

Scientific production on functional foods: an analysis of Brazilian publications between 2007 and 2013

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Abstract

The Brazilian scientific literature on functional foods is the subject matter of this article. It is a survey, using bibliometric techniques, of articles published on the subject from 2007-2013, available on the Capes Journals Site. Among the 164 articles in Portuguese found in that site, 22 were selected for the analysis. Eight journal articles were found on the subject and two concentrated 63.63% of the production: (36.36%) on Food and Nutrition and (27.27%) on Food Science and Technology. The parallel topics covered were antioxidants, fatty acids, prebiotics and probiotics. Unicamp was the institution with the highest number of articles analyzed, representing 13.64% of the sample. As for the method of approach, there is a clear predominance of the quantitative method (54.54%), which can be explained by the use of sensory and physicochemical reviews, instruments commonly used on quantitative analysis found in 45.45% of the surveyed items. Most authors have training in nutrition and are tied up to universities. The research was exploratory with the use of document analysis, at first, and descriptive with quantitative method, afterwards. The analysis studied the number of articles, higher education institutions, themes, methodology, data collection instruments and the authors training area. Published works are aimed both to support interventions as boosting the theoretical development of the area.

Keywords: Functional Foods. Review. Electronic Journals.

Introduction

The Hippocratic principle - “Let food be thy medicine and medicine be thy food” - uttered 2,500 years ago, already demonstrated that the beneficial effects on health ‘of certain types of food are known for a very long time.’¹

Health and quality of life are nowadays one of the most salient concerns of some consumer segments. This concern is due primarily to three factors: a poor diet, physical inactivity and stress, which cause health problems such as obesity; the knowledge advancement in the health field, which allows us to understand the harm of this lifestyle in the medium and long term; and because of the knowledge diffusion speed, we see a greater information among consumers and, therefore, a higher concern with health and quality of life.²

The idea of health as quality of life, conditioned by several factors, such as peace, shelter, food, income, education, economic resources, stable ecosystem, sustainable resources, equity and social justice, came up with the International Conference on Health Promotion in Ottawa, in 1986.³ The Ottawa Chart⁴ considers health as a positive concept, for which are necessary personal and social resources, and physical capacity.

In this scenario, there is a growing interest in the so-called “functional foods”, which aim to contribute to the health promotion.^{5,6} A research *Health Focus* conducted in 30 countries revealed that 44% of the Brazilian consumers, from A and B classes, choose food influenced by the relationship they have with health – which constitutes one of the highest rates in Latin America.⁷

Several factors have stimulated the development of functional foods over the past few years, among which are: the increase of life expectancy in developed countries (whose populations will require hospital care for a longer period of time), the high cost of health services, the progress in food technology and ingredients, the public research institutions need to spread the results of their investigations and the increased coverage of different types of media given to these findings and health issues.⁸

Given the central role that the scientific research faces the challenges of that area, this study purpose is to gather information on the contemporary scientific literature on functional foods, specifically published in national journals in the Nutrition area in the period between 2007 and 2013. Accordingly, the study general objective focuses on the analysis of the scientific production on functional foods.

Publications available on the Capes Journals site were used. In this sense, this study aims to identify, through the use of bibliometric techniques, higher education institutions (HEI) with higher production and that were the most productive; the parallel themes of the functional food articles; the periodicals with higher productivity on the subject; the research methods used; the data collection instruments adopted; the most searched foods. Finally, we examined the training areas of the first author by consulting Lattes curriculum.

The choice of Capes Journals site is justified for it is an indexing, research system with free availability of scientific literature that seeks to promote access, organization, dissemination and scientific production analysis of different areas of knowledge. Therefore this study seeks to contribute to the research on functional foods, analyzing a relevant part of the Brazilian scientific production.

The article is structured in four parts. Initially, an overview on bibliometric techniques and their use in the scientific production study of one area is presented, then the central theme developed, which are functional foods. Later on, the methodology used in the study is outlined and the results obtained described. Finally, the conclusions and the recommendations of the work are presented.

Bibliometrics in the analysis of scientific production

Functional foods are attracting the interest of many researchers, which leads them to study this issue on a continuous and systematic way. One of the ways in the quest to understand the subject is bibliometrics, which is “a quantitative technique and statistical measurement of the production rates and dissemination of the scientific knowledge”.⁹

Among bibliometrics main laws are the Lotka's Law⁹, focused on the study of the authors scientific productivity; the Bradford Law focused on the productivity journals analysis; and the Zipf's Law⁹, which focus on the identification of words frequency in the study. By the bibliometric techniques use, it becomes possible to measure the productivity and dispersion of the scientific knowledge production, as well as the identification of the distribution model and frequency of words in a text.

The Lotka's Law,⁹ also known as the Inverse Square Law, was formulated in 1926 and means that a large scientific production comes from a small number of authors.⁷ The Zipf's Law⁹, also known as the Least Effort Law, focuses in measuring the frequency with which certain words appear in the studied literature.

Bradford¹⁰ made his first comments on the articles dispersion in 1934, but in 1948 only they were recognized with the status of law. The Law statement says:

*[...] if journals are sorted in decreasing productivity order of articles on a particular subject, they may be distributed on a journals core more specifically devoted to this subject, and in various groups or areas, containing the same number of items than the core, always when the journals number and the successive zones are equal to $1:n:n^2$.*¹⁰

About bibliometrics, Bernardino & Cavalcante claim:

*Bibliometrics is the study of production, dissemination quantitative aspects and the use of recorded information; it develops standards and mathematical models to measure these processes, using their results to develop forecasts and support decision making.*¹¹

Therefore, by bibliometrics it is possible to outline a safe scenario of scientific literature on functional foods in the country, able to guide researchers and publishers, among others, on issues that merit investment. The bibliometric techniques use allows to analyze the scientific production development and distribution, considering at the same time, the social structure of those performing such production as well as the interaction between those who produce and those who consume this content.¹⁰ The bibliometric study aims to measure and quantify results minimizing possible distortions in the analysis and data interpretation.¹² By the use of statistical and mathematical techniques in this study we can objectively analyze the scientific production.

Functional foods

In Japan in the 1980s, the term “functional foods” was introduced (FOSHU - foods for specified health use), to characterize a new conception of food that detain medicinal properties reducing health care costs. This term was launched as part of a government program, whose objective was to develop healthy food for a population that grew older and had a high life expectancy.¹

Functional foods are those that, in addition to contributing to nutrition, contain substances that may be considered biologically active, producing clinical or health benefits. They are able to reduce the risk of some diseases and assist in physiological functions of the organism.¹³

Another accepted definition describes functional foods as:

[...] foods for which can be satisfactorily demonstrated that they beneficially affect one or more functions of the organism, as well as ensuring adequate nutritional effects, leading to a general health improvement and well-being and/or reduction of diseases risk.¹⁴⁻¹⁶

Regarding the definition, it is important to mention the necessary distinction related to the term “nutraceutical”. While functional foods refer to food or beverages consumed in the daily diet that can bring health benefits due to physiologically healthy factors, nutraceuticals are related to a wide range of foods and food components with strong appeal to health including food supplements, isolated nutrients, herbal products, or processed food.¹ According to Campos,

[...] from a practical viewpoint, one functional food can be one natural food; a food to which has been added an ingredient, or a food from which a component was removed by technological or biotechnological processes.¹⁷

Brazilian laws do not clearly define functional foods, but claims the functional property as being “related to the metabolic or physiological role that the nutrient or non-nutrient plays in growth, development, maintenance and other normal functions of the human body.”¹⁸ In addition, the Ministry of Health, through the National Health Surveillance Agency (ANVISA), regulated functional foods by the ANVISA/MS 16/99,¹⁹ ANVISA/MS 17/99;²⁰ and ANVISA/MS 19/99 resolutions.²¹

These foods have the potential to promote health through mechanisms not provided in conventional nutrition, it should be however said that this effect is restricted to health promotion and not curing diseases.²² The diet incorporation to a healthy lifestyle, once this may be associated to disease prevention and health promotion consequently led to the creation of a market for these products.⁸

A functional food can be classified according to the food itself or by the bioactive components present therein, such as, for example, probiotics, fibers, phytochemicals, vitamins, minerals, herbs, omega 3 fatty acids (ω -3), as well as certain peptides and proteins.⁸ There are two other forms of foods classification: a) the source being from a plant or animal; b) the many benefits they offer, working in six areas of the body, namely: the gastrointestinal system; the cardiovascular system; the substrates metabolism; growth, development and cellular differentiation; acting in the physiological functions behavior and as antioxidants.²³

Functional foods are the new trend of the powerful food market at the beginning of the XXI century²⁴. Among the key factors that explain the functional foods success, are the growing concern for health and well-being, changes in food industry regulation and the growing scientific evidence of the relationship between diet and health.²⁵

The development of functional foods is a field full of opportunities. Consumers are demanding food that meet their nutritional needs, and may contribute to their health strengthening and well-being, delaying as much as possible the emergence of diseases.

The functional foods global market, mostly in developing countries, showed a significant growth in the 1990s. It should be pointed out that, like any other market, the functional food is influenced by several actors. The economic field is a field of action, socially constructed, where agents with different features according to the volume and capital structure they have, face each other in their different forms: financial, cultural, technological, legal, organizational, commercial and symbolic and, depending on these resources, actors define action strategies within the limits imposed by the field structure, specifically by their degree of concentration.^{26,27}

The State plays a relevant role in the social market construction process. Of all the characteristics of companies in which the economic order is “immersed”, the most important for the contemporary societies are the shape and the strength of its statesman tradition.²⁸ The state can influence the demand construction through the production of individual preferences systems and the necessary resources attribution (ex. credit advice, tax benefits, etc.²⁸

Methodology

The data in this study consisted of articles published in national journals from 2007 to 2013, available on the Capes Journals site in January 2014. The functional foods publications inclusion was defined from the titles, abstracts and keywords analysis containing the theme “functional foods” in articles published in national journals. For the analysis, we used only articles.

This study can be characterized as exploratory, with a quantitative method. The research is of document type,²⁹⁻³² as the study object material are articles published in scientific journals, a type of periodical publication. In a second step, the research takes a descriptive character.

As the study overall objective was to analyze the production of functional foods in Brazil, in the exploratory and quantitative phase of the research a survey of scientific articles published in national journals and available on the Capes Journals site was carried out. Therefore, the articles analysis produced between 2007 and 2013 was chosen, as this period refers to the most current literature on the subject.

In the research at first, we attempted to qualify all scientific papers on functional foods available on the site. We proceeded to filtering, searching on the topic subject, using the following criteria: peer-reviewed journals, articles that mentioned the “functional foods” term in the title, abstract and/or the keywords, language: Portuguese and between the years 2007 and 2013.

Following this approach, the items have been separated for analysis. Under these conditions, we found a total of 22 scientific articles, which were incorporated into the descriptive quantitative second stage of the research. At this stage, the initial aim was to identify the articles following variables: the HEI that were the most productive; the parallel themes of the functional food articles; journals with higher productivity on the subject; the research methods used; the data collection instruments adopted; the most searched foods; and finally, we examined the first author areas of training by consulting Lattes curriculum.

Then, the results quantification was carried out by the simple frequency count. Upon completion of this step, in each of the reviewed articles, data were analyzed using descriptive statistics, with Microsoft Excel software support. The results were gathered in charts and graphic.

Results and discussions

Sample profile

Authors' articles and HEI linked to functional foods research

In the articles examined the presence of the same author in more than one article was not detected. This can infer the lack of references in academia when it comes to functional foods, and can be directly connected to the fact that research on these foods is still recent in the country.

We verified that some HEI have greater participation in scientific literature on functional foods. As can be seen in Chart 1, UNICAMP, UFRJ and USP have together a representation of 31.82% of the surveyed items.

Chart 1. Distribution of HEI scientific production. Brazil, 2007-2013.

IES	f (TOTAL)	f (%)
UNICAMP	3	13,64%
UFRJ	2	9,09%
USP	2	9,09%
Others	15	68,18%

Source: Research results

Most frequent issues related to the topic

For matters related to functional foods, we found that antioxidants, fatty acids, prebiotics and probiotics are some of the subjects treated in parallel when it comes to functional foods. This has been observed in a few articles. For example, antioxidants topics were found in three articles (13.64%); prebiotics have topics in five (22.73% of total). Prebiotics are non digestible food ingredients that act in the body, providing a growth substrate of microorganisms in the intestines, changing thereby the intestinal flora activity.¹

With regards to health, they contribute to the modulation of important physiological functions - such as calcium absorption and lipid metabolism - and the modulation of intestinal micro flora composition, playing a fundamental role in the intestinal physiology and reduced risk of colon cancer.³³ The probiotics use in food can increase crispness in snacks and cereals and extend the breads and cakes life. Its solubility allows them to be incorporated into liquid food or drinks without altering the food sensory characteristics.³⁴

Articles distribution per journal

From the conducted survey, it can be seen that some journals have a higher volume of publications on functional foods. From the eight journals analyzed two concentrated 63.63% of the production, i.e., more than half of the analyzed articles. When checking the

publications distribution pattern on functional foods, it appears that the *Food and Nutrition* journal has the largest number of articles on the theme, representing 36.36% of the total, followed by the *Food Science and Technology*, which concentrates 27.27% of the total. The journals choice relates to the authors training area (mostly from Nutrition and Food Engineering area), and reveals differences in these publications thematic specificities and scope.

The publications distribution on functional foods per journal (Chart 2) also reveals differences between the dissemination vehicles concerning the studies presence on the subject. Such differences can be attributed to several factors, among which the authors preference for certain journals, the theme specificity of some of them and the frequency thereof.

Chart 2. Distribution of articles per journal. Brazil, 2007-2013.

JOURNALS	f (TOTAL)	f (%)
Foods and Nutrition	8	36,36%
Science and Foods Technology	6	27,27%
Nutrition Review	2	9,09%
Rural Science	2	9,09%
Others	4	18,20%

Source: Research results

Used methodologies

As for the research methods used in the studies published in the analyzed articles, the mixed type ones are the preference of most of the authors (Chart 3). This fact can be explained for in most articles the authors aimed to obtain data on the compounds present on the studied foods and the consumption perception on such foods.

The survey showed that quantitative studies are the majority with 54.54% of the share, followed by qualitative studies, which are present in 36.36% of the articles. Having in mind that the methodologies have a close relationship with the research objectives, we could

identify as the research main focuses: data on the studied food compounds and analyze the perception on the consumption of such foods. According to research related to food and nutrition, the qualitative methodologies have significantly increased the dialogue of these areas with Social Sciences and Humanities. It is note worthy that the qualitative studies represent an advance, but still require theoretical and methodological improvement to overcome the descriptive studies.³⁵

Chart 3. The articles methodology distribution. Brazil, 2007-2013.

RESEARCH METHODS	f (TOTAL)	f (%)
Quantitative	12	54,54%
Qualitative	8	36,36%
Mixed	2	9,09%

Source: Research results

Data collection instruments

Following the survey on functional foods published articles in national journals, the data collection instruments adopted by the authors were analyzed. Firstly, it is important to emphasize the close relationship between objectives, research methodologies and the data collection tools.

Considering the above on these methods, it was noticed that the sensory analysis, physical and chemical analysis as well as questionnaires are the instruments preferred by researchers (Chart 4). According to the Brazilian Association of Technical Standards, the sensory analysis is a scientific discipline used to interpret reactions to food characteristics and materials and how they are perceived by senses.³⁶ This methodology is widely used by the food industry as a way to analyze the quality and acceptability of a product.³⁷ This methodology is generally carried out by a team whose goal is to analyze the product sensory characteristics.³⁷ As a result, it is possible to evaluate, for example, the raw material to be used in a new product, the processing effect, the texture quality, flavor, storage stability, consumer reaction, among others.

As for the physical-chemical analysis they are based on instrumental techniques that seek to quantify analytes, even at very low concentrations. These techniques are very useful, for the technological advances in food science, developing mainly toxicological studies of identity and quality of food.³⁸

In short, as most of the items had a quantitative and exploratory character, there is a preference for instruments measuring the food components and their consumption awareness in study, which explains, for example, the sensory analysis prevalence in the researched articles.

Chart 4. Distribution of the articles data collection instruments. Brazil, 2007 – 2013.

INSTRUMENTS	f (TOTAL)	f (%)
Sensorial Analysis	6	27,27%
Physic-Chemistry Analysis	4	18,18%
Questionnaires	3	13,64%
Rheological Properties Evaluation	2	9,09%
Documental Search	2	9,09%
Bibliographic Search	2	9,09%
Observations	1	4,55%
Others	7	31,82%

Source: Research results

Surveyed food

The soybean search was the preference of most of the authors. The soybean, food of universal consumption, is of great importance regarding functional foods, having a high quality protein, capable of being used preventively and therapeutically in the cardiovascular diseases, cancer, osteoporosis and symptoms of menopause treatments.³⁹

Regarding the functional food concept, soy opens perspectives to the food industry for the development of various food formulations, which helps justify its preference among researchers. Moreover, the