AMINO ACID PROFILE IN LATVIAN POTATO VARIETIES PREPARED BY VARIOUS COOKING METHODS

Irisa Murniece, Daina Karklina, Ruta Galoburda

Latvia University of Agriculture, Faculty of Food Technology
Liela Street 2, Jelgava, LV3001, Latvia, e-mail: irisamurniece@yahoo.com

Abstract

Potato consumption in Latvia is taking significant part from total vegetable amount therefore it is an important to focus attention on potato nutritional changes during mostly used heat treatment methods. In fact potato contains small amount of protein but it is high in nutritional quality – contains considerable amount of crucial amino acids which change notably during frying/backing process.

Consequently the aim of the research was to estimate changes in amino acid profile among various potato varieties prepared using various heat treatment processes.

Following Latvian potato varieties were selected: 'Brasla', 'Imanta', 'Zile', 'Madara' and 'Lenora'. Potatoes were prepared using different heat treatment methods: shallow frying (150±5 °C), deep fat frying (180±5 °C) and baking in oven (210±5 °C). The highest total amino acid content was found in raw potatoes of the variety 'Brasla' and crucial amino acid content in 'Lenora' on dry matter (DM) basis while the lowest both total and crucial amino acid amount in the variety 'Imanta'. Among the baked potatoes in the variety 'Lenora' total amino acid content was found as the highest but crucial amino acids – in the variety 'Madara' like in shallow and deep fat fried potatoes. For their part, similarly the lower amount of total amino acids – in the variety 'Brasla' and crucial amino acids in the variety 'Imanta'. In addition, the effect of type of heat treatment and kind of potato variety on each amino acid was studied. Comparing heat treatment types significant changes were discovered in Arginine (Arg), Aspartic acid (Asp), Phenylalanine (Phe), Tyrosine (Tyr), Isoleucine (Ile), Histidine (His, Lysine (Lys) and Valine (Val) while among varieties in Asp, Ile, Val, Glutamic acid (Glu), Methionine (Met) and Tyr.

Key words: potato varieties, amino acids, heat treatment methods

Introduction

The potato (*Solanum tubersoum L.*) originated in the Andes Mountains of South America where it has been an important food for 8,000 years and know is spread through the entire World (Harris, 1992). Potatoes have an important role in a healthy diet, as they are a good source of complex carbohydrate, dietary fibre, vitamin C and protein. Concerning the protein amount, potatoes in average contain about 2% when quality is considered to be excellent, e.g. amount of lysine in potatoes is similar to that in typical animal protein (Salunkhe *et al.*, 1998), but the nutritional value of potato protein varies with variety, storage and environmental conditions as well as the type of cooking (Lisinska, 1989; Harris, 1992). Traditionally, potatoes are a central component of warm meal in many European countries (Wandel *et al.*, 2001) and are prepared using various methods of cooking from where the traditional ones and well known are boiling, frying and baking (Salunkhe *et al*, 1998). Frying, especially deep fat frying has become the most popular preparation technology during the last few decades. In the research by Nordic and Baltic countries' authorities on the type of potato cooking methods, it was discovered that in Latvia consumption level of fried potatoes comparing with neighbour countries has been one of the highest (NorBaGreen, 2003). Out of that, in Latvia other cooking methods like shallow frying and baking in oven are famous as well. One of the explanations could be formation of desirable flavour, colour, taste and texture during frying and baking processess which can be pointed out by occurrence of Maillard reaction (Sanibal, 2004; Amrein, 2003). Reaction is based on the high temperature during heating process where the accumulated reducing sugars react with free amino acids in the tuber cells (Mottram *et al.*, 2002) and nutritional changes in amino acid content occur. Several amino acids, like Asp, Asn, Gln, Glu, Val and Lys, which are present in relatively minor amounts had been shown to be the most active amino acids in the Maillard reaction (Ashoor *et al.*, 1984; Akiko *et al.*, 2005) Therefore, the aim of the research was to evaluate the changes in amino acid profile during various heat treatment processes in several potato varieties selected and cultivated in Latvia.

