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The missing vitamin alphabet

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The missing vitamin alphabet

Abstract

Aim The aims of this paper were to catalogue a complete list of all the alphabetical names for vitamins that have appeared in the scientific literature, provide the citations of their first use and seek explanations for any apparent gaps in the naming system. **Methods** The names of known vitamins and pseudo-vitamins were identified from standard nutrition textbooks, historical monographs and several review articles. If the first citation for the alphabetical vitamin name was not found in these sources, additional searches were conducted in the Scopus and Medline databases, in Google and Google Scholar, using the names of vitamins as search terms. **Results** Sixty-seven different alphabet-based vitamin names were tabulated, including where possible the scientific and alternative names, a description of the source substance, physiological roles and the first citation of the alphabetical name. The results show that all the letters of the alphabet have been used to describe putative vitamin compounds. The simple alphabetical naming system proposed by Drummond in 1920 lasted for less than a decade. A number of other systems have been used based on the name of the discoverer, the source of the material or its physiological function. **Conclusions** Using simplified alphabetical names may assist in nutrition communication and education of the general public, but dietitians need to be careful to maintain a clear understanding of the proper biochemical distinctions and nomenclatures of the known vitamins, especially when writing for academic publication.

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Abstract

Aims

The aims of this paper were to catalogue a complete list of all the alphabetical names for vitamins that have appeared in the scientific literature, provide the citations of their first use, and seek explanations for any apparent gaps in the naming system.

Method

The names of known vitamins and pseudo-vitamins were identified from standard nutrition textbooks, historical monographs, and several review articles. If the first citation for the alphabetical vitamin name was not found in these sources, additional searches were conducted in the Scopus and Medline databases, in Google and Google Scholar, using the names of vitamins as search terms.

Results

67 different alphabet-based vitamin names were tabulated, including where possible the scientific and alternative names, a description of the source substance, physiological roles, and the first citation of the alphabetical name. The results show that all the letters of the alphabet have been used to describe putative vitamin compounds. The simple alphabetical naming system proposed by Drummond in 1920 lasted for less than a decade. A number of other systems have been used, based on the name of the discoverer, the source of the material, or its physiological function.

Conclusions

Using simplified alphabetical names may assist in nutrition communication and education of the general public, but dietitians need to be careful to maintain a clear understanding of the proper biochemical distinctions and nomenclatures of the known vitamins, especially when writing for academic publication.

Keywords: coenzymes, nutritive value, terminology, vitamins

Introduction

In 1912, Hopkins published his classic paper in which he described the important influence of certain dietary constituents on the processes of growth and nutrition, which he termed 'accessory factors for the diet'.¹ At about the same time Funk, who was working on the subject of experimental beri-beri, coined the name 'vitamine' for the same class of substances.² Having evidence that the factor was an organic base, and therefore an amine, Funk chose the term vitamine because it was clearly vital (essential for life).³ Not all of these factors later proved to be amines and in 1920 Drummond suggested the name be changed to 'vitamin' and the substances be given an alphabetical nomenclature (Vitamin A, B, C etc.).⁴ However this system did not lend itself to strict adherence when it soon became clear that vitamin B consisted of multiple compounds with different physiological functions and they began to be named as with numerical subscripts of the B vitamin group: B1 (the anti-neuritic vitamin), B2 (the anti-pellagra vitamin), and B3 (pigeon growth vitamin).⁵

Today the vitamin nomenclature policy adopted by most scientific journals⁶ is based on the recommendations of the Joint International Union of Pure and Applied Chemistry (IUPAC)-International Union of Biochemistry (IUB) Commission on Biochemical Nomenclature.⁷ Many established vitamins still have permitted alphabetically-based names that are in common use today (eg, vitamin A, Vitamin C, Vitamin B12), but many do not, although they once may have been given other names (eg, niacin, folate, biotin, pantothenic acid).

When we consider the nomenclature of vitamins today the question arises: where are the missing vitamins? We have vitamins B6 and B12, but what happened to B7- B11? We have vitamins E and K, but where are vitamin F-J? Although some authors have compiled lists of some obsolete vitamin names,^{3, 8} none has attempted to provide a comprehensive list or document the original published sources of the names used. The aims of this paper were to catalogue a complete list of all the alphabetical names for vitamins that have appeared at some time in the scientific literature, provide the citations of their first use, and to seek explanations for any apparent gaps in the naming system.

