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DEGREES OF LEXICAL INTEGRATION: DERIVATIONAL WORD FAMILIES OF SEVEN ARABIC-DERIVED SCIENTIFIC TERMS IN ENGLISH

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Abstract: English contains many scientific words whose ultimate source is Arabic, but most of them entered English through Medieval Latin, French, Italian, or Spanish rather than directly. Studies of these words usually focus on their etymology and on how their meanings changed. Less attention has been given to what happened to them after they entered English, in particular whether they became bases for new English words. This article examines the derivational word families of seven Arabic-derived scientific terms: algebra, algorithm, alcohol, alkali, elixir, zero, and zenith. Using the online Merriam-Webster Dictionary as the main source, with other dictionaries for cross-checking, it records the derivatives of each term, the word-formation process involved, and the date of first known use. Twenty-three derivatives were identified. Their distribution is very uneven: alkali has eight, alcohol five, algebra and zero three each, algorithm and zenith two each, and elixir none. Suffixation accounts for 19 of the 23 derivatives, conversion for three, and one case is a new combining form, -aholic, extracted from alcoholic. The results show that the date of borrowing does not predict the size of a word family. Elixir and zenith, two of the three oldest terms in the sample, have the smallest families, while alcohol, borrowed later, is the only term that has given English a new word-forming element. The study argues that integration depends more on the communicative range of a term than on its age.

Keywords: Arabic loanwords; lexical integration; derivation; word families; scientific vocabulary; historical lexicography; English

1. Introduction

Much of the English vocabulary of science was borrowed from other languages, and a smaller group of these words can be traced to Arabic. Darwish (2015) notes that many Arabic loanwords in English belong to science, with examples such as zero, algebra, alcohol, and alkali. However, the fact that a word has an Arabic source does not mean that it was borrowed directly from Arabic. Many of these words passed through Medieval Latin, French, Italian, or Spanish before they reached English (Darwish, 2015). For this reason, the present study separates the ultimate Arabic source of each word from the immediate language through which it entered English.

Research on borrowing has long distinguished between the act of taking a word from another language and the later process by which the word is adapted to the system of the receiving language (Haugen, 1950). A loanword may keep its foreign form and stay in a narrow technical use, or it may become a normal English word that takes English suffixes, changes word class, and forms new words. Previous work on Arabic-derived words in English has approached them in several ways. Cannon (1994)

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compiled a historical dictionary of more than two thousand such words and recorded, among other details, their derivative forms and an approximate degree of assimilation. Darwish (2015) surveyed the history of Arabic loanwords in English, and Adzieva (2022) examined the morphological adaptation of Arabic borrowings in English scientific discourse. Among the studies reviewed here, however, none compares the dated derivational families of individual scientific terms in order to explain why some of them have become more deeply integrated than others. This article addresses that question for a small sample of seven terms.

This article focuses on one indicator of integration: the derivational word family. A word family is understood here as a base word together with the words formed from it in English, such as algebraic and algebraist from algebra. The size and variety of a word family, and the dates when its members first appear, can show how deeply a borrowed word has become part of English. The study compares seven Arabic-derived scientific terms from mathematics, chemistry, pharmacy, and astronomy, and asks whether they show different degrees of integration. It addresses three research questions:

RQ1. What derivatives has each of the seven terms formed in English, and when are they first recorded?

RQ2. Which word-formation processes (for example, suffixation, conversion, or the creation of new combining forms) are involved in these word families?

RQ3. Do the seven terms show different degrees of lexical integration, and how can these differences be explained?

2. Literature Review

2.1 Borrowing and lexical integration

Haugen (1950) described borrowing as the attempt to reproduce in one language patterns that were first found in another. He distinguished importation, in which a foreign form is taken over, from substitution, in which native material replaces part of the foreign model. On this basis he separated loanwords, loanblends, and loanshifts (Haugen, 1950). His framework is useful here because the formation of English derivatives from a borrowed base is a later step in which native English morphology is combined with imported material. More recently, the Loanword Typology project compared lexical borrowing across a sample of 40 languages (Haspelmath & Tadmor, 2009). In the introductory chapter to that handbook, Haspelmath (2009) defines and discusses the basic notions needed to compare loanwords across languages. In the same spirit, the present study compares its seven terms using criteria that are stated in advance (Section 2.4).

