Is D-Methionine the only D-amino acid to be converted into the L-form?

Methionine is the first limiting amino acid (AA) in poultry and one of the first limiting amino acids in other species.

DL-Methionine became commercially available and became a popular source of methionine after being shown that it is more efficient than the liquid form.

by Dr Behnam Saremi, Head of Technical Center, CJ Europe GmbH. www.cjbio.net

It was believed that D-Methionine is 90% converted to L-Methionine and that DL-Methionine is 95% bioavailable although there were clear data about DL-Methionine being excreted at 10% and being oxidised at 5.5%. This did not get enough attention because L-Methionine was not commercially available.

Nevertheless, L-Methionine became commercially available in 2015 as the only natural source of methionine. L-Methionine can be directly utilised for growth and physiological needs (a game changer for the industry). L-Methionine is available in high volumes produced from renewable resources.

Crystalline L-Methionine provides the opportunity to relieve farm animals of the unnecessary job of converting the isomers and precursors of methionine to L-Methionine. The question is do farm animals have to convert only D-Methionine to the L-form?

D-amino acids (D-AAs)

It is a widely accepted fact that plants harbour free D-AAs as they could be identified in different plant species and tissues. Free D-AAs were found in the range of 0.2% up to 8% relative to the corresponding L-AAs in plants.

Processing (heating, alkaline, and acid treatment) increases the content of D-AAs. Some insects, worms and marine invertebrates also contain substantial quantities of D-AAs, for example, quantities of D-AAs occurring in marine shellfish can exceed 1%. On examination of free D-AAs in milk, fermented milk, fresh cheese and curd cheese, Bruckner and Hausch (1990) established that considerable quantities of D-AAs occur both in raw milk and in fermented dairy products manufactured from it. The empirical data are presented in Table 1.

Table 1. Free amino acid content of milk and fermented milk products[1] (mg/100 g). [1]% D=(D/D+L)×100. [2]Asx=Asp+Asn, calculated as aspartic acid; Glx=Glu+Gln, calculated as glutamic acid. [3]% D-allo-Ile=D-allo-Ile/(D-allo-Ile+L-allo-Ile+D-Ile+L-Ile). [4]AA = amino acids.

Amino acid	Raw/ pasteurised milk	Kefir	Yoghurt	Curdled milk	Fresh cheese	Hard cheese
D-Ala	0.003-0.012	0.31	1.35	0.46	1.07	2.48
D-Asx	0.017-0.038	0.35	0.31	0.25	0.38	0.37
D-Glx[2]	0.070-0.190	0.50	1.09	0.58	0.75	2.13
D-Val[2]	–	0.03	–	0.04	0.09	–
D-Leu	–	0.11	–	0.15	0.16	–
D-Lys	–	0.09	–	0.13	0.44	1.49
D-allo-Ile[3]	–	0.07	–	0.02	–	0.27
D-Ser	–	0.02	–	–	–	–
D-Pro	–	–	–	–	–	2.18
Free AAs[4] (mg/100g)	3.29-10.3	26.2	28.4	36.8	39.2	159
Free D-AAs (mg/100g)	0.09-0.24	1.48	2.75	1.63	2.89	8.92

Treated product (Untreated control; ref.)	Amino acids					
	Asp	Ala	Phe	Leu	Val	Met
Toast[2]	10.5	2.8	2.4	2.7	1.1	1.7
Bread	5.6	2.4	2.3	3.2	0.9	2.3
Extruded soya bean meal	7.6	2.2	2.4	2.7	0.8	–
Soya bean meal	4.4	2.5	2.8	1.4	1.0	–
Soya protein[3]	27.7	9.9	19.7	3.1	1.0	18.2
Untreated	0.5	0.2	0.5	0.2	0.03	0.3
Zein[4]	40.2	17.6	31.3	5.0	2.9	19.5
Not heat treated	3.4	0.7	2.2	0.7	0.4	0.9
Hamburger[5]	5.5	2.8	2.7	3.2	1.5	2.9
Raw meat	6.2	3.2	2.8	3.1	1.6	2.4
Chicken muscle[6]	22.4	0.5	0.4	0.1	–	–
Raw chicken	2.9	–	–	–	–	–
Bacon, 180°C[7]	10.7	2.4	3.1	3.1	1.6	–
Not heat treated	2.4	–	1.8	3.3	0.7	–
Casein, 230°C[7]	31.0	12.0	–	7.0	4.4	–
Not heat treated	3.1	1.5	–	–	–	–

Table 2. D-AA content of various foodstuffs (%)[1]. [1]D-AA % = (D/D+L)×100, [2]The white bread was heated for 1 minute 45 seconds, only its surface having been analysed, [3]Three hours, 65°C, 0.1N NaOH. [4]Four hours, 85°C, 0.2N NaOH. [5]The hamburger was fried on both sides for four minutes. The temperature of the pan was 250±C. Only the surface was analysed. [6]Heating at 121°C for four hours. [7]Heated for 20 minutes.

The feed industry uses a mixture of different processing technologies such as pelleting, extrusion, pressure, etc, similar to the food industry.

Table 2 gives the D-AA content of various processed foodstuffs in comparison with untreated controls. Heat treatment or combined heat and alkali treatment in every case gave rise to D-AAs in measurable quantities. The highest D-aspartic acid content (31%) was determined in the casein heated to 230°C for 20 minutes.

Conclusion

Plants contain the D-form of AAs and feed processing makes the content of D-AAs even higher. Thus, there is a hidden pressure on the enzymatic machinery which is supposed to convert D-AAs to the L-form. The question is why one should exert an additional pressure to the cellular system of farm animals in order to convert D-Methionine to L-Methionine?

Farm animals already have a high metabolic rate because of their fast growth. Nutritionists can reduce the stress on the farm animals by means of using a commercially available L-Methionine.

Farm animals have to convert not only D-Methionine to the L-form but also other D-AAs which exist in the plants or the ones in which their concentrations are increased because of processing the raw materials or complete feed ■

References are available from the author on request