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Comprehensive review of scientific literature pertaining to nitrogen protein conversion factors

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CONTENTS

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Comprehensive review of scientific literature pertaining to nitrogen protein conversion factors

Foreword

Further to a call from the Codex Committee on Nutrition and Foods for Special Dietary Uses (CCNFSDU) to provide scientific justification for the use of specific protein conversion factors, the IDF has prepared a comprehensive review of scientific literature on nitrogen conversion factors. The review shows that there is substantial scientific evidence to support a specific nitrogen protein conversion factor for specific sources of protein (e.g. milk and milk products, soy and soy products etc.), rather than to introduce a single inaccurate nitrogen conversion factor, as has been envisaged in the revision of the Codex Standard for Infant Formula.

As the debate continues, IDF would like to share its findings with interested parties and is therefore publishing its review of scientific literature in this issue of the Bulletin of the IDF.

IDF is grateful to all National Committees and other parties that contributed to this review.

Christian Robert
IDF Director General
March 2006

1 Summary

The Codex Committee on Nutrition and Foods for Special Dietary Uses (CCNFSDU) is developing a Draft Revised Standard for Infant Formula that stipulates numerical values for minimum and maximum content of protein as part of the section on essential composition.

The 27th Session of the CCNFSDU, (21-25 November 2005) was not able to find a consensus on the question of nitrogen conversion factors pertaining to the calculation of protein contents in infant formula. It was agreed to retain in square brackets the footnote 2* that contains a proposed conversion factor of 6.25 for all nitrogen sources as part of Section 3 on the Codex Draft Revised Standard for Infant Formula. CCNFSDU requested Codex members and observers to provide scientific justification for the use of specific nitrogen protein conversion factors by 15 February 2006. (Codex ALINORM 06/29/26, para 80 – 83, para. 106 and Appendix IV/A).

*) Wording of the footnote:

"[For the purpose of this standard, the calculation of the protein content should be based on N x 6.25, unless a scientific justification is provided for the use of a different conversion factor for a particular nitrogen source.] The protein levels set in this standard are based on a nitrogen conversion factor of 6.25."

In response to the CCNFSDU request, IDF has conducted a comprehensive review of the scientific literature pertaining to nitrogen protein conversion factors.

As a result, IDF has identified the following conversion factors for particular sources of protein in infant formulae:

- milk and milk products: 6.34 to 6.38
- soy and soy products: 5.7 to 5.8

IDF was not able to find any justification in the scientific literature for use of a universal protein conversion factor of 6.25 as has been proposed and is still retained by the European Society for Paediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN) / International Expert Group (IEG), which is the body that has been asked to act as a scientific-technical advisor to CCNFSDU for the development of the Draft Revised Standard for Infant Formula.

IDF concludes that there exists no scientific justification to support the proposed change of the original protein source nitrogen conversion factor for soy from 5.71 to 6.25, or to change the internationally recognized nitrogen conversion factor for milk protein from 6.38 to 6.25.

2 Comprehensive review of scientific literature pertaining to nitrogen protein conversion factors

A. Findings from the reports of FAO/WHO (5, 9)

A number of scientific studies from FAO/WHO dated from 1970 to 2003 have been analyzed.

According to a recent report of FAO/WHO (5), it is recommended to use a specific factor for nitrogen content when the specific factor is known. For foods that are not included in the list (see Table 1 below) the protein content is derived by multiplying the nitrogen content by the factor of 6.25 on the assumed 16% average nitrogen content of protein. The report further states that it is common knowledge that this 16% average is not accurate, and, therefore, the figure for protein calculated by this method is imprecise.

