A Research Note

Composition of Raw and Cooked Potato Peel and Flesh: Amino Acid Content

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ABSTRACT

The nitrogen and total amino acid contents of Katahdin and Pontiac varieties of potatoes are reported for the peel and flesh, before and after cooking. With the exception of glutamic acid and γ-aminobutyric acid, all of the contents were higher in the peel. Losses of nitrogen and amino acids were minor in boiling whole potatoes but greater in oven baking in the peel or in boiling the peeled potato. Microwave cooking losses were less than in oven baking.

INTRODUCTION

POTATOES are a good source of food nutrients in the United States, as has been pointed out in earlier papers (Toma et al., 1978; True et al., 1978; True et al., 1979; Augustin et al., 1979). The total amino acid contents of raw potatoes in important commercial cultivars from three major production areas of the United States are being reported in another paper (Talley et al., 1983). But invariably potatoes are cooked before they are eaten. What effect does this have on the composition of the food as eaten? Some aspects of this question have been examined earlier (Toma et al., 1978; Augustin et al., 1978; Eppendorfer et al., 1979; True et al., 1979). Also many people believe the nutrients are present in higher concentrations in the peel than in the flesh. In some areas, peels alone, especially fried, are popular. Some phases of this question have been examined by Augustin et al. (1979). The differences in amino acid content of the peel and flesh, and the effect of cooking, for Katahdin and Pontiac cultivars of potatoes grown in Maine and The Red River Valley, respectively, were investigated.

MATERIALS & METHODS

Samples

The freeze-dried potato samples used in this study were obtained from scientists participating in a project to determine the nutritional contents of the potato in the United States (Toma et al., 1978). Samples received in capped vials were stored in the freezer at −10°C. They were obtained in triplicate except for the Katahdin peel samples from Maine, where only one sample of each was available. One determination was made on each replicate except in the case of tryptophan where two were made. The samples were warmed to room temperature and mixed by rotating before removing samples via a weighing tube for analysis, exposing them to the room air as little as possible during the weighing. Their selection and preparation were described by Augustin et al. (1979). With the exception of the peeled boiled potatoes, the potatoes were cooked whole. All were hand peeled (Augustin et al., 1979).

Amino acid determinations

The samples were acid-hydrolyzed, both as received and in oxidized form, and alkali-hydrolyzed for tryptophan as described by Talley et al. (1983). The amino acid composition of the hydrolyzed samples was determined with an amino acid analyzer as described in the same paper. Except where only one sample was available, mean values are reported as well as the lowest and the highest value in the group. An analysis of variance was made on the original data for each table. The coefficient of variation is a measure of the error due to the methods, replication, etc. and is not a measure of overall variation since the treatment effects were subtracted out. The values in the same group, followed by the same letter are not significantly different at the p = 0.05 level as determined by Duncan's (1955) Multiple Range Test. The original data are available, but are not given in this report.

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RESULTS & DISCUSSION

TABLE 1 shows the nitrogen and amino acid values obtained for the Katahdin cultivar, grown in Maine, arranged in descending order of nitrogen content for peel and then for flesh. These samples did not include samples of the whole raw potato. In general, the peel was higher in nitrogen content and in amino acid content than the flesh. However, glutamic acid and γ-aminobutyric acid were exceptions.

Cooking decreased the nitrogen and amino acid content in differing degrees. Oven baked peel showed large losses, probably due to decomposition because of the high temperature. Baked flesh actually gave a higher mean nitrogen value than raw flesh, though not significantly different. [If the moisture determinations had been 100% accurate and the difference had been significant, this apparent contradiction of the Law of Conservation of Mass can be explained rather simply by elimination of water due to decomposition of, e.g., starch (Willits, 1951)]. Potatoes boiled after peeling also had large losses of amino acids and nitrogen. The least losses were in boiled unpeeled potatoes. Eppendorfer et al. (1979) also reported only slight losses in boiling. The peel seems to protect against losses, as pointed out previously (Toma et al., 1978). Increased leaching would be expected in the case of peeled potatoes. The free amino acids would be expected to leach faster than those combined in the form of protein. However, the losses of asparagine, glutamine, aspartic acid, glutamic acid, and γ-aminobutyric acid were not abnormally high although these are present in higher concentrations in the free amino acid fraction (Talley et al., 1970). The cooking water was not available for testing this point.

