Stability of Amino Acids during Cooking and Processing of Sweet Potatoes

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Changes in the amino acid content of Jewel sweet potato were related to the heat processing treatment. Baking the roots caused less amino acid loss than either canning in syrup or dehydrating into flakes. The major nutritional change caused by heat processing was lysine destruction, which was significantly greater for canning and dehydration than for baking. Roots canned in syrup contained significantly less nitrogen that did roots processed by the other treatments.

Reports on the amino acid content of sweet potato suggest that the protein has a high chemical score (Nagase, 1957; Purcell et al., 1972), containing more lysine than the FAO reference protein (FAO/WHO, 1973). The protein appears to be of good biological quality (Adolph and Liu, 1939). In fact, Walter and Catignani (1981) have demonstrated that isolated protein from both "Jewel" and "Centennial" cultivars had a PER equal to that of ANRC casein.

Sweet potatoes are usually cooked before being eaten, and it is possible that some of the lysine is destroyed by reaction with carbohydrates during heating (Harris and von Loeseke, 1960; Frangng and Adrian, 1972a,b). Other amino acids such as tyrosine, leucine, isoleucine, and phenylalanine, which are slightly lower in boiled than in uncooked dry beans (Talover and Pitan, 1972), might also be destroyed by heat in sweet potatoes. All of the above listed amino acids are more abundant in isolated sweet potato protein than is needed for balance according to the FAO reference protein (Purcell et al., 1972). If destruction of these amino acids due to processing is small, sweet potato products might be recommended to supplement diets composed mostly of grains (FAO/WHO, 1970). We compared the amino acids of sweet potatoes that had been baked, canned, or prepared into dehydrated flakes from cooked sweet potato puree.

MATERIALS AND METHODS

"Jewel" sweet potatoes grown at the North Carolina Agricultural Research Service Central Crops Research Station near Clayton, NC, were cured for 1 week at 30 °C and 80–90% relative humidity and stored at 13 °C until sampled. Samples were analyzed immediately after curing and after 1 and 3 months of storage.

Preparation of Samples. Samples were taken to the laboratory, washed with water, and divided into three lots of about 2 kg each. One lot was baked for 90 min at 190 °C in a convection oven. After the sweet potatoes were cooled, the roots were cut lengthwise, the edible portions were removed with a fork, and the pulp was thoroughly mashed and mixed. Samples were freeze-dried and stored under nitrogen until assayed. Other lots were peeled before further preparation.

The second lot was cut into 2-cm dice, covered with water, heated to 121 °C for 10 min, and blended into a puree. The puree was dried into flakes on a 6 × 8 in. double-drum dryer, heated with 60 psig of steam, and had a retention time of 45 s (Deobald and McLemore, 1962; Hoover, 1965). The flakes were stored under nitrogen until analysis. The third lot was cut into 5.0-cm pieces, packed into 303 cans, covered with 30% sucrose syrup, heated to 80 °C, and sealed in the cans. The canned samples were then heated to 121 °C for 65 min, cooled, and stored. One day prior to analysis one can was opened, and the contents were poured onto a 4-mesh screen and drained for 5 min. The samples were then thoroughly mashed and strried; portions were freeze-dried. The dried samples were ground to pass an 80-mesh screen and weighed for analysis.

Analysis. Nitrogen was determined by the macro-Kjeldahl procedure using copper and selenium catalysts. Protein was calculated as $N \times 6.25$. Amino acids were measured as previously described (Purcell and Walter, 1980).

Samples containing 60 mg of protein were treated with amyloglucosidase (Sigma) to hydrolyze the starch and with Pronase (Sigma; *Streptomyces gresius*) to hydrolyze proteins. The hydrolysates were passed through ion-exchange cleanup columns (Pataki, 1969). The amino acid eluates were refluxed in 6 N HCl in the absence of oxygen. The amino acids were measured by the method of Spackman et al. (1958) using a Beckman Model 119 amino acid analyzed. After being cured and at 1 and 3 months of storage, three replicates of each treatment were assayed and the data were statistically evaluated by analysis of variance (SAS Institute Inc., 1979). Cystine and tryptophan were measured colorimetrically after enzyme hydrolysis (Walter et al., 1978).

RESULTS AND DISCUSSION

There were no significant differences in protein or amino acid content due to month; therefore, the data for the 3 months were combined.

