to 4.9 μg in 1 L of wine. In view of the above data and arguments, we feel that instead of simply banishing $(EtOCO)_2O$ from beverage industry, prescribing the conditions of its use on a scientific basis would be more reasonable. We suggest that before treatment the ammonia content and the pH of the individual samples be determined, eq 5 be consulted, using the proper values for $k'$ and $k_2$ (see Tables I and II), and a decision as to the controlled use of $(EtOCO)_2O$ be made depending on the expected amount of urethane generated under the given conditions.

ACKNOWLEDGMENT

We thank L. Ehrenberg and Siv Osterman-Golkar, University of Stockholm, as well as L. Maros and F. Ruff, Eötvös University, Budapest, for helpful discussions.

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Received for review March 24, 1977. Accepted October 4, 1977. This work has been supported by the Royal Swedish Academy of Sciences, the Swedish Atomic Research Council and the Hungarian Academy of Sciences.

# Effects of Blanching on Protein Fractions of Certain Sweet Corn Cultivars

Blanching of sweet corn did not alter significantly total protein, alkali-soluble protein, or free amino acids. Blanching reduced salt and alcohol-soluble proteins and caused marked increases of insoluble protein. Changes during blanching varied with cultivars and stage of maturity. Attention to those variables when selecting sweet corn for processing could help improve product quality.

When heated under moist conditions, many proteins are denatured and become much less soluble in aqueous media. Seed proteins differ considerably from animal proteins in that plant proteins often are incompletely coagulated by heat (Osborne, 1924). Heat sensitivity of corn globulins is influenced by moisture content, temperature, and duration of heating (Rukina and Ruchkin, 1970). Rukina and Ruchkin (1970) reported that heat decreased the salt-soluble protein fraction of field corn. Green (1972) found that heated sweet corn had a lower sulfhydryl content in the salt-soluble fraction, and he concluded that soluble proteins influenced the physical characteristics of processed sweet corn.

Quantities of certain protein fractions of sweet corn vary among cultivars and with stage of maturity (Pukrushpan et al., 1977). The objective of this study was to determine the effects of blanching on the protein fractions of the cultivars when harvested at various stages of maturity.

## MATERIAL AND METHODS

Five sweet corn cultivars were grown, harvested, and sampled as described by Pukrushpan et al. (1977). Samples with more than 80% moisture were classified as immature, those between 75 and 77% as mature, and those with 70 to 72% moisture as overmature. The ears were blanched in boiling water for 6 min and were cooled by immersing in cold water. The ears were drained, packaged in polyethylene bags, and stored at −20 °C. The frozen corn was prepared for analysis by dipping in boiling water for 3 min, cutting the kernels from the cob, and homogenizing the kernels in acetone to yield a defatted residue. Protein fractionation and analyses were performed as described by Pukrushpan et al. (1977).

The data were analyzed statistically by the analysis of variance, F test, and least significant differences (LSDs).

## RESULTS AND DISCUSSION

In earlier work by Pukrushpan et al. (1977), certain protein fractions varied significantly with stage of maturity and among cultivars. In this experiment, protein fractions of unblanched corn again differed significantly with stage of maturity, but only total protein and free amino acids differed significantly among cultivars (Table I). However, stages of maturity at time of sampling were different from those of the earlier report.

Total protein concentration decreased with increasing maturity (immature 16.5, mature 14.0, overmature 12.6%, LSD 0.9) and varied with cultivars (Bonanza 15.68 Jubilee 15.2, Triumphant II 14.2, Yukon 13.2, and NK51036 13.0%, LSD 1.2). Salt-soluble protein decreased with increasing maturity (immature 4.5, mature 3.1, overmature 2.4%, LSD 0.7). Alcohol-soluble protein varied significantly only with stage of maturity (immature 1.9, mature 3.1, overmature 3.8%, LSD 0.5). Alkali-soluble protein also varied only with maturity (immature 4.8, mature 4.2, overmature 3.9%, LSD 0.7), as did insoluble protein (immature 3.6, mature 2.3, overmature 1.8%, LSD 0.6). Free amino acids differed both by cultivar and with maturity (Bonanza 0.22, Jubilee 0.15, NK51036 0.15, Triumphant II 0.13, Yukon 0.13%, LSD 0.04; immature

 