2.2 Arabic-derived vocabulary in English

Cannon (1994) is the most comprehensive dictionary of English words of Arabic origin. According to its publisher's description, it contains 2,338 entries, and each entry gives the date of first record in English, the semantic field, variant forms, etymology, definitions, derivative forms, and the approximate degree of assimilation. Durkin (2014) provides a general history of loanwords in English and explains how the origins of loanwords are traced, when and why they were adopted, and what happens to them after adoption. Darwish (2015) surveys Arabic loanwords in English and notes that many of them belong to science, with examples such as zero, algebra, alcohol, and alkali. He also describes several routes of transmission, including Old French and Latin translations of Arabic scientific works. The study closest to the present one is Adzieva (2022), who identified 201 Arabic borrowings in English scientific texts and dictionaries. According to her abstract, many of these words developed from older stems through abbreviation, contraction, suffixation, and compounding, and some now express new concepts in fields

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such as information technology, biology, and medicine. Adzieva's study covers a large set of words; the present study looks more closely at a small set and asks how, and how much, each word family has grown.

2.3 Derivation and morphological productivity

The formation of new words from a base is studied under the heading of derivational morphology. Plag (2018) gives an introduction to English word-formation, that is, the ways in which new words are built on existing ones. Three processes are relevant here. Suffixation adds a bound element to the end of a base, as in alkaline from alkali. Conversion changes the word class of a word without changing its form, as when the noun zero is used as a verb. A combining form or splinter is a part of an existing word that speakers reuse to build new words, as -aholic is reused from alcoholic. Bauer (2001) reviews the many definitions of morphological productivity and concludes that no single method can measure it reliably. For this reason, the present study does not claim to measure productivity. It describes instead the derivatives that dictionaries have recorded, which shows the words that have actually been formed and used, not the full potential of each base.

2.4 Analytical framework

The framework of this study combines Haugen's (1950) view of integration as a process that follows borrowing with the description of word-formation processes. For each of the seven terms, integration is described on four indicators: (a) the number of recorded derivatives; (b) the range of word classes in the family (noun, adjective, verb, adverb); (c) the number of different word-formation processes involved; and (d) the chronology of the family, that is, the time between the first record of the base and the first records of its derivatives. On the basis of these indicators, the terms are placed in descriptive groups in Section 4.3. They summarise the comparison and should not be read as a fixed scale.

3. Method

3.1 Research design

The study uses a qualitative historical-lexicographical design supported by descriptive counts. It does not use corpus frequencies. Its data are the entries of historical and contemporary dictionaries, which record the forms, meanings, and dates of English words. The analysis is descriptive and comparative: it describes the word family of each term and then compares the seven families.

3.2 Selected terms

The seven terms were selected because they belong to four scientific domains, because their Arabic origin is widely recorded in reference works, and because they are still in common use. Table 1 lists the terms with the Arabic sources and routes given by Merriam-Webster. Two terms need special care. Algorithm is not derived from an ordinary Arabic word but from a Latinised form of the name of the scholar al-Khwārizmī. Zenith comes from a modified form of Arabic samt (al-raʾs) and reached English through Spanish, Latin, and French.