Table 1. Specific factors for the conversion of nitrogen content to protein content (selected foods) (Sources : 5, 9)

Foodstuff	Nitrogen Conversion Factor
Wheat meal	5.83
Flour	5.70
Pasta	5.70
Bran	6.31
Rice	5.95
Rye/Barley/Oats	5.83
Ground nuts	5.46
Soybean/Seeds/Flour/Products	**5.71**
Milk	**6.38**
Cheese	6.38
Whey cheeses	6.38
Other foodstuffs not listed	6.25
Mixed protein sources (foodstuffs)	6.25

B. Overview of scientific data on protein sources of different origin and corresponding nitrogen conversion factors

These tables gather the scientifically analyzed nitrogen conversion factors and percentages of Nitrogen for different types of samples and their references :

- Vegetable and nut proteins (Table 2)
- Dairy proteins (Table 3)
- Dairy components (Table 4)

Table 2. Referenced scientifically analyzed samples of **vegetable and nut protein sources** currently available.

Product Name/Class	Nitrogen Conversion Factor (NCF)	% N in Protein	Ref No.	References : scientific publication, analytical data, legislation
Soy Isolate	5.6-5.8***	17.54	1	De Rham, O. (1982) Lebensm. Wiss. Technol. 15, 226-231.
Soy Meal	6.30*** No amides	15.87	2	Boisen, S. Bech-Andersen, S.and Eggum B.O. (1987) Acta Agric.Scand. 37, 299-304
Soy Meal	5.65*** With Amides	17.70	2	Boisen, S. Bech-Andersen, S.and Eggum B.O. (1987) Acta Agric.Scand. 37, 299-304
Soy Meal	5.49***	18.21	2	Boisen, S. Bech-Andersen, S.and Eggum B.O. (1987) Acta Agric.Scand. 37, 299-304
Soy (Glycine max)	5.75-5.8***	17.24	1	De Rham, O. (1982) Lebensm. Wiss. Technol. 15, 226-231.
Soy (Glycine max)	5.38-5.67***	18.18	3	Mosse, J. (1990) J. Agric. Food Chem. 38, 18-24.
Soy (Glycine max)	5.71	17.51	4	Jones, D.B. (1941) United States Department of Agriculture, Circular No. 183. (Original version 1931).
Soy (Glycine max)	5.71	17.51	5	FAO/WHO (2003) FAO food and nutrition paper 77, Rome, ISSN 02544725
Soy (Glycine max)	5.71	17.51	6	European Commission Directive 91/321/EEC of 14 May 1991 on infant formulae and follow-on formulae.
Soy (Glycine max)	5.71	17.51	7	European Commission Directive 96/4/EC of 16 February 1996 is an amendment to directive 91/321/EEC
Soy (Glycine max)	5.71	17.51	8	Leatherhead Food Research Association. Analytical Methods Manual. 1996. Nitrogen (or Total Protein) Content by Kjeldahl.
Soy (Glycine max)	5.71	17.51	9	FAO/WHO (1970) FAO Nutritional Study 24, Rome
Soy (Glycine max)	5.76	17.36	10	Morr C.V. (1982) Food Sci. 47, 1751
Soy (Glycine max)	5.76	17.36	3	Mosse, J. (1990) J. Agric. Food Chem. 38, 18-24.
Soy Flour	5.70	17.54	11	AOAC 945.39

Table 2. Referenced scientifically analyzed samples of **vegetable and nut protein sources** currently available. (continued)