Materials and Methods

In the cooperation with State Priekuli Plant Breeding Institute (Latvia) five table potato varieties almost in the same size were chosen: 'Lenora', 'Brasla', 'Imanta', 'Zile' and 'Madara' which are selected and cultivated under the control of the institute. Selected potato varieties were analysed after short period (2 weeks during sizing) of storage at temperature 4–6 °C and relative air humidity (RH) 80 %.

Washed and hand-peeled potato tubers were cut in three ways: for shallow frying potatoes were sliced into 0.7x1.0 and 3–4 cm long strips while for deep fat frying – into 0.6×0.6 and 4–5 cm long strips but potatoes prepared for oven frying were cut horizontally into halves. Control sample is raw potato.

Sunflower-seed oil was used for frying. Potatoes were baked in oven (210±5 °C), shallow fried on the pan (150±5 °C), and deep fat fried in the deep fat fryer (180±5 °C), (Fig. 1). Throughout the oven and deep fat frying procedure time/temperature was recorded by USB TC-08 Thermocouple Data Logger PICO-Technologist equipment (Fig. 1).

Amino acids were determined by AOAC official method 994.12, total protein content was determined by the Kjeldahl method (LVS ISO 5983:1997) and dry matter (DM) content by LVS ISO 6496:1999 and XM120 Precisa moisture analyser.

Figure 1. Time/temperature control with TC-08 Thermocouple Data Logger equipment

Obtained data were analysed by statistical software S-PLUS 6.1 Professional Edition. By means of specifying the differences between independent groups *Two-Way Analysis of Variance* and for the multiple comparisons of the means *Tukey* test was applied. Conclusions were done at 95% significance level.

Results and Discussion

In the research the amount of protein, DM content and 16 amino acids including seven essentail: Thr, Val, Met, Ile, Leu, Phe and Lys were determined in five various potato varieties prepared applying several heat treatment methods. To compare obtained amino acid values data were calculated on DM basis. The protein content is presented in g per 100 g of product (Table 1).

Table 1

Protein content in potato varieties prepared by several cooking methods, g 100 g $^{-1}$

Potato variety	Control	Baked in oven	Shallow fried	Deep fat fried
	Mean±SD	Mean±SD	Mean±SD	Mean±SD
'Brasla'	2.09±0.04	2.33±0.10	2.63±0.08	3.41±0.04
'Imanta'	1.68±0.07	2.11±0.11	2.13±0.10	4.76±0.13
'Lenora'	2.04±0.06	2.08±0.07	1.94±0.07	2.70±0.08
'Madara'	1.55±0.04	2.46±0.10	2.61±0.13	4.27±0.08
'Zile'	1.44±0.01	2.07±0.11	2.86±0.13	3.48±0.08

Among the potato varieties and cooking methods the highest protein content was found in the control samples of 'Brasla', among baked samples – 'Madara', shallow fried – 'Zile' and deep

fat fried – 'Imanta' while the lowest – in the control and baked samples of 'Zile' furthermore shallow fried and deep fat fried – 'Lenora'.
Changes of the protein content can be explained by occurrence of several reactions during pre-treatment and heat treatment at high temperature.
There are several amino acids which biological activity loses during heat treatment process therefore it is important to follow up the changes of the amino acids itself. Comparing the differences among samples by type of cooking methods (n=4) and potato varieties (n=5) per each type of amino acids (n=16) the differences was found $p<0.001$ within some of varieties and cooking methods (Table 2, 3).

Table 2

Differences of amino acid content among the potato varieties

Amino acid	'Brasla'	'Imanta'	'Lenora'	'Madara'	'Zile'
Aspartic acid (Asp)* **	A	A	B	B	AB
Glutamic acid (Glu)* **	A	B	B	B	AB
Valine (Val)* **	A	A	AB	B	A
Methionine (Met) **	A	A	B	AB	AB
Isoleucine (Ile)* **	A	A	B	B	AB
Tyrosine (Tyr)*	AB	A	AB	AB	AB

The same letter within each component is not significantly different at the 5 % level by the Tukey multiple-comparison test. * $p \leq 0.05$; ** $p \leq 0.01$; *** $p \leq 0.001$

