Web-based Databases and Literature for Research and Development for the Food Industry

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Abstract

In the past decade, it has been realised that the Internet is an immensely powerful source of information with growing applicability in the developing world. This paper will cite Internet references that would illustrate food and nutrition applications. The areas considered cover events, useful data, research and development that would enhance health and safety through the promotion of quality in the food industry. The Internet instantly transmits information - news, messages, upcoming events (training, workshops, and conferences). Other than the search engines, web-based encyclopaedia, dictionaries, books and catalogues are abundantly available. Authoritative bodies supply international food composition reference databases freely. Several publishers agreed to make biomedical journals and databases available free of charge or at considerably cheaper prices for libraries in the developing world. Well-known universities fully described on the web their lecture materials, presentations and laboratory experiments. Partial or full-text descriptions for assaying food constituents are not uncommon. Online handbooks for routine technical data are facilitated through indexing and search facilities. International organisations support laboratories by making partial or full-text standards for improving quality and technical competence available. These important applications of the Internet as a source of information will be cited from the recently launched Analytical Chemistry Web Directory, "WebAnalytes"[1], as a way to illustrate the advantages of finding inter-related information in one resource site. "WebAnalytes" with more than 2,200 links is direct-to-the-resource in approach and saves the search time of the visitor. "Chemistry in Africa" [2] is a resource page for African chemical activities and databases including food and nutrition resources. It is deliberately linked to WebAnalytes as a strategy to increase the web-presence of the latter in the libraries of African academic and research institutions as well as in production enterprises.

Introduction

Webanalytes [1] as a web directory for analytical chemistry currently consists of 13 subject categories, one general reference page for chemists, "RefCard" [2] and Chemistry in Africa [3]. Each category has sub-categories with sections which may be inter-linked to other pages for the purpose of cross-referencing. The directory page lists the categories and is the gateway to the latter. The sub-categories in each page are also shown on the directory contents although no links are made to minimise confusion during visits. This would save the visitor a considerable time since it would reflect the type of information likely or unlikely available in the website. WebAnalytes has over 2,200 links and attempts to be direct to the desired resource for the same reason just given.

Concepts in science, or in any group of discipline for that matter, are inter-linked and this is more so in our days as a result of increasing interdependence of applications of science and technology. Analytical chemistry applications are as diverse as the types of products in the market ranging from foods to synthetic materials. It has a direct role in improving the quality of life in society through assessment of the required quality and quantity of consumer products. In organising an analytical chemistry web directory it is important to reflect this

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diversity of applications as much as possible. At the same time topics are inter-related. This can be shown by a simple example: glucose assay in food or blood could use the same chemistry e.g. glucose by glucose oxidase enzymatic method. Further, web resources with general topics are also obvious resources for food chemistry (e.g. analytical (bio) chemistry, chromatography). This additionally signifies the point that the resources in WebAnalytes are diversely useful for the food sector.

As a former academic in Ethiopia, the author understands well the huge problem of retrieving data and literature in the developing world, obviously due to the prohibitively expensive journals and books. The advent of internet technology is revolutionising our age. Connected homes in the developed world can be regarded as web libraries today to any desired specialisations. The Internet is also gradually introduced in the cities of the developing world. Many university departments in Africa are becoming connected and the Internet is becoming a major source of academic and research information in these institutions, despite power interruptions and other infrastructure problems.

Driven by these developments of our age, the work of preparing chemistry resources was initiated about two years ago through development of small web-pages. An example: the first edition of Chemistry in Africa was launched in January 2001, using the web space provided by an Internet provider, Wanadoo. Reorganising and upgrading these pages into the current development (WebAnalytes) demanded a more professional and commercial web hosting service. This process of reorganisation took about six months giving the present structure which was launched at the end of 2002. WebAnalytes' mission is to cover the diverse principles and applications of analytical chemistry and related sciences for improving the quality of science education & research, health, safety & environment as well as for promoting the material life of societies, with commitment to supplementing the needs for scientific literature in the developing world [4].

The next sections will highlight Internet databases and literature for research and development as a vehicle for promoting food quality. This cannot by any means be exhaustive as much fewer examples will be cited to illustrate how food databases, research literature and nutrition education obtained from these web sources could be beneficial for promoting food quality and safety in the developing world (at the time of submission of this paper, 23/03/03, "FOOD" as a key word occurs just over 140 times in the whole website, in the first 12 categories listed in the directory page, e.g. 39 times in the biomedical page). Authoritative sources will be considered for the illustrations.