Table 1. The seven Arabic-derived terms analysed

No.	English term	Arabic source (MW)	Domain	Route into English (MW)	First known use (MW)	Derivatives
1	algebra	al-jabr	Mathematics	Medieval Latin	1551	3

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No.	English term	Arabic source (MW)	Domain	Route into English (MW)	First known use (MW)	Derivatives
2	algorithm	al-Khwārizmī (personal name)	Mathematics / Computing	Medieval Latin algorismus > Old French / ME algorisme; altered form	1811	2
3	alcohol	al-kuḥul (from kuḥl)	Chemistry	Old Spanish > Medieval Latin > New Latin	1672	5
4	alkali	al-qili	Chemistry	Medieval Latin > Middle English	14th c.	8
5	elixir	al-iksīr (prob. < Greek xērion)	Chemistry / Pharmacy	Medieval Latin > Middle English	14th c.	0
6	zero	ṣifr	Mathematics	Medieval Latin zephirum > Italian zero > French zéro	1598	3
7	zenith	samt (al-raʾs)	Astronomy	Old Spanish zenit > Medieval Latin > Middle French cenit > ME cenyth	14th c.	2

Note. MW = Merriam-Webster.com Dictionary (accessed 19 November 2026). Routes simplify the MW etymologies; ">" means "passed into". Derivatives = one-word derivatives counted under the rules in Section 3.4.

3.3 Data sources

The main source is the online Merriam-Webster Dictionary (Merriam-Webster, n.d.), which gives for each entry an etymology, a date of first known use, and a list of derivatives. It was chosen because it is freely accessible, it gives dates in a consistent format, and it lists derivatives either as separate entries or at the end of the entry for the base word. Where Merriam-Webster gives no date for a derivative, the derivative is counted but its date is reported as not given. Two other sources were used for cross-checking: the Online Etymology Dictionary for algebra, and Dictionary.com for zenithal. The Oxford English Dictionary, which is the standard historical dictionary of English, could not be consulted for this study. All entries were accessed on 19 November 2026.

3.4 Data collection and coding

For each term, every derivative listed in the Merriam-Webster entry, or found as a separate entry formed from the base, was recorded in a data sheet with the following fields: base term, derivative, word class, word-formation process, date of first record, meaning, and source. A derivative was included only

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if Merriam-Webster records it. Each derivative was coded for its word-formation process (suffixation, conversion, or creation of a combining form). Three decisions defined what was counted. First, only one-word derivatives were counted, including those formed by conversion (a change of word class without a change of form). Compounds and phrases such as zero-sum or alkali metal were noted but not counted, because they are very numerous for some terms and their listing in the dictionary is less systematic. Second, derivatives of derivatives (for example, alkalinity from alkaline) were counted in the family of the original base. Third, a new combining form extracted from a derivative was counted as one item.

3.5 Reliability and use of AI tools

All dates and derivatives were taken directly from the dictionary entries. Where two dictionaries disagree, both accounts are reported. An AI tool was used to help plan the structure of the article, to locate the dictionary entries, and to improve the clarity of the English. No data, dates, or etymologies were generated by the tool; all were taken from the dictionary entries cited, and all were checked by the author against those entries.

4. Results

4.1 The word families

Table 2 lists the 23 derivatives identified. The seven families differ greatly in size. Alkali has the largest family, with eight derivatives. The earliest is the adjective alkaline (1682), followed by alkalescent (1726), alkalinize (1800), alkaloid (1820), and alkalied (1857); alkalinity, alkaloidal, and alkalify are listed without dates. Several of these are second-order derivatives formed from alkaline or alkaloid rather than from alkali itself.

Alcohol has five derivatives. The adjective alcoholic is first recorded in 1789, the noun alcoholism in 1848, and the noun alcoholic (a person) in 1852; the adverb alcoholically is undated. Merriam-Webster also records the combining form -aholic, whose etymology it gives simply as alcoholic. This element appears in workaholic (1947) and shopaholic (1977). It is the only case in the data in which an Arabic-derived base has produced a new English word-forming element.

Algebra and zero have three derivatives each. For algebra, Merriam-Webster records algebraist (1673) and lists algebraic and algebraically without dates; the Online Etymology Dictionary dates algebraic to the 1660s and an earlier variant algebraical to the 1570s. Zero differs from the other terms because two of its three derivatives are formed by conversion: the adjective (1821) and the verb (1911). The ordinal zeroth dates from 1850. The verb also forms the phrasal verbs zero in and zero out, and the entry lists many compounds, such as zero-sum and ground zero, which were not counted.