Product Name/Class	Nitrogen Conversion Factor (NCF)	% N in Protein	Ref No.	References : scientific publication, analytical data, legislation
Soy Flour	5.71	17.51	9	FAO/WHO (1970) FAO Nutritional Study 24, Rome
Soy Products	5.71	17.51	9	FAO/WHO (1970) FAO Nutritional Study 24, Rome
Brazil Nut (Bertholletia excelsa)	6.97***	14.35	12	Chunhieng, T., Goli, T., Piombo, G., Pioch, D., Brochier, J., and Montet, D. (2004) Bois Forets Trop. 280, 91-98
Casava Root (Manihot esculenta)	4.75-5.87***	21.05-17.24	13	Yeoh, H., and Truong, V. (1996) J. Sci. Food Agric. 70, 51-54
Corn (Zea mays)	5.77***	17.33	14	Baudet, J., Huet, J. C., and Mosse, J. (1986) J. Agric. Food Chem. 34, 365-370
Corn (Zea mays)	5.89***	16.98	15	Notheisz, K. (1983) Cereal Res. Comm.11, 57-58
Corn (Zea mays)	6.14***	16.29	15	Notheisz, K. (1983) Cereal Res. Comm.11, 57-58
Corn (Zea mays)	6.39***	15.65	15	Notheisz, K. (1983) Cereal Res. Comm.11, 57-58
Corn (Zea mays)	6.28***	15.92	15	Notheisz, K. (1983) Cereal Res. Comm.11, 57-58
Mushrooms (Basidiomycetes)	4.70***	21.28	16	Mattila, P., Salo Vaananen, P., Konko, K., Aro, H., and Jalava, T. (2002) J. Agric. Food Chem. 50, 6419-6422
Pea (Pisium sativium)	5.52***	18.12	17	Holt, N. W., and Sosulski, F. W. (1979) Can J of Plant Sci. 59, 653-660
Peanut (Arachis hypogaea)	5.46***	18.31	18	Misra, J. B. (2001) Peanut Sci. 28, 48-51
Potato (Solanum tuberosum)	6.24***	16.03	19	van Gelder, W. M. J. (1981) Potato Res. 24, 423-425
Processed Red Kidney Beans	5.63-5.67***	17.76-17.64	20	Wu, W., Williams, W. P., Kunkel, M. E., Acton, J. C., Huang, Y., Wardlaw, F. B., and Grimes, L. W. (1995) J. Food Sci. 60, 854-857
Rye (Secale cereale)	5.52***	18.12	21	Baudet, J., Huet, J. C., and Mosse, J. (1987) Agronomie 7, 813-820
Sorghum (Sorghum vulgare)	5.81***	17.21	22	Mosse, J., Huet, J. C., and Baudet, J. (1988) Cereal Chem. 65, 271-277
Triticale (Triticale sp.)	5.36***	18.66	23	Rakowska, M., and Ochodzki, P. (1992) Polish Jour of Food and Nutrition Sci.1, 23-29

Table 2. Referenced scientifically analyzed samples of **vegetable and nut protein sources** currently available. (continued)

Product Name/Class	Nitrogen Conversion Factor (NCF)	% N in Protein	Ref No.	References : scientific publication, analytical data, legislation
Wheat (Triticum aestivium)	5.33-5.56***	18.76-17.99	24	Mosse, J., J. C. Huet and J. Baudet. (1985) J. Cereal Sci. 3, 115-130.
Wheat Flour	5.61***	17.82	25	Tkachuk, R. (1966) Cereal Chem. 43, 223-225
Barley (Hordeum vulgare)	5.83	17.15	9	FAO/WHO (1970) FAO Nutritional Study 24, Rome
Bran	6.31	15.85	9	FAO/WHO (1970) FAO Nutritional Study 24, Rome
Brazil Nut (Bertholletia excelsa)	5.46	18.32	10	AOAC 979.09
Corn (Zea mays)	6.25	16.00	10	AOAC 979.09
Groundnuts	5.46	18.32	9	FAO/WHO (1970) FAO Nutritional Study 24, Rome
Oats (Avena sativa)	5.83	17.15	9	FAO/WHO (1970) FAO Nutritional Study 24, Rome
Others foodstuffs	6.25	16.00	9	FAO/WHO (1970) FAO Nutritional Study 24, Rome
Pasta	5.70	17.54	9	FAO/WHO (1970) FAO Nutritional Study 24, Rome
Peanut (Arachis hypogaea)	5.46	18.32	10	AOAC 979.09
Rice (Oriza sativa)	5.95	16.81	9	FAO/WHO (1970) FAO Nutritional Study 24, Rome
Rye (Secale cereale)	5.83	17.15	9	FAO/WHO (1970) FAO Nutritional Study 24, Rome
Wheat (Triticum aestivium)	5.70	17.54	26	Osborne B. G., The determination of protein in cereals, in Developments in food proteins, Elsevier applied science publishers, 1986
Wheat (Triticum aestivium)	5.70	17.54	10	AOAC 979.09
Wheat Flour	5.70	17.54	10	AOAC 979.09
Wheat Flour	5.70	17.54	9	FAO/WHO (1970) FAO Nutritional Study 24, Rome
Wheat Meal	5.83	17.15	9	FAO/WHO (1970) FAO Nutritional Study 24, Rome
Notes	*** Calculated from amino acid data			

Table 3. Referenced scientifically analyzed samples of **dairy protein sources** currently available.