Training

Events posted on websites of organisations specialising in foods, nutrition and agriculture typically relate to development news, workshops, training, symposia and conferences. A very good example of a website which announces training regularly is that of the FAO/IAEA Training and Reference Centre [4]. The Centre organises different training programmes for laboratories of the developing world seeking to monitor quality control and to achieve technical competence. It assists laboratories to improve their technical competence in accordance with ISO/IEC 17025 as well as to train personnel on how to achieve internationally acceptable analytical results. Hence the training courses at the Centre provided are of two different types, namely for officials involved in the management of quality (planning, decision making and supervision) and for analysts working in the laboratory. The main areas of training in the Centre relate to microbial contaminants, mycotoxins in foods and feed, pesticide residues, radionuclides, toxic metals as well as veterinary drug residues in food. One recent example of upcoming training news posted at the centre's website during the time of submission of this paper is "Development of Quality Assurance for Mycotoxin Analysis of Food and Feed"

Another useful source for training information in the food sector is the website of the International Network of Food Data Systems (INFOODS) [6]. The website has page that lists "Courses and Workshops in Food Composition".

Food Composition

Food composition databases are numerous and some are listed in WebAnalytes. Probably the most important of all is the USDA National Nutrient Database for Standard Reference [7]. This database is maintained by the Food Composition Laboratory with a mission "to develop innovative measurement systems for the determination of food components that influence human health". The database is in the public domain and can be used freely without limitation to access. Its online search programme is easy to find food components. It contains food composition data for both processed and raw foods e.g. search "egg" for egg products, "milk" for milk products. Examples one can comfortably consider searching crops from tropical regions are cassava or coffee. In the former, the database submits food composition for raw cassava only. The other way one can use this database is to identify which food items contain a certain, desired or undesired, substance and to what level or range. The substance may be a natural product or an industrial additive to the food (e.g. colorant, flavouring agent or preservative). A curious example -cholesterol, is found in many foods naturally typically in fatty foods and egg and egg products. Thus one can compare the presence of nutrients, or undesired constituents, in different foods using the component search made individually, as cited earlier. As an instance one may compare cholesterol amounts in raw egg (whole fresh) per 100 g product in chicken, duck and goose after first searching "egg" as a key word.

Obviously, food composition researchers and quality control analysts could benefit from such references for comparing their results with the food composition levels reflected in this database. In this regard, the components of raw foods, or naturally processed products (e.g. yoghurt) in the database could be of particular interest to producers in the developing world.

Another interesting website worth citing in this paper is "Dr Duke's Phytochemical and Ethnobotanical Databases" [8]. One of the plant search databases results in a list of concentration ranges of the natural products available in a plant of interest with links to (i) its biological activity and plants that contain high amounts of the phytochemical and (ii) reference source. The author's favourite example is coffee, *Coffea arabica* [9]. Clicking one of the chemicals in coffee (list), e.g. caffeine, gives its numerous reported biological activities as well as a list of plants containing high concentrations of caffeine.

Other smaller but important databases of specialised/specific nature are also linked under the Foods & Drinks subcategory of WebAnalytes [10].

Quality Control and Standards

Quality Control. A food product should be certified for its quality before distribution to local market or for export. Products are certified for quality by the standard bureau of each country and this will demand passing the quality requirement set by a national or international standard. This is also normally the case in the developing world, but it does not necessarily mean that the testing laboratory is accredited. Accreditation refers to recognition for the technical competence of the laboratory by an accreditation body. The latter may be a national, regional or international body which is recognised for its competence by ILAC - International Laboratory Accreditation Cooperation. The accreditation for testing a particular product (set of products) refers to fulfilling both management and technical requirements. The current standard to this is ISO 17025 -General Requirements for the Competence of Calibration and Testing Laboratories [11] (it can be purchased online as a pdf file). This standard technically compliments to ISO 9000. Consequently, any laboratory that satisfies the requirements of ISO 17025 also meets ISO 9000 requirements. The reverse is not true.

A food quality testing laboratory which is accredited to ISO 17025 would imply that its test results (for which it is accredited) are recognised in other countries laboratories where their laboratory competence is recognised in accordance with ISO 17025. This is an aspect of the ILAC Mutual Recognition Arrangement -a process to develop a global network of accredited testing and calibration laboratories. This leads to recognition of test results by other accredited laboratories and has obviously huge positive implications in promoting export. The website of ILAC has pages with discussion on the benefits of accreditation [12]. It has also a big section which offers a series of full-text guidelines. One of the guidelines worth citing in this regard is ILAC-G13:2000: Guidelines for the Requirements for the Competence of Providers of Proficiency Testing Schemes. It can be downloaded from the same website (ILAC Publications)

The lack of development with regard to accreditation can be illustrated with the situation in Africa. Chemistry in Africa [3] has a long list of links to several sites of African regional and national standards and accreditation institutions. The are a few full members of ILAC in the region., namely the South African National Accreditation Service (SANA) [13], National Laboratory Association of South Africa (NLA) [14] and the Conseil Accreditation of Tunisia. Quite obviously, accreditation is a major limit of development in the developing world. This is more so in Africa.