Methods

The search began with a compilation of the names of known vitamins and pseudo- vitamins identified in standard nutrition textbooks,^{3,8-11} some historical monographs on vitamins,¹²⁻¹⁴ and several review articles.¹⁵⁻¹⁸ If the first citation for the alphabetical name of each vitamin was not found in these sources, additional searches were conducted in the Scopus and Medline databases, from 1900 onward, using the names of vitamins as search terms, supplemented with similar searches in Google and Google Scholar, and hand searching of the reference lists in articles retrieved. All original articles were obtained and searched to confirm they included the first naming of a vitamin. Since this was an historical search for the first article using each particular name, rather than a systematic literature review, a Prisma diagram has not been developed, but Table 1 summarises the search process.

Results

Table 2 shows the results of the literature search, with 67 entries for different alphabet-based vitamin names, including where possible the scientific and alternative names, a description of the source substance, physiological roles, and the first citation of the alphabetical name. Only 14 of these names are now approved for scientific use. The results show that all the letters of the alphabet have been used to describe putative vitamin compounds at some time. A few letters were used for the names of 'Factors' rather than vitamins (R, W, X, Y), but these have been included for completeness. Vitamins that are not officially known today by alphabetical names (niacin, folate, biotin, pantothenic acid and choline) are only listed in this table if there were obsolete alphabetical names ascribed to them.

Discussion

The original citation articles show that the simple alphabetical naming system proposed by Drummond lasted for less than a decade.⁴ A number of other systems were used by different researchers, based on the name of the discoverer, the source of the material, or its physiological function (see Table 3). Some supplement products have been marketed with trademarked vitamin names, despite lack evidence of their essentiality (eg, vitamins B7, B16, B17, O).¹⁹⁻²¹ Some alphabetical names have been used for several different substances by different researchers. For example the term Vitamin B8 has been used for Biotin²²⁻²⁴ and for adenylic acid (inositol),^{3, 8, 14, 25} and the term vitamin B8 is still widely used in online literature

for inositol supplements.²⁶⁻²⁸ Other examples of vitamin names used for multiple substances included vitamins B15, Q and U (see Table 2).

Some potential alphabetical names were never used: vitamin B9 was skipped because when Briggs named vitamins B10 and B11 (reporting chick feathering and chick growth factors respectively) he assumed there were already nine B vitamins (thiamin, riboflavin, pantothenic acid, choline, niacin, pyridoxine, biotin, inositol and folic acid).²⁹ Similarly the term vitamin B21 seems never to have been used, although a naturopathic promotion of an aloe vera extract has been called vitamin B22.⁴⁶

Some alphabetical names are commonly but incorrectly used. The nomenclature policy of American Institute of Nutrition is that the term 'niacin' (and not vitamin B3) should be used as a generic term for several compounds that have activity as pellagra-preventing vitamins, including nicotinic acid and nicotinamide.⁶ Although the original substance termed vitamin B3 was shown to be pantothenic acid³² that alphabetical name is often but erroneously used for niacin.⁸ The term is still commonly found in current scientific literature^{86,87} and popular sources such as Wikipedia.⁵⁰ The reasons for this are not clear, but it has been suggested that the name was brought back into use in a book called the *Vitamin B-3 Therapy*, by a co-founder of Alcoholics Anonymous, who wanted a more acceptable name for niacin, which was being used to treat alcoholism.⁸⁸

When many of the early vitamin names were coined they were ascribed to fairly crude biological extracts, not purified chemical forms, and many were only shown to have physiological effects in experimental animals. Subsequently some (eg, vitamins B4 and B10) were found to contain mixtures of several vitamins and these original names have been discontinued. Other names were given by different researchers researching the same vitamins independently, and are no longer used (eg, vitamins Bp, G, H). Some vitamin names have been used for nutritional factors that are minerals (B18), lipids (F), and even pharmaceutical drugs (H3, V).

The flourishing era of vitamin discovery has been divided into three periods: 1900-1930s (when accessory food factors were first recognised as essential); 1930s to 1950s (an era of isolation and synthesis of purified compounds) and 1950s to the 1980s (when IUPAC and IUB developed a consistent nomenclature system).¹⁶ However, despite scientific agreement today,

the general public may still be confronted with meaningless terms ('B-vitamin deficiency', for example) or claims of vitamin status for compounds that clearly have no essential requirement (eg, vitamins B17 or O).

Knowledge of the history and development of vitamin nomenclature may be useful for dietitians in three ways:

- 1) dietitians need to know the correct vitamin nomenclature to use when writing for academic publication, and where to find the accepted international rules ⁶
- 2) dietitians need to be aware of possible confusion in the meaning of alphabetical vitamin terms, particularly when reading older literature: for example, when the same name (such as vitamin B8) has been used for several different chemical substances
- 3) members of the general public may be misled by substances marketed with trademarked vitamin names (such as Vitamin O), and dietitians need to be able to provide clear and accurate advice about their true status.