Algorithm and zenith have two derivatives each. Algorithmic and algorithmically are listed without dates. For zenith, the adjective zenithal is dated circa 1731 by Merriam-Webster but 1855–60 by Dictionary.com; this disagreement is discussed in Section 5. Zenithward(s) is undated. Finally, no derivative of elixir was found: the Merriam-Webster entry lists no derived forms.

Table 2. Derivatives of the seven terms

Base	Derivative	Word class	Process	First known use	Source	Note
alkali	alkaline	adjective	suffixation (-ine)	1682	MW	

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Base	Derivative	Word class	Process	First known use	Source	Note
alkali	alkalinity	noun	suffixation (-ity)	not given	MW	from alkaline
alkali	alkalescent	adjective	suffixation (-escent)	1726	MW	
alkali	alkaloid	noun	suffixation (-oid)	1820	MW	
alkali	alkaloidal	adjective	suffixation (-al)	not given	MW	from alkaloid
alkali	alkalinize	verb	suffixation (-ize)	1800	MW	from alkaline
alkali	alkalify	verb	suffixation (-ify)	not given	MW	
alkali	alkalied	adjective	suffixation (-ed)	1857	MW	
alcohol	alcoholic	adjective	suffixation (-ic)	1789	MW	
alcohol	alcoholic	noun	conversion	1852	MW	from adjective
alcohol	alcoholically	adverb	suffixation (-ally)	not given	MW	
alcohol	alcoholism	noun	suffixation (-ism)	1848	MW	
alcohol	-aholic	combining form	extraction from alcoholic	not given	MW	workaholic 1947; shopaholic 1977
algebra	algebraic	adjective	suffixation (-ic)	not given	MW	1660s (Etymonline)
algebra	algebraically	adverb	suffixation (-ally)	not given	MW	
algebra	algebraist	noun	suffixation (-ist)	1673	MW	
zero	zero	adjective	conversion	1821	MW	
zero	zero	verb	conversion	1911	MW	also zero in, zero out
zero	zeroth	adjective	suffixation (-th)	1850	MW	

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Base	Derivative	Word class	Process	First known use	Source	Note
algorithm	algorithmic	adjective	suffixation (-ic)	not given	MW	
algorithm	algorithmically	adverb	suffixation (-ally)	not given	MW	
zenith	zenithal	adjective	suffixation (-al)	c. 1731	MW	1855–60 (Dictionary.com)
zenith	zenithward(s)	adverb	suffixation (-ward)	not given	MW	

Note. Source: Merriam-Webster.com Dictionary unless stated otherwise (accessed 19 November 2026). No derivatives of elixir were found.

4.2 Word-formation processes

Suffixation is the dominant process. It accounts for 19 of the 23 derivatives, and it is the only process found for alkali, algebra, algorithm, and zenith. The suffixes are mostly common English or Latinate ones, such as -ic, -al, -ism, -ist, and -ize, and the adverb-forming -ally. Conversion accounts for three derivatives: the noun alcoholic and the adjective and verb zero. The remaining case is the combining form -aholic. Unlike the suffixes above, it did not exist before the base was borrowed. Speakers cut it out of alcoholic and used it to form new words meaning “a person with a compulsive need for something”. In word-formation terms it is a splinter or combining form, and no other item in the data shows this kind of innovation.

4.3 Comparing degrees of integration

Table 3 compares the seven terms on the four indicators defined in Section 2.4. The terms fall into three groups. Alcohol and zero show the widest integration: they use more than one word-formation process, including conversion, and they have entered everyday English, alcohol through -aholic and zero through its use as a verb and in many compounds. Alkali has the largest family, but all its derivatives are formed by suffixation and nearly all belong to the language of chemistry. Algebra, algorithm, and zenith have small families formed by suffixation only. Elixir has no recorded derivatives.