Table 2 shows the values for Pontiac potatoes, grown in the Red River Valley. The results are similar to those in Table 1, though there was increased loss of ASP and GLU in the peeled boiled potatoes. Possibly in both cultivars, a trace of glutamic acid (glutamine) has been converted to γ-aminobutyric acid, especially during baking with its higher temperature and lower moisture. Any pyroglutamic acid formed by cyclization of glutamine, would be expected to hydrolyze to glutamic acid during hydrolysis of the samples. Maillard browning normally is limited in potatoes by low reducing sugar concentrations. However, storage at low temperatures (below about 5°C) can cause a rise in reducing sugar concentrations. (These potatoes were stored at 7.2°C prior to use.) The free amino acids and the epsilon group on lysine give fairly high concentrations of the amino component. Of course, at elevated temperatures, starch and sucrose can break down into active components, and thus lead to losses by Maillard browning.

In general, the nitrogen and amino acid contents were found to be highest in the peel, but as pointed out by Augustin et al. (1979), the effect is not great when the ratio of peel to flesh is considered, which is true when potatoes are used as conventional food. But this factor may become important if the peels alone are eaten. Especially if the peels are processed after peeling and before eating, determinations should be made directly on those products if a

—Continued on page 1363

Table 1—Total amino acid contents of raw and cooked peel and flesh of the Katahdin cultivar grown in Maine

	Micromoles amino acid per gram potato (dry basis)												
VAR[a]	RP[b]	BOP[b]	MBP[b]	BAP[b]	BF[c]	RF[c]	MBF[c]	BUF[c]	PBF[c]	Low[d]	High[d]	CV[d]	Mean[d]
Nitrogen	1393a	1356ab	1239b	955d	1090c	1056cd	1019cd	1009cd	980d	947	1393	4.2	1072
CYH (ox)	14.6b	28.1a	8.7cb	9.0cb	8.0c	8.1c	7.7c	8.0c	7.3c	6.4	28.1	5.5	9.4
ASP	194.8a	137.1cb	133.8cb	111.6c	145.9b	140.9cb	154.6b	148.1b	142.6b	111.6	194.8	7.4	146.0
$METSO_2$ (ox)	11.8ab	14.1a	12.3ab	9.9b	10.0b	10.9b	11.0b	10.8b	10.7b	9.1	14.1	9.6	11.0
THR	37.6a	34.0a	26.5b	22.1bcd	19.8d	22.5cbd	22.8cb	21.4cd	22.1cd	19.0	37.6	6.3	23.5
SER	43.0a	42.6a	35.7b	31.1c	25.2d	24.2d	29.4c	26.0d	24.9d	23.7	43.0	3.3	28.5
GLU	96.0cb	92.0cb	86.2cb	74.6c	118.9a	103.4b	120.7a	103.8b	100.4b	74.6	128.3	6.2	104.8
PRO	33.4a	32.6a	27.1b	24.7cb	18.3d	17.8d	21.4c	18.4d	17.0d	16.0	33.4	7.4	20.9
GLY	50.7a	47.9a	38.0b	32.5c	27.2d	28.8cd	29.9c	28.0cd	29.2c	26.6	50.7	3.8	31.5
ALA	42.7a	42.3a	33.9b	28.5c	22.6e	23.5ed	25.4d	22.7e	23.2e	20.7	42.7	4.4	26.3
VAL	48.7a	48.8a	40.1ab	35.8b	33.5b	34.1b	35.6b	34.1b	35.1b	31.3	48.8	8.8	36.3
ILE	33.5a	31.2a	26.3b	22.5c	18.5e	19.5ed	20.8cd	18.9ed	19.9ed	17.0	33.5	5.0	21.4
LEU	52.4a	49.6ab	40.9cd	35.1cd	26.7e	29.8ed	30.0ed	30.0ed	29.9ed	24.8	52.4	8.7	32.5
TYR	21.5a	21.5a	17.9b	15.9b	15.8b	16.1b	17.1b	15.2b	17.1b	14.4	21.5	6.2	16.9
PHE	29.1a	27.6ab	23.4cb	20.6cd	18.7d	21.2cd	20.4cd	18.2d	19.8cd	17.4	29.1	7.7	20.8
GAM	16.8cb	14.4c	14.0c	14.1c	25.8a	22.1b	25.9a	21.3b	19.3cb	14.0	29.8	9.5	21.2
HIS	8.1c	12.0c	11.1ab	5.4d	10.3ab	10.8ab	11.2a	10.9ab	9.6cb	5.4	12.0	8.0	10.3
ORN	0.0a	0.0a	0.0a	0.0a	1.5a	1.0a	1.0a	0.9a	0.4a	0.0	2.1	80.3	0.7
LYS	41.0a	39.6a	34.0b	27.8c	27.4c	28.5c	30.6cb	28.2c	28.2c	25.4	41.0	5.9	30.1
NH_3	108.9ab	119.9ab	80.1b	56.8b	112.0ab	105.8ab	89.2b	148.1a	119.3ab	56.8	169.4	20.1	109.9
ARG	22.9cb	25.8cb	21.4c	20.5c	27.3b	26.9b	30.9a	25.6cb	27.6ab	20.5	32.1	7.0	26.6
TRP	4.7ab	5.2a	4.3cb	3.6c	4.6ab	4.3cb	4.3cb	3.9c	4.5ab	3.6	5.3	8.7	4.4
N[e]	1	1	1	1	3	3	3	3	3	19	19	19	19