Product Name/Class	Nitrogen Conversion Factor (NCF)	% N in Protein	Ref No.	References : scientific publications, analytical data, national legislation
Raw Milk	6.38	15.67	27	Hammarsten, O. (1883) Z. physiol. Chem. 7, 227
Milk and dairy products	5.94	16.84	28	Salo-Vaananen and Koivistoinen, (1996) Food Chemistry 57, 27-31
Milk	6.38	15.67	29	Jones, D.B. (1941) United States Department of Agriculture, Circular No. 183. (Original version 1931).
Milk	6.35 with carbohydrate	15.75	30	van Boekel M.A.J.S. and B. Ribadeau Dumas (1987) Neth. Milk Dairy J. 41, 281-284
Milk	6.34 with carbohydrate	15.76	31	Karman A.H. and van Boekel M.A.J.S. (1986) Neth. Milk Dairy J. 40, 315-336
Milk	6.34	15.76	32	Grappin R. et Ribadeau-Dumas B. Analytical Methods for milk proteins in Advanced Dairy Chemistry, Edited by P.F. FOX, Elsevier Applied Science, 1992
Milk and milk products	6.38	15.70	33	Adrian et al, la science alimentaire de A à Z, Editions Lavoisier , 1995
Milk	6.35	15.60	34	Grappin R. et al, Analytical Methods in Encyclopedia of dairy sciences, Elsevier Science, 2002
Milk	6.38	15.67	5	FAO/WHO (2003) FAO food and nutrition paper 77, Rome, ISSN 02544725
Milk Chocolate Flavored	6.38	15.67	35	AOAC 939.02 (TNx2xNCF)1.07
(acid) Casein	6.36 with carbohydrate	15.73	30	van Boekel M.A.J.S. and B. Ribadeau Dumas (1987) Neth. Milk Dairy J. 41, 281-284
(acid) Casein	6.34 with carbohydrate	15.76	31	Karman A.H. and van Boekel M.A.J.S. (1986) Neth. Milk Dairy J. 40, 315-336
(acid) Whey	6.28 with carbohydrate	15.92	30	van Boekel M.A.J.S. and B. Ribadeau Dumas (1987) Neth. Milk Dairy J. 41, 281-284
(acid) Whey	6.30 with carbohydrate	15.88	31	Karman A.H. and van Boekel M.A.J.S. (1986) Neth. Milk Dairy J. 40, 315-336
Rennet whey	6.41 with carbohydrate	15.59	30	van Boekel M.A.J.S. and B. Ribadeau Dumas (1987) Neth. Milk Dairy J. 41, 281-284
Rennet whey	6.45 with carbohydrate	15.5	31	Karman A.H. and van Boekel M.A.J.S. (1986) Neth. Milk Dairy J. 40, 315-336
Whey powders	6.38	15.67	32	Codex Stan A15 – 1995 Rev. 1 – 2003
Edible Casein products	6.38	15.67	33	Codex Stan A18 – 1995 Rev. 1 – 2001
evaporated milks	6.38	15.67	34	Codex Stan A3 – 1971 Rev. 1 – 1999

Table 3. Referenced scientifically analyzed samples of **dairy protein sources** currently available. (continued)