Total protein contents of the three products, dry basis, were 7.52% for baked, 5.55% for canned, and 7.06% for flakes. The type of heat treatment significantly affected amino acid content (Table I). Lysine contents were higher and serine contents were lower in the baked samples than in the canned and flaked samples. histidine content was lower in the flaked samples than in the others. Leucine and alanine contents were highest in the canned samples. Methionine was higher in the baked samples than in the flaked samples. Baking was considered to be the least severe heat treatment with internal temperatures probably not exceeding 100 °C (Nelson, 1973). There is no suitable method for analyzing the protein content of the raw sweet potato because the starch cannot be enzymatically degraded in the raw state nor otherwise separated without removing protein fractions. Acid hydrolysis in the presence of the amount of starch contained in the sweet potato causes considerable destruction of the amino acids.

The amino acid composition appeared to be similar to the composite calculated for sweet potato protein fractions

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Table I. Amino Acid Composition of Baked, Canned, and Flaked Sweet Potatoes: Means of Three Replicates for the Months August, September, and November[a]

amino acid	g of amino acid/16 g of nitrogen recovered			
	baked	canned	flaked	FAO
threonine	4.50	4.90	4.82	4.0
valine	6.83	6.81	6.07	5.0
methionine	2.69^{B}	2.38^{A,B}	2.06^{A}	
half-cystine	0.56	0.64	0.86	
total sulfur	3.25	3.02	2.92	3.5
isoleucine	4.57	4.53	4.31	4.0
leucine	7.47^{A}	9.01^{B}	7.57^{A}	7.0
tyrosine	5.81	5.74	5.04	
phenylalanine	7.32	7.82	6.65	
total aromatics	13.13	13.56	11.69	6.0
lysine	6.60^{B}	4.84^{A}	4.74^{A}	5.0
tryptophan	0.44	0.46	0.75	1.0
total essential	46.79	47.13	42.87	
aspartic acid	20.22	16.82	22.19	
serine	3.83^{A}	5.20^{B}	5.14^{B}	
glutamic acid	7.41	7.48	7.25	
proline	3.99	3.74	3.92	
glycine	4.19	4.57	4.69	
alanine	6.24^{A}	7.12^{B}	5.63^{A}	
histidine	2.75^{B}	2.90^{B}	2.36^{A}	
arginine	4.28	5.11	5.65	
total nonessential	52.91	53.04	56.83	

[a] Values in horizontal rows with the same or no superscripts are not significantly different at $P \leq 0.05$.

(Purcell et al., 1978b). Canning was the most severe heat treatment and probably caused nitrogen compounds that cannot be precipitated by heat to leach from the sweet potato into the syrup. Canned sweet potatoes contained 26% less total nitrogen than the baked sweet potatoes. We assumed that this was the amount leached into the syrup.

The composition of leachable nitrogeneous compounds was probably similar to that of the syrup fraction previously studied by Purcell et al. (1978a). That fraction contained a large proportion of asparagine and glutamic acids and lower amounts of the other acids. Leaching could have caused the apparent increase in the concentration of some of the amion acids, i.e., alanine and leucine, because the amounts of amino acids were calculated on the basis of grams per 16 g of N recovered. There is one report (Meredith, 1979) that nitrogeneous material is present in the syrup from canned sweet potatoes. The leachable nitrogeneous compounds were previously reported to include only a small amount of lysine; therefore, lysine was believed to have been destroyed by interaction with carbohydrates at high temperatures.

Flaking involved the most severe short-time heat treatment. The initial cooking was at least comparable to baking. During dehydration, temperature of the drums could have reached 145 °C. Although the product would not have reached that temperature, the temperature was sufficient to create a molten mass which hardened into brittle flakes immediately after leaving the drum. Thus, during dehydration, proteins and carbohydrates were together in high concentration at high temperature. Although the canned roots were not subjectd to the temperature extreme that the flakes were, the long period at 121 °C must have been sufficiently rigorous to cause a comparable amount of lysine destruction.

Destruction of lysine appears to be the major change of amino acids caused by processing sweet potatoes. Both the canned and flaked samples contained >26% less of this essential amino acid than did baked sweet potatoes. Contents of tryptophan and total sulfur-containing amino acids were low in all of the products. Methionine content was low only in the flakes.

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