[a] VARiable; Nitrogen (Kjeldahl); CYH = cysteic acid, a measure of the original cystine and cysteine, determined in an oxidized sample; $METSO_2$ = methionine sulfone, a measure of original methionine, determined in an oxidized sample; GAM = γ-aminobutyric acid; the remaining amino acid symbols have their usual meanings; (the number of TRP determinations is twice that of the others).
[b] RP = raw peel, BOP = peel from boiled whole potato; MBP = peel from microwave cooked whole potato; BAP = peel from oven baked whole potato; from single replicate samples; and the values compared with each other and with those of the flesh replicates, values followed by the same letter are not significantly different at the p = 0.05 level.
[c] BF = Flesh from oven baked whole potato; RF = raw flesh; MBF = flesh from microwave cooked whole potato; BUF = flesh from boiled unpeeled whole potato; PBF = peeled boiled flesh; means of the replicate determinations; and the values compared with each other and with those of the peels, values followed by the same letter are not significantly different at the p = 0.05 level.
[d] Low = lowest value of the lot and highest value of the lot to give the range covered; CV = coefficient of variation (does not include treatment effects); and mean here is the mean value of all determinations.
[e] N = Number of determinations in the group (treatment) average.

Table 2—Total amino acid contents of raw and cooked peel and flesh of the Pontiac cultivar grown in the Red River Valley