Product Name/Class	Nitrogen Conversion Factor (NCF)	% N in Protein	Ref No.	References : scientific publications, analytical data, national legislation
sweetened condensed milks	6.38	15.67	35	Codex Stan A4 – 1971 Rev. 1 – 1999
Milk powder	6.38	15.67	36	Codex Stan A5 – A10
Fermented milks	6.38	15.67	37	Codex Stan 243 – 2003
Milk	6.38	15.67	38	ISO 8968 -1 | IDF20-1 Milk. Determination of nitrogen content. Kjeldahl Method
Milk	6.38	15.67	39	AOAC 991.23
Processed Cheese	6.38	15.67	40	ISO | IDF25. Processed cheese products. Protein Determination
Milk and milk products	6.38	15.67	41	European Regulation n° 213/2001 of 9 January 2001
Milk	6.38	15.67	42	British Standards BS 1741: Part 1:1968 Milk
Liquid Milk	6.38	15.67	43	British Standards BS 1741: Part 7:1963 Liquid Milk
Dried Milk	6.38	15.67	44	British Standards BS 1743: Part 5: 1968 Dried Milk
Cheese	6.38	15.67	45	British Standards BS 770: Part 8: 1987 Cheese.
Cheese	6.38	15.67	46	AOAC 920.123
Liquid milks	6.38	15.67	47	AOAC 920.105
Dried milk	6.38	15.67	48	AOAC 930.29
Sweetened condensed milks	6.38	15.67	49	AOAC 920.115
Evaporated milk	6.38	15.67	50	AOAC 945.48
Milk and dairy products	6.38	15.67	8	Leatherhead Food Research Association. Analytical Methods Manual. 1996. Nitrogen (or Total Protein) Content by Kjeldahl.
Whey protein concentrate	6.38	15.67	51	J Adler-Nissen. Enzymic Hydrolisis of food proteins. Elsevier Applied Science. (1988) 15-17
Caseins and caseinates	6.38	15.67	52	IDF 92. Caseins and Caseinates. Determination of protein content
Cream	6.38	15.67	53	AOAC 920.109
Ice Cream and Frozen Desserts	6.38	15.67	54	AOAC 930.06

Table 3. Referenced scientifically analyzed samples of **dairy protein sources** currently available. (continued)

Product Name/Class	Nitrogen Conversion Factor (NCF)	% N in Protein	Ref No.	References : scientific publications, analytical data, national legislation
Infant Formulae	6.38	15.67	55	AOAC 986.25
Skim Milk Powder	6.91*** No Amides	14.47	2	Boisen, S. Bech-Andersen, S.and Eggum B.O. (1987) Acta Agric.Scand. 37, 299-304
Skim Milk Powder	6.13*** With Amides	16.31	2	Boisen, S. Bech-Andersen, S.and Eggum B.O. (1987) Acta Agric.Scand. 37, 299-304
Skim Milk Powder	5.75***	17.39	2	Boisen, S. Bech-Andersen, S.and Eggum B.O. (1987) Acta Agric.Scand. 37, 299-304
Cow's milk protein	6.38	15.67	56	Commission Directive 91/321/EEC of 14 May 1991 on infant formulae and follow-on formulae.
Whey Powder	6.38	15.67	57	Codex Stan 234 – 1999 Codex Recommended Methods of Analysis and Sampling
Milk	6.38	15.67	58	Codex Stan 1-1985 (Rev. 1-1991, amended in 1999,2001,2003 and 2005) Codex General Standard for the Labelling of Prepackaged Foods
Skimmed Milk Powder	6.38	15.67	59	European Commission Regulation (EC) No 322/96 of 22 February 1996 laying down detailed rules of application for the public storage of skimmed-milk powder (Official Journal L 045 , 23/02/1996 P. 0005 - 0023)
Milk	6.38	15.67	60	European Council Regulation (EC) No 2597/97 of 18 December 1997 laying down additional rules on the common organization of the market in milk and milk products for drinking milk (Official Journal L 351 , 23/12/1997 P. 0013 - 0015)
Cow's milk protein	6.38	15.67	61	Commission directive 96/4/EC of 16 February 1996 is an amendment to directive 91/321/EEC
Infant Formula	6.38	15.67	61	Commission directive 96/4/EC of 16 February 1996 is an amendment to directive 91/321/EEC
Notes	*** Calculated from amino acid data			

Table 4. Referenced scientifically analyzed samples of **dairy protein components** currently available.

