars.

TABLE 1
Effect of Frequency of Frying Time of Oil on Determination of Reducing Sugars in French Fried Potatoes

| Frequency of frying | Moisture (%) | Reducing sugars (mg per 100 g sample) | Reducing sugars (mg per 100 g DWB) ^b | % Change |
|---------------------|--------------|---------------------------------------|---|----------|
| Raw potato | 76.1 | 461 ± 1.5 ^a | | |
| First | 50.2 | 587 ± 3.5 | 776 | 0 |
| Fifth | 50.5 | 379 ± 4.0 | 767 | -1.2 |
| Seventh | 50.3 | 384 ± 5.3 | 772 | -0.6 |
| Thirteenth | 49.7 | 415 ± 4.5 | 826 | 6.4 |
| Twentieth | 50.3 | 418 ± 7.6 | 841 | 8.3 |
| Twenty-second | 49.8 | 461 ± 5.3 | 919 | 18.4 |

^a Mean ± standard deviation for three replicates.

^b DWB = Dry weight basis.

7th and 13th times of frying and thereafter as compared with the same fried potatoes in oil for the first time. The reason for such change may be due to change in soybean oil pigmentation and/or Maillard reaction postulated by previous researchers (Anderton, 1953; Habib & Brown, 1957; Hoover & Xander, 1961; De Fouw *et al.*, 1981; Mazza, 1983). If such a change was related to Maillard reaction, it would lower the contents of reducing sugars. It is assumed that change in oil pigmentation interfered with spectrophotometer absorbance which leads to higher erratic values. As there is no difference in reducing sugar content of potatoes from the same fat which were finish-fried at different frying times, a new calibration curve (dotted line) was constructed (Fig. 2) to measure the difference.

For french fries prepared in oil subjected to such frequent deep fat frying, the 3,5-dinitrosalicylic acid method for determining reducing sugar would give erroneous values (higher than the actual amount present in the samples). Therefore, caution should be exercised in interpreting data or a different method of determination may be appropriate.

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