Using simplified alphabetical names may assist in some nutrition communication and education of the general public but, as nutrition scientists, dietitians need to be careful to maintain a clear understanding of the proper biochemical distinctions and nomenclature of the known vitamins.

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Conflict of interest

The author declares no conflict of interest

Authorship

The author was solely responsible for research design, data collection and writing of the manuscript

Table 1. Process Flow Chart

Process	Vitamins identified
Names of known vitamins and pseudo- vitamins identified in standard nutrition textbooks, ^{3,8-11} some historical monographs on vitamins, ¹²⁻¹⁴ and several review articles ¹⁵⁻¹⁸	A, B, B1-B17, Bc, Bp, Bt, Bx, C, D, E, F, G, H, I, J, K, L, M, N, O, P, PP, Q, R, S, T, U, V, Factor W, X, Y, Zoopherin
Number of first citations identified from references in texts or reviews	33
Number of first citations identified by searches conducted in Scopus and Medline databases	23
Names of additional substances identified from Google searches	B18-22, Bf, Bm, Bv, Bw, Factor R, Factor U, Factor X, Factor Y
Number of first citations identified from reference in online article	2
Number of first citations identified by searches conducted in Scopus, Medline, Google Scholar databases.	9

Table 2. Alphabetical nomenclature used for vitamins and related substances ^(a)

Letter	Scientific name	Alternative names	Substance / source	Role	First reference
A*	Retinol Pro-vitamin A: Beta-carotene			Visual pigments in eye; regulation of gene expression and cell differentiation; essential for endothelial maintenance. Beta-carotene is an antioxidant	McCollum et al 1916 ³⁰ (<i>Fat-soluble A</i>) Drummond 1920 ⁴ (<i>Vitamin A</i>)
B	-		A mixture of water soluble substances	Growth promoting factor in rat	McCollum et al 1916 ³⁰ (<i>Water-soluble B</i>)
B ₁ *	Thiamin			Coenzyme in pyruvate and 2-oxo-glutarate dehydrogenases	Chick & Roscoe 1927 ³¹
B ₂ *	Riboflavin			Coenzyme in oxidation and reduction reactions; prosthetic group of flavoproteins	Chick & Roscoe 1927 ³¹
B ₃	Pantothenic acid or (incorrectly) Niacin			Functional part of coenzyme A and acyl carrier protein	Williams and Waterman 1928 ³²
B ₄	-		Believed to be mixture of arginine, glycine, riboflavin, and pyridoxine	Unconfirmed activity to prevent muscular weakness in rats and chicks	Reader 1930 ³³
B ₅	Probably Niacin			Unconfirmed growth promoter in pigeons	Carter et al 1930 ³⁴
B ₆ *	Pyridoxine			Co-enzyme for transamination and decarboxylation of amino acids	Gyorgy 1934 ³⁵
B ₇	Carnitine	Vitamin I	Alcoholic extract of rice	Factor that prevented digestive disturbance in pigeons	Centanni 1938 ³⁶
B ₈	a) Inositol (not a vitamin) b) Biotin	Adenylic Acid		Constituent of phospholipids	a) Anon 1943 ¹⁴ b) Piccionchi et al 2003 ²⁴
B ₉	-		Never assigned. Briggs named B10 in 1943 assuming there were nine B- vitamins	-	n/a