Table 3

Differences of amino acid content per DM depending on the heat treatment method

Amino acid	Control	Baked in oven	Shallow fried	Deep fat fried
Aspartic acid (Asp) **	A	AB	AB	B
Valine (Val)*	A	AB	AB	B
Isoleucine (Ile)*	A	AB	B	B
Tyrosine (Tyr)* **	A	B	B	B
Phenylalanine (Phe) **	A	AB	B	B
Histidine (His)* **	A	B	B	AB
Lysine (Lys) **	A	AB	B	B
Arginine (Arg)*	A	AB	AB	B

The same letter within each component is not significantly different at the 5 % level by the Tukey multiple-comparison test. * $p \leq 0.05$; ** $p \leq 0.01$; *** $p \leq 0.001$

In table 4 can follow up the changes in the amount per each amino acid on DM basis between potato varieties prepared by several heat treatments.

Table 4

Amino acid content depending on type of heat treatment and potato variety, g 100 g $^{-1}$ dry matter

Potato varieties: **B** – 'Brasla', **I** – 'Imanta', **L** – 'Lenora', **M** – 'Madara', **Z** – 'Zile'

Amino acids	Control					Baked in oven					Shallow fried					Deep fat fried				
Variety	**B**	**I**	**L**	**M**	**Z**	**B**	**I**	**L**	**M**	**Z**	**B**	**I**	**L**	**M**	**Z**	**B**	**I**	**L**	**M**	**Z**
Asp	1.32	1.34	1.85	1.57	1.57	1.20	1.10	1.61	1.67	1.22	1.11	1.08	1.56	1.72	1.41	0.88	1.03	1.17	1.41	1.35
Thr	0.28	0.30	0.33	0.34	0.29	0.33	0.27	0.29	0.31	0.26	0.30	0.23	0.25	0.35	0.40	0.26	0.23	0.20	0.28	0.20
Ser	0.29	0.28	0.31	0.28	0.29	0.25	0.21	0.29	0.28	0.29	0.21	0.20	0.29	0.31	0.40	0.22	0.21	0.22	0.26	0.20
Glu	1.05	1.28	1.88	1.61	1.28	1.00	1.54	1.57	1.25	0.97	0.93	1.51	1.52	1.75	1.32	0.79	1.45	1.27	1.36	0.77
Pro	0.20	0.23	0.19	0.22	0.21	0.25	0.24	0.21	0.21	0.23	0.18	0.23	0.22	0.28	0.37	0.26	0.26	0.16	0.23	0.16
Gly	0.19	0.22	0.20	0.18	0.16	0.19	0.18	0.16	0.21	0.16	0.15	0.16	0.18	0.22	0.28	0.18	0.17	0.14	0.19	0.12
Ala	0.21	0.24	0.22	0.27	0.22	0.22	0.18	0.25	0.21	0.23	0.21	0.20	0.25	0.25	0.37	0.22	0.21	0.22	0.23	0.14
Val	0.31	0.22	0.31	0.38	0.22	0.22	0.18	0.29	0.31	0.26	0.21	0.20	0.33	0.31	0.28	0.18	0.19	0.26	0.28	0.22
Met	0.09	0.07	0.12	0.12	0.09	0.07	0.08	0.13	0.12	0.09	0.09	0.08	0.14	0.11	0.11	0.08	0.07	0.09	0.09	0.09
Ile	0.17	0.15	0.21	0.21	0.18	0.14	0.12	0.16	0.21	0.19	0.12	0.14	0.18	0.19	0.15	0.13	0.13	0.14	0.19	0.16
Leu	0.38	0.42	0.46	0.34	0.41	0.36	0.33	0.33	0.42	0.45	0.33	0.34	0.29	0.41	0.34	0.33	0.30	0.26	0.35	0.37
Tyr	0.38	0.23	0.42	0.41	0.36	0.22	0.18	0.25	0.24	0.19	0.21	0.20	0.29	0.22	0.31	0.26	0.19	0.22	0.21	0.22
Phe	0.31	0.31	0.32	0.25	0.23	0.25	0.21	0.25	0.24	0.26	0.21	0.20	0.22	0.22	0.25	0.20	0.19	0.22	0.21	0.24
His	0.20	0.21	0.21	0.20	0.25	0.14	0.12	0.16	0.17	0.13	0.12	0.11	0.18	0.16	0.15	0.13	0.11	0.12	0.12	0.12
Lys	0.36	0.28	0.46	0.32	0.36	0.31	0.27	0.29	0.31	0.32	0.27	0.25	0.29	0.31	0.31	0.26	0.26	0.22	0.28	0.31
Arg	0.59	0.28	0.50	0.49	0.41	0.33	0.39	0.45	0.35	0.29	0.51	0.34	0.40	0.28	0.28	0.37	0.30	0.20	0.26	0.27
Essential	1.91	1.76	2.19	1.97	1.79	1.69	1.45	1.74	1.93	1.83	1.52	1.44	1.70	1.90	1.83	1.45	1.37	1.39	1.68	1.59
Total	8.26	6.07	7.98	7.20	6.55	5.50	5.57	6.69	6.53	5.53	5.14	5.47	6.60	7.10	6.71	4.77	5.29	5.11	5.94	4.95