Component Name	Nitrogen Conversion Factor (NCF)	% N in Protein	Ref No.	References : scientific publications, analytical data, national legislation
αs1- CN	6.36***	15.71	30	van Boekel M.A.J.S. and B. Ribadeau Dumas (1987) Neth. Milk Dairy J. 41, 281-284
αs1- CN	6.34***	15.77	31	Karman A.H. and van Boekel M.A.J.S. (1986) Neth. Milk Dairy J. 40, 315-336
αs2- CN	6.29***	15.89	30	van Boekel M.A.J.S. and B. Ribadeau Dumas (1987) Neth. Milk Dairy J. 41, 281-284
αs2- CN	6.30***	15.83	31	Karman A.H. and van Boekel M.A.J.S. (1986) Neth. Milk Dairy J. 40, 315-336
β-CN	6.37***	15.70	30	van Boekel M.A.J.S. and B. Ribadeau Dumas (1987) Neth. Milk Dairy J. 41, 281-284
β-CN	6.34***	15.76	31	Karman A.H. and van Boekel M.A.J.S. (1986) Neth. Milk Dairy J. 40, 315-336
κ-CN	6.35***	15.74	30	van Boekel M.A.J.S. and B. Ribadeau Dumas (1987) Neth. Milk Dairy J. 41, 281-284
κ-CN	6.38***	15.67	31	Karman A.H. and van Boekel M.A.J.S. (1986) Neth. Milk Dairy J. 40, 315-336
γ-CN	6.34***	15.78	30	van Boekel M.A.J.S. and B. Ribadeau Dumas (1987) Neth. Milk Dairy J. 41, 281-284
γ-CN	6.30***	15.87	31	Karman A.H. and van Boekel M.A.J.S. (1986) Neth. Milk Dairy J. 40, 315-336
β-LG	6.29***	15.91	30	van Boekel M.A.J.S. and B. Ribadeau Dumas (1987) Neth. Milk Dairy J. 41, 281-284
β-LG	6.38***	15.68	31	Karman A.H. and van Boekel M.A.J.S. (1986) Neth. Milk Dairy J. 40, 315-336
α-LA	6.25***	15.99	30	van Boekel M.A.J.S. and B. Ribadeau Dumas (1987) Neth. Milk Dairy J. 41, 281-284
α-LA	6.14***	16.29	31	Karman A.H. and van Boekel M.A.J.S. (1986) Neth. Milk Dairy J. 40, 315-336
SA	6.07***	16.46	30	van Boekel M.A.J.S. and B. Ribadeau Dumas (1987) Neth. Milk Dairy J. 41, 281-284
SA	6.07***	16.46	31	Karman A.H. and van Boekel M.A.J.S. (1986) Neth. Milk Dairy J. 40, 315-336
Ig	6.20***	16.14	30	van Boekel M.A.J.S. and B. Ribadeau Dumas (1987) Neth. Milk Dairy J. 41, 281-284
Ig	6.20***	16.14	31	Karman A.H. and van Boekel M.A.J.S. (1986) Neth. Milk Dairy J. 40, 315-336
PP5, 8F, 8S	6.54***	15.30	30	van Boekel M.A.J.S. and B. Ribadeau Dumas (1987) Neth. Milk Dairy J. 41, 281-284
PP5, 8F, 8S	6.54***	15.30	31	Karman A.H. and van Boekel M.A.J.S. (1986) Neth. Milk Dairy J. 40, 315-336

Table 4. Referenced scientifically analyzed samples of **dairy protein components** currently available. (continued)