Letter	Scientific name	Alternative names	Substance / source	Role	First reference
B ₁₀	-		Believed to be a mixture of folic acid and B12	A factor for feather growth in chickens	Briggs et al 1943 ³⁷
B ₁₁	-		Later identified as a mixture of folic acid and thiamin	A factor for feather growth in chickens	Briggs et al 1943 ³⁷
B ₁₂ *	Cobalamins			Coenzyme in transfer of one-carbon fragments and metabolism of folic acid. Prevents pernicious anemia	Rickes et al 1948 ³⁸
B ₁₃	Orotic acid		Not considered a vitamin	A growth factor in rats	Novak & Hauge 1948 ³⁹
B ₁₄	-		Unidentified crystalline substance from urine	Increases bone marrow proliferation in culture and haemopoiesis in rats	Norris & Majnarich 1949 ⁴⁰
B ₁₅	a) Pangamic acid b) Not defined		b) Beef liver extract	a) No proven biological value but reported to enhance oxygen uptake b) A growth factor in chicks	a) Krebs et al 1951 ⁴¹ b) Tomiyama & Yone 1953 ⁴²
B ₁₆	Dimethyl-glycine (DMG)		Not considered a vitamin. Intermediate in pathway between choline and glycine	A dietary supplement	Velisek 2014 ⁹
B ₁₇	Amygdalin	Laetrile Nitriloside	Cyanogenic glycoside from apricot kernels	Not a vitamin. Unsubstantiated claims of anticarcinogenic activity	Krebs 1970 ⁴³
B ₁₈	Arsenic		Essentiality not demonstrated ⁴⁴	May have roles in metabolism of methionine and regulation of gene expression	Herbert 1979 ⁴⁵
B ₁₉	-		Never used		-
B ₂₀	Carnitine		Trimethyl-ammonium-3-hydroxybutyrobetaine	In activated form as acylcarnitine serves as carrier of fatty acids across mitochondrial membranes	Velisek 2014 ⁹
B ₂₁	-		Never used		-
B ₂₂	Not defined		Aloe Vera extract	Promoted in naturopath book	Clark 1973 ⁴⁶
Bc	Folic acid (obsolete name)			Prevents hypochromic macrocytic anemia in chicks	Hogan & Parrott 1940 ⁴⁷

Letter	Scientific name	Alternative names	Substance / source	Role	First reference
Bf	Carnitine			Required for transport of fatty acids into the mitochondria	Bernadier et al 2007 ²⁵
Bm	Myo-inositol	Mouse antialopaeaia factor		Constituent of phospholipids	Velisek 2014 ⁹
Bp	Choline			Prevents perosis in chickens Constituent of phospholipids	Hogan et al 1940 ⁴⁸
B _T	Carnitine			Growth factor for insects	Fraenkel et al 1948 ⁴⁹
Bv	-		Said to be "a type of B6 other than pyridoxine"	-	Anon 2014 ⁵⁰
Bw	Probably biotin			A growth factor	Anon 2014 ⁵⁰
Bx	Obsolete name of PABA; also used at one time for pantothenic acid			A hair growth factor in foxes	Lunde et al 1939 ⁵¹
C*	Ascorbic acid	Hexuronic acid Cevitamic acid		Coenzyme in hydroxylation of proline and lysine in collagen synthesis; antioxidant	Drummond 1919 ⁵² (<i>water-soluble C</i>) Drummond 1920 ³ (<i>Vitamin C</i>)
C ₂	Bioflavonoids	Vitamin P Vitamin J		A postulated antipneumonia factor	Cotereau et al 1948 ⁵³
D*	Calciferols			Antirachitic factor	McCollum et al 1922 ⁵⁴
D ₂ *	Ergocalciferol		A vitamin D active substance derived from irradiation of ergosterol	Maintenance of calcium balance; regulation of gene expression	Windaus et al 1932 ⁵⁵
D ₃ *	Cholecalciferol		Derived from UV irradiation of 7-dehydrocholesterol	Maintenance of calcium balance; regulation of gene expression	Windaus et al 1936 ⁵⁶
E*	Tocopherols			Antioxidants. Prevent myopathies and certain types of infertility in animals	Sure 1924 ⁵⁷
F	Essential fatty acids (not vitamins) Once used for thiamin		Linoleic, linolenic, arachadonic acids	Structural elements of cell membranes; eicosanoid precursors	Evans et al 1934 ⁵⁸

Letter	Scientific name	Alternative names	Substance / source	Role	First reference
G	Obsolete term for Riboflavin			Coenzyme in oxidation and reduction reactions; prosthetic group of flavoproteins	Sherman & Axtmayer 1927 ⁵⁹
H	Obsolete term for Biotin			Coenzyme in carboxylation reactions in gluconeogenesis and fatty acid synthesis	Gyorgy 1931 ⁶⁰
H ₃	Novocaine (procaine hydrochloride)	Gerovital	Not a vitamin	Promoted without evidence as alleviating aging	Anon 1999 ⁶¹
I	Mixture also formerly called B7		Alcoholic extract of rice	Factor that prevented digestive disturbance in pigeons	Centanni 1938 ³⁶
J	Bioflavonoids	Vitamin C2 Vitamin P	Fruit extracts	A postulated antipneumonia factor	Von Euler et al 1935 ⁶²
K*	Naphthoquinones	Antihæmorrhagic factor		Coenzymes in blood clotting	Dam H 1935 ⁶³
K ₁ *	Phylloquinones		Vitamin K active substances produced by	Coenzymes in blood clotting	McKee et al 1939 ⁶⁴
K ₂ *	Menaquinones		Vitamin K active substances synthesized by micro-organisms and produced from other vitamins by animals	Coenzymes in blood clotting	McKee et al 1939 ⁶⁴
K ₃ *	Menadione		Synthetic vitamin K active substance not found in nature	Coenzyme in blood clotting	Dam 1967 ⁶⁵
L	Never defined		Factor isolated from yeast	Claimed to be essential for lactation in the rat	Nakahara et al 1938 ⁶⁶
L ₁	Ortho-aminobenzoic acid	Anthranilic Acid	Liver filtrate activity	Proposed as necessary for lactation	Nakahara et al 1938 ⁶⁶
L ₂	Adenine derivative		Unconfirmed yeast filtrate	Proposed as necessary for lactation	Nakahara et al 1938 ⁶⁶
M	Obsolete term for Folic Acid		Pteroylglutamic acid	Prevents nutritional cytopenia in monkeys	Day et al 1938 ⁶⁷