Some of amino acids play an important role during Maillard reaction like Lys which is one of the most essential amino acids and is present in considerable amount in the potatoes. Another important amino acid is Asp which is one of the main precursors of acrylamide formation through the Maillard reaction. Losses of Tyr can be explained by the oxidation in the presence of oxygen during potatoes cutting prior to frying.

Conclusions

1. There are considerable differences in several amino acid profiles among potato varieties and type of heat treatment was found. Significance within the type of the potato variety was found in Asp, Glu, Val, Met, Ile and Tyr while within the type of heat treatment applied in Asp, Val, Ile, Tyr, Phe, His, Lys and Arg.
2. The change in Lys was discovered in type of heat treatment however differences within the varieties were not significant as well as Glu and Val while Asp changes were found both within the potato variety and type of heat treatment.
3. From the nutritional point of view, fair essential amino acid content in the control samples was in 'Lenora', in baked, shallow fried and deep fat fried potato samples of the variety 'Madara'.

References

1. Akiko, O.T., Chie, M.E., Yoshihiro, C., Hiroshi, O., Hiroshi, Y., Mitsuru, Y., Akira, K., Shogo, T., Shigenobu, T., Takahiro, N., Hiroaki, Y., Motoyuki, M. (2005) Change in content of sugars and free amino acids in potato tubers under short-term storage at low temperature and the effect on acrylamide level after frying. *Biosc. Biotechnol. Biochem*., 69, pp. 1232–1238;
2. Amrein, T.M., Bachmann, S., Noti A. *et al* (2003) Potential of acrylamide formation, sugars, free asparagine in potatoes: a comparison of cultivars and farming systems. *Agric. Food Chem.*, 51, pp. 5556–5560;
3. Ashoor, S. H., Zent, J.B. (1984) Maillard browning of common amino acids and sugars. *Food Sci*., 49, pp. 1206–1207;
4. Harris P. M. *The Potato Crop*. (1992) New York, Madras: Chapman & Hall, pp. 907
5. Lisinska, G., Leszczynski, W. (1989) Potato Science and Technology. Elsevier Applied Science, London, UK.
6. Mottram, D., Wedzicha, B., Dodson, A. (2002) Acrylamide is formed in the Maillard reaction. *Nature*, 419, pp. 448–449.
7. Salunkhe D.K., Kadam S.S. Handbook of Vegetable Science and Technology: production, composition, storage and processing. (1998) New York, New York: Marcel Dekker, pp. 721.
8. Sanibal, E.A.A., Mancini-Filho, J. (2004) Frying Oil and Fat Quality Measured by Chemical, Physical, and Test Kit Analysis. *American Oil Chemists' Society*, 81, 9, pp. 847–852
9. The NORBAGREEN 2002 study (2003) Consumption of vegetables, potatoes, fruit, bread and fish in the Nordic and Baltic countries, Nordic Council of Ministers, TemaNord, pp. 907;
10. Wandel, M., Fagerli, R., Kjaernes, U. (2001) Changes in potato consumption in different stages of life in Norway, *Appetite*, 36, pp. 211–223.