Component Name	Nitrogen Conversion Factor (NCF)	% N in Protein	Ref No.	References : scientific publications, analytical data, national legislation
PP3	6.55***	15.27	30	van Boekel M.A.J.S. and B. Ribadeau Dumas (1987) Neth. Milk Dairy J. 41, 281-284
PP3	6.55***	15.27	31	Karman A.H. and van Boekel M.A.J.S. (1986) Neth. Milk Dairy J. 40, 315-336
Lactoferrin	6.14*** with carbohydrate	16.29	30	van Boekel M.A.J.S. and B. Ribadeau Dumas (1987) Neth. Milk Dairy J. 41, 281-284
Lactoferrin	6.14*** with carbohydrate	16.29	31	Karman A.H. and van Boekel M.A.J.S. (1986) Neth. Milk Dairy J. 40, 315-336
Transferrin	6.21***	16.10	30	van Boekel M.A.J.S. and B. Ribadeau Dumas (1987) Neth. Milk Dairy J. 41, 281-284
Transferrin	6.21***	16.10	31	Karman A.H. and van Boekel M.A.J.S. (1986) Neth. Milk Dairy J. 40, 315-336
MFGM	7.08***	14.13	30	van Boekel M.A.J.S. and B. Ribadeau Dumas (1987) Neth. Milk Dairy J. 41, 281-284
MFGM	7.08***	14.13	31	Karman A.H. and van Boekel M.A.J.S. (1986) Neth. Milk Dairy J. 40, 315-336
Casein	6.38	15.67	62	Budsławski, J. Chemia i analiza mleka i jego przetworów, PWRiL, Warszawa 1963:104
Milk Protein	6.38	15.67	63	Pijanowski, E. Zarys chemii i technologii mleczarstwa, T.1, PWRiL, Warszawa 1980:72
Milk Protein	6.39	15.65	64	Campbell, J.R., Marshall, R.T. Podstawy produkcji mleka spożywczego i jego przetworów, PWN, Warszawa, 1982:486
Casein	6.38	15.67	51	J Adler-Nissen. Enzymic Hydrolisis of food proteins. Elsevier Applied Science. (1988) 15-17
Casein In Fluid Milk	6.38	15.67	65	AOAC 927.03
Albumin	6.38	15.67	66	AOAC 925.24
Casein in Malted and Chocolate Milk	6.38	15.67	67	AOAC 941.06
Non Casein Nitrogen	6.38	15.67	68	AOAC 998.05
Non Casein Nitrogen	6.38	15.67	69	AOAC 998.06
Non Casein Nitrogen	6.38	15.67	70	AOAC 998.07
Non Protein Nitrogen	6.38	15.67	71	AOAC 991.21
Protein Nitrogen	6.38	15.67	72	ISO 8968-5|IDF 20-5. Milk — Determination of nitrogen content — Part 5:Determination of protein-nitrogen content
Notes	*** Calculated from amino acid data			

C. Specific comments on key references

A comprehensive review of analyses conducted by selected groups of researchers cited in the attached tables deserves further comment to explain the resulting data more clearly. In particular, referenced data from three of these groups – FAO/WHO (9), Karman & van Boekel (31), and van Boekel & Ribadeau-Dumas (30) have been misinterpreted to such an extent that a single NCF of 6.25 has been inappropriately justified.

Karman and van Boekel (1986) compared the experimental conversion factors against the theoretical conversion factors calculated from amino acid sequencing work (Eigel, W.N. et al. 1984. J Dairy Sci. 67:1599-1631). They found significant differences between experimental conversion factors and theoretical values. This is very important because the multiple techniques utilized in this study are still being used in national and international standards for the determination of non-protein nitrogen (NPN) and casein (68, 69, 70, 71, 72.). Since the NPN content and composition provide the basis for the proposed lower NCF, it is then clear that inaccuracies in this determination would greatly affect the presumed NPN content in the test portion. Therefore, it is not scientifically plausible to accept the validity of the proposed 6.25 NCF.

In their 1986 publication, Karman and van Boekel alluded to the uncertainty of both the conversion factor (6.34 for milk) and their conclusions. This uncertainty resulted from their recognition of the influences stemming from the cattle's genetic variants, the carbohydrate content that exists in milk, and the individual variation in protein composition of the samples. In 1987, van Boekel and Ribadeau-Dumas (30) reviewed these conversion factors further. In this later review, they concluded that, due to differences in amino acid composition and the individual protein compositions in the samples they evaluated, the conversion factor would be higher than those in the previously published paper, specifically 6.35 - 6.36, versus 6.34. It is obvious that this conversion factor of 6.36, or even 6.34, does not scientifically justify the proposed NCF of 6.25.