Letter	Scientific name	Alternative names	Substance / source	Role	First reference
N	-		Mixed extracts from brain and stomach	Purported to have anti-cancer activity	Podionova et al 1968 ⁶⁸
O	Bis-beta-carboxyethyl germanium sesquioxide	Organic germanium Vitamin O™	Diet supplement claiming to be a special supplemented oxygen in liquid form produced through electrical activation of sea water	Unsubstantiated claims for benefits with angina, anemia and various forms of cancer	Anon 2002 ⁶⁹ Hall 2003 ⁷⁰
P	Bioflavonoids (Rutin, citrin, hespedin, eriodictin)	Citrin	Fruit extracts	Reduce capillary fragility	Rusznayk & Szent-Gyorgyi 1936 ⁷¹
PP	Obsolete name for Niacin	Nicotinamide		Coenzyme in oxidation and reduction reactions; functional part of NAD and NADP	Goldberger et al 1926 ⁷²
Q or Q ₁₀	a) Coenzyme Q (not a vitamin) b) Proposed new vitamin	a) Ubiquinone b) Phospholipid from soybean	Soybean	Redox coenzyme in mitochondrial electron transport chain Clotting factor, corrects abnormal bleeding	a) Folkers et al 1997 ⁷³ Karlsson et al 1997 ⁷⁴ b) Quick 1974 ⁷⁵
Factor R	Obsolete term for conjugated Folic Acid			Chicken growth factor	Schumacher et al 1940 ⁷⁶
Factor S Vitamin S	a) Strepogenin (peptide) b) Salicylic acid		Probably biotin	Chicken growth factor	a) Schumacher et al 1940 ⁷⁶ b) Velisek 2014 ⁹
T	Mixture of folic acid, Vitamin B12 and nucleotides		Unconfirmed activity isolated from termites, yeasts or moulds	Reported to increase protein utilization in rats	Goetsch 1947 ⁷⁷
Factor U Vitamin U	a) Methylsofonium salts of methionine b) Undefined extract		- An extract from cabbages	Growth factor for chickens Proposed to healing of ulcers	a) Stokstad & Manning 1938 ⁷⁸ b) Cheney 1949 ⁷⁹

Letter	Scientific name	Alternative names	Substance / source	Role	First reference
V	a) Probably NAD			Promoting bacterial growth	a) Cody 1984 ⁸⁰
	b) Sildenafil citrate	Viagra		Boost cardiovascular capacity	b) Mason 2008 ⁸¹
Factor W	Probably Biotin			Promoting bacterial growth	Frost & Elvehjem 1937 ⁸²
Factor X	Obsolete term for vitamin E			Antioxidant in cell membranes	Evans & Bishop 1922 ⁸³
Factor Y	Probably vitamin B ₆			Rat growth factor	Chick & Copping 1930 ⁸⁴
Zoopherin	Obsolete term for vitamin B ₁₂			Rat growth factor	Zucker et al 1948 ⁸⁵

- a) Letters with asterisks are currently approved alphabetical vitamin names. The following recognised vitamins, which do not take an alphabetical name, have been omitted from this table: niacin, folate, biotin, pantothenic acid, and choline.

Table 3. Different methods of allocating alphabetical vitamin names

Method	Examples
Chronological order of discovery	A, B, C, D
Named after discoverer	F - Funk G - Goldberger Q - Quick
Animal requiring the vitamin, or site of action or source of material	Bc - Chicken M - Monkey T - Termite
Function/deficiency effect	Bp - Perosis in chicks H – 'Haut (skin) Faktor' K – 'Koagulations-Vitamin' (coagulation) P – 'Permeability' (capillary fragility) PP - Pellagra-preventing L - Lactation O - Oxygen U - Unidentified function