A Tanzanian example cited in a recent article, published in *Analytical Chemistry* [15], illustrates how an acceptable work of even an unaccredited laboratory could enhance economic development. A pesticide residue analysis research at the University of Dar es Salaam, Tanzania, was involved in determining the level of pesticides in fish from Lake Victoria. The result had helped the lifting of suspended exports of fish from Lake Victoria to the European Union (EU). This example makes it quite evident that Tanzania's fish export could better be enhanced if laboratory technical competence had been formally established

Standards. If we change our focus to testing standards, the excellent example of free full-text of standards is the web edition of the Codex Alimentarius. The Codex Alimentarius Commission (established in the mid 1960's by the UN FAO and WHO) adopts standards for commodities, codes of practice and maximum limits for additives, contaminants, pesticides residues and veterinary drugs [16] These are prepared by specialised committees and task forces within the Commission. The standards developed establish food safety standards as reference for the food industry thereby facilitating international trade of food commodities. Compliance of food quality laboratories with Codex Alimentarius protects public health and provides consumer confidence in the sector by advancing the quality required. Over 230 full-text (pdf) Codex standards (from 1966-2001) are posted on the Internet for public use [16].

The availability of full-text standards is one step forward. Laboratories need also relevant guidelines for the development and validation of test methods, be it a standard, an earlier validated method, or a newly developed method. Links to guidelines for these are listed in the standards page [17]. A notable example is the full-text online article by Mark Green, "A Practical Guide to Analytical Method Validation" [18].

The Standards Page in WebAnalytes includes links not only to websites relating to issues discussed just earlier but also to online resources and databases of certified reference materials, accepted test methods (or their sources), good laboratory practices, and quality assurance electronic journals.

Education

The most extensive of all the categories in WebAnalytes is the education section. In specialised fields like food chemistry, a background knowledge and experience in analytical chemistry is an obvious requirement. The student of food (analytical) chemistry should go through some or all of the normal analytical chemistry university programmes. Tens of

analytical chemistry education resources are listed in the analytical directory under the Education category. These are mostly from websites of North American Universities.

Several web links of food chemistry education courses including full-text lecture materials are presented in the biomedical page [1]. The food chemist should of course have a direct interest in most of the other biomedical methods in this page –biochemistry and biotechnology, and clinical and forensic chemistry.

Food Safety

Food safety procedures and guidelines are of many types and this includes chemical, microbial and radionuclide contaminations as well as pesticide residues. The Health, Safety and Environment (SHE) page [1] is devoted to these issues. Apart from the food-related links in this page, links to hazardous chemicals, water quality chemistry, chemical protection/compatibility, environmental chemistry, SHE literature as well as a section of pesticides chemistry should be of great interest. Natural toxins in raw foods, or their precursors (e.g. cassava cyanide), should be removed prior to consumption from their raw sources. The Natural products category in Chemistry Africa [3] has a collection of links to poisonous plants databases. The biomedical journals and databases are of course important sources of food related health and safety literature including detoxification topics.

Research Literature

One very important development behind the emergence of the Internet in the last decade is the availability of research literature in the public domain. This has allowed publishers to maintain sites with online journals and monographs. Most of the chemistry and related journals including those relevant to food and nutrition make their abstracts available to the public. A whole category page in WebAnalytes is devoted to publications referring to links to individual specialised and general journals sorted by publishers, journal databases as well as bibliographies of research publications.

Regarding access to journals for developing countries, the most important advance in the last year has been the offer made by the World Health Organisation (WHO) and several biomedical publishers. The organisations initially agreed to grant access to over 1000 biomedical journals free of charge (or at significantly reduced rates) for about 70 Developing Countries. To this end the WHO ushered [19] the establishment of the system HINARI (Health InterNetwork Access to Research Initiative) [20]. Further developments involved more biomedical publishers and increasing the capacity of HINARI to over 2,000 journals and databases (HINARI is conspicuously linked to Chemistry in Africa and the main directory). Today, institutions from 110 countries can access to HINARI after valid registration [21]. As might be expected, one can observe that most of the institutions in Africa are eligible to receive this benefit.

Conclusion

This paper has attempted to demonstrate that organised science web resources could better facilitate research and development for the developing world. With reference to the linked resources in the directory (WebAnalytes) it is demonstrated that the diverse applications of analytical chemistry plays a central role in maintaining food quality and promoting public health and safety. Also, the examples cited strongly reflect that formally recognised quality control (accreditation) promotes economic development.

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