In Miera's unpublished PhD thesis that evaluated various formulas, the average calculated NCF was 6.38 for whey predominant formulas and 5.76 for soy formula, both of which agree with studies by Morr (10) and Mosse (3). Other conversion factors based on a higher N per protein values have been suggested by Salo-Vaananen et al. (28), whose researchers grouped different foodstuffs and calculated an **average** NCF for each group. Regretfully, in the analyzed group where the dairy protein source data were averaged, the researchers also included eggs. From the work of de Rham (1) where eggs were segregated, the egg NCF is 6.0, therefore lowering the average NCF for dairy in the Salo-Vaananen (28) report as a whole. Therefore, consideration should be given to this identified flaw in the research.

Further work by Boisen et al. (2) discovered that calculations of the conversion factor from N to protein, excluding N from amides, resulted in values ranging from 6.91 in skim milk powder to 5.53 in meat and bone meal, while the same calculations including N from amides resulted in values ranging from 6.13 in skim milk powder to 4.88 in meat and bone meal. In the latter case, all conversion factors were below 6.25. On the other hand, this group concluded that it is not necessary to estimate amidation rates when conversion factors are calculated from the total N in the protein source. This is due to almost identical molecular weights of the amide and acid forms. As such, it can be stated that for skim milk powder a NCF of 6.91 is justified.

Boisen (2) also concluded that a detrimental consequence of using a common factor of 6.25 is exemplified by replacing dietary protein in skim milk powder with protein from grass meal. Such a substitution would result in approximately 25% less protein in the diet, which is significant regardless of the application. Therefore, to be able to compare or replace one protein source with another, the use of correct and specific conversion factors, when known, is vital to the nutritional value of the formulated food.

3 Conclusion

There exists no scientific justification to support the change of the original protein source nitrogen conversion factor for soy from 5.71 to 6.25, or to change the established nitrogen conversion factor for milk protein from 6.38 to 6.25. Any such modifications are not supported by the conclusions drawn from the scientific studies reviewed herein.

COMPREHENSIVE REVIEW OF SCIENTIFIC LITERATURE PERTAINING TO NITROGEN PROTEIN CONVERSION FACTORS

ABSTRACT

This IDF review of scientific literature shows that there is substantial scientific evidence to support a specific nitrogen protein conversion factor for specific sources of protein, rather than to introduce a single nitrogen protein conversion factor, as has been envisaged in the revision of the Codex Standard for Infant Formula.

Keywords: protein, nitrogen, infant formulae, codex, conversion factor, standard, nutrition

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Example: 1 Singh, H. & Creamer, L.K. Aggregation & dissociation of milk protein complexes in heated reconstituted skim milks. J. Food Sci. 56:238-246 (1991).

Example: 2 Walstra, P. The role of proteins in the stabilization of emulsions. In: G.O. Phillips, D.J. Wedlock & P.A. William (Editors), Gums & Stabilizers in the Food Industry - 4. IRL Press, Oxford (1988).

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"...... Usually double quotes and not single quotes
? !...... Half-space before and after question marks, and exclamation marks
± ...... Half-space before and after
micr<u>oo</u>rganisms...... Without a hyphen
Infra-red ...... With a hyphen
et al....... Not underlined nor italic
e.g., i.e.,... ...... Spelled out in English - for example, that is
lit<u>re</u>...... Not liter unless the author is American
ml, mg,... ...... Space between number and ml, mg,...
skimmilk ...... One word if adjective, two words if substantive
sulfuric, sulfite, sulfate...... Not sulphuric, sulphite, sulphate (as agreed by IUPAC)
AOAC <u>International</u> ...... Not AOAC<u>I</u>
program<u>me</u> ...... Not program unless a) author is American or b) computer program
milk and milk product ...... rather than "milk and dairy product" - Normally some latitude can be allowed in non scientific texts
-ize, -ization ...... Not -ise, -isation with a few exceptions
Decimal comma...... in Standards (only) in both languages (as agreed by ISO)
No space between figure and % - i.e. 6%, etc.
Milkfat...... One word
USA, UK, GB...... No stops
Figure ...... To be written out in full
1000-9000 ...... No comma
10 000, etc. ...... No comma, but space
hours...... ø h
second ...... ø s
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