Table 3. Indicators of integration for the seven terms

Term	First use	Derivatives	Word classes	Processes	Earliest dated derivative	Group
alcohol	1672	5	adj., n., adv., combining form	3	1789 (117 years later)	wide
zero	1598	3	adj. (incl. ordinal), verb	2	1821 (223 years later)	wide
alkali	14th c.	8	adj., n., verb	1	1682	large but technical
algebra	1551	3	adj., adv., n.	1	1673 (122 years later)	limited

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Term	First use	Derivatives	Word classes	Processes	Earliest dated derivative	Group
algorithm	1811	2	adj., adv.	1	not given	limited
zenith	14th c.	2	adj., adv.	1	c. 1731 (MW)	limited
elixir	14th c.	0	—	0	—	none

Note. Counts follow Table 2. "Processes" counts suffixation, conversion, and extraction of a combining form. Years between base and derivative are given only where both dates are exact.

5. Discussion

The first finding is that the age of a borrowing does not predict the size of its word family. Elixir, zenith, and alkali all have a first known use in the fourteenth century, yet elixir has no derivatives, zenith has two, and alkali has eight. Alcohol, first recorded in 1672, has a smaller family than alkali but a much wider one. Read against Haugen's (1950) distinction between borrowing and later adaptation, this means that time in the language does not explain integration on its own. The way each word is used seems to matter as well.

A possible explanation, which the present data can suggest but not prove, lies in the communicative range of each term. Alkali names a class of substances that chemists need to describe in many ways: as a property (alkaline), a degree (alkalinity), a process (alkalinize), and a related class of compounds (alkaloid). Its family is therefore large but specialised. Alcohol and zero, by contrast, moved out of the laboratory and the arithmetic book into general use. Merriam-Webster gives the source of alcohol as a term for powdered antimony, from Arabic kuḥl (kohl), which shows a large change of meaning before the modern sense. Once alcohol came to mean an everyday drink, words for the social problem of drinking (alcoholic, alcoholism) followed, and alcoholic became familiar enough for speakers to extract -aholic from it. Zero became a verb, which is perhaps the clearest sign that a borrowed noun is treated as an ordinary English word.

Elixir and zenith show the opposite pattern. Both remain closely tied to older fields, alchemy and astronomy, and their modern extensions are semantic rather than morphological: Merriam-Webster records elixir in the sense of a cure-all and an essential principle, and zenith in the sense of a culminating point. These words have widened their meaning without forming new words. This suggests that semantic and morphological integration can develop independently, a point that later research could test on a larger sample.

The disagreement over zenithal (circa 1731 in Merriam-Webster, 1855–60 in Dictionary.com) and the many derivatives listed without dates show a limitation of dictionary evidence. Dictionaries record first known uses, which can change as new evidence is found, and they do not always state whether a derivative was formed in English or borrowed already formed from another language. The entries consulted for alkaloid, for example, do not say whether it was formed in English or taken from another European language. Cannon (1994) recorded an approximate degree of assimilation for each Arabic-derived word, and Adzieva (2022) found suffixation and compounding among the main processes of morphological adaptation in scientific Arabicisms. The present results agree with the importance of suffixation, and they add a comparison of individual word families based on explicit indicators.

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Following Bauer's (2001) caution, however, the counts describe recorded derivatives only and should not be read as a measure of morphological productivity.

6. Conclusion

This study examined the derivational word families of seven Arabic-derived scientific terms in English. Twenty-three derivatives were identified in the Merriam-Webster Dictionary (RQ1). Suffixation was by far the most common process, with three cases of conversion and one new combining form, -aholic (RQ2). The terms show clearly different degrees of integration (RQ3). Alcohol and zero are the most widely integrated, alkali has a large but technical family, algebra, algorithm, and zenith have small families, and elixir has none. The age of a borrowing did not predict these differences; the evidence points instead to the range of contexts in which a term is used.

The study has several limitations. It analyses only seven terms. It relies mainly on one dictionary, and the Oxford English Dictionary could not be consulted, so some dates may be revised. Dictionary data record established words, not all real usage, and the study used no corpus frequencies. Future research could check the dates against the OED, extend the analysis to a larger sample such as the entries in Cannon (1994), and use corpus data to test whether family size is related to frequency of use.

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