Table I. Analysis of Variance of Protein Fractions and Free Amino Acids of Sweet Corn Cultivars at Different Stages of Maturity and When Subjected to Blanching[a]

| | | Mean squares | | | | | |
|---|---|---|---|---|---|---|---|
| Factors | DF | Total protein | Salt-soluble protein | Alcohol-soluble protein | Alkali-soluble protein | Insoluble protein | Free amino acids |
| Cultivars | 4 | 8.28** | 1.44 | 0.44 | 1.41 | 1.28 | 0.009** |
| Maturity | 2 | 37.90** | 11.49** | 8.81** | 2.40* | 8.83** | 0.217** |
| Blanching | 1 | 0.00 | 49.67** | 9.24** | 1.79 | 108.29** | 0.001 |
| Cultivar × blanching | 4 | 0.19 | 1.09 | 0.38 | 0.42 | 0.75 | 0.000 |
| Maturity × blanching | 2 | 0.72 | 3.37* | 0.61 | 0.66 | 4.32** | 0.001 |
| Residual | 16 | 0.93 | 0.62 | 0.27 | 0.57 | 0.45 | 0.001 |

[a] Significant at 5% level (*); significant at 1% level (**).

Table II. Analysis of Variance of Percent Reductions of Salt-Soluble and Alcohol-Soluble Proteins which Occurred during Blanching[a]

| | | Mean squares | |
|---|---|---|---|
| Factors | DF | Salt-soluble protein | Alcohol-soluble protein |
| Maturity | 2 | 271* | 169* |
| Cultivars | 4 | 476** | 389** |
| Residual | 8 | 61 | 37 |

[a] Significant at 5% level (*); significant at 1% level (**).

Table III. Effect of Blanching on Salt and Alcohol-Soluble Proteins of Sweet Corn at Three Stages of Maturity (Average Percentage Reduction of All Cultivars)[a]

| Fraction | Immature | Mature | Overmature |
|---|---|---|---|
| Salt soluble | 60.7[a] | 50.8[b] | 51.9[b] |
| Alcohol soluble | 30.3[b] | 25.1[c] | 35.5[a] |

[a] Values within fractions having common superscripts do not differ significantly at the 5% level.

0.21, mature 0.15, overmature 0.11%, LSD 0.03).

Blanching did not alter significantly total protein, alkali-soluble protein, or free amino acids. Salt-soluble protein decreased markedly during blanching, the average of all unblanched samples being 4.6 and of the blanched samples 2.0% (LSD 0.6)—a loss of about half of the salt-soluble protein. Highly significant reductions during blanching occurred in alcohol-soluble protein (unblanched 3.5, blanched 2.4%, LSD 0.4), although the amount of reduction was less than that for salt-soluble protein.

Blanching effects on salt and alcohol-soluble proteins varied with stage of maturity and with cultivars, as shown by analysis of variance of the percent reductions resulting from blanching (Table II). Salt-soluble protein decreased most at the immature stage, while alcohol-soluble decreases were greatest at the overmature stage (Table III). Salt-soluble protein was more heat resistant in Triumphant II, and alcohol-soluble protein was more resistant in NK51036 (Table IV).

Insoluble protein increased markedly during blanching (unblanched 0.7, blanched 4.5%, LSD 0.5) because of decreased solubility of salt-soluble and alcohol-soluble

Table IV. Effect of Blanching on Salt and Alcohol-Soluble Proteins of Cultivars of Sweet Corn (Average Percentage Reduction of All Stages of Maturity)[a]

| Fraction | Yukon | Bonanza | NK-51036 | Jubilee | Triumphant II |
|---|---|---|---|---|---|
| Salt soluble | 68.2[a] | 57.7[b] | 56.0[b] | 53.5[b] | 33.0[c] |
| Alcohol soluble | 37.3[b] | 31.9[b] | 14.2[d] | 24.3[c] | 44.0[a] |

[a] Values within fractions having common superscripts do not differ significantly at the 5% level.

proteins. The greatest increase in insoluble protein occurred at the immature stage, when salt-soluble protein was highest (immature 6.2, mature 4.0, overmature 3.1%, LSD 0.9).

It has been suggested that soluble protein content may influence the processing characteristics of sweet corn. Some characteristics may be detrimental, such as curdling during the preparation of cream style corn. Since the effect of blanching on protein solubility varies with maturity and cultivars, attention to those variables in selecting sweet corn for processing could help improve product quality.

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Received for review June 27, 1977. Accepted November 28, 1977. Contribution numbers: 199j, 606j, 289j, Departments of Biochemistry, Horticulture, and Statistics, respectively, Kansas Agricultural Experiment Station.