	Micromoles amino acid per gram potato (dry basis)											
VAR[a]	BOP[b]	MBP[b]	BAP[b]	BUF[b]	RWP[b]	MBF[b]	BF[b]	PBF[b]	Low[c]	High[c]	CV[c]	Mean[c]
Nitrogen	1386a	1238b	929d	1049c	1036c	1035c	942d	858d	743	1420	4.0	1059
CYH (ox)	14.7a	14.5a	11.7b	11.4b	10.1cb	11.1cb	9.1c	9.7cb	8.9	15.1	9.4	11.5
ASP	142.3ab	148.9a	111.3c	138.0ab	142.5ab	139.1ab	135.7b	120.5c	105.1	154.1	4.6	134.8
$METSO_2$ (ox)	12.5a	11.0b	9.7b	10.9b	9.9b	9.8b	9.7b	10.0b	8.6	12.9	6.9	10.4
THR	36.0a	31.5b	27.8c	26.2cd	24.8ed	25.3cde	24.7ed	23.4e	21.6	38.2	5.1	27.5
SER	44.5a	46.0a	35.4b	31.1c	31.5c	30.6c	30.2c	28.0d'	27.4	46.5	3.5	34.7
GLU	93.1b	84.1b	69.4c	112.3a	114.2a	106.4a	110.1a	109.1a	63.6	115.3	6.8	99.9
PRO	35.6a	34.6a	25.4cb	25.9b	25.5cb	23.4cb	25.6cb	22.0c	20.4	36.1	7.5	27.2
GLY	48.8a	47.9a	40.3b	32.7c	32.9c	32.3c	31.7c	32.4c	30.6	51.9	5.6	37.4
ALA	43.6a	43.6a	34.3b	30.6c	27.3c	28.9c	29.8c	30.4c	27.1	46.1	5.4	33.6
VAL	49.6a	47.7a	39.4b	41.9b	38.4b	38.2b	40.3b	37.8b	35.1	51.6	6.5	41.7
ILE	32.1a	29.0b	25.1c	23.0cd	20.7d	21.4d	20.8d	20.8d	19.8	34.2	6.9	24.1
LEU	48.5a	45.7a	41.8b	34.6c	31.5c	32.7c	33.4c	31.5c	29.7	50.5	5.6	37.5
TYR	22.0a	21.6a	17.4b	16.3cb	15.8cb	15.9cb	14.7c	16.2cb	14.0	23.4	6.2	17.5
PHE	26.7a	26.2a	21.7b	20.2cb	19.0c	19.7cb	19.2c	19.8cb	17.7	27.9	6.0	21.6
GAM	19.9cb	15.5c	21.7b	26.8a	18.4c	20.3cb	27.3a	25.4ab	11.2	29.9	17.2	20.9
HIS	13.8a	2.4d	9.7cb	10.3b	9.6cb	9.5cb	8.7c	8.9c	1.7	14.3	7.3	9.1
ORN	0.19cb	0.00c	0.24abc	0.00c	0.21abc	0.61a	0.42ab	0.16cb	0.00	0.68	94.4	0.23
LYS	39.7a	41.5a	26.8cb	25.1c	29.1b	29.0b	26.8cb	27.1cb	24.5	43.1	6.3	30.6
NH_3	112.0ab	91.6abc	58.4c	101.7ab	119.9a	75.0cb	90.3abc	108.8ab	49.2	146.4	21.2	94.7
ARG	26.8a	25.4ab	20.6c	23.3cb	23.2cb	23.5cb	22.7cb	23.5cb	18.6	28.1	6.9	23.6
TRP	5.0a	4.8a	3.9b	3.8cb	3.5d	3.6cd	3.1e	3.7cbd	3.0	5.1	5.5	3.9
N[d]	3	3	3	3	3	3	3	3	24	24	24	24

[a] See footnote to Table 1.
[b] BOP = peel from boiled whole potato; MBP = peel from microwave cooked whole potato; BAP = peel from oven baked whole potato; BUF = flesh from boiled unpeeled whole potato; RWP = raw whole potato; MBF = flesh from microwave cooked whole potato; BF = flesh from oven baked whole potato; PBF = peeled boiled flesh; and means followed by the same letter are not significantly different at the p = 0.05 level.
[c] See footnote d under Table 1.
[d] N = Number of determinations in the group (treatment) average.

true picture is to be obtained. Under the conditions discussed here, the greater losses during cooking occur during the oven baking of the peel on whole potatoes or the boiling of peeled potatoes. Microwave cooking showed smaller losses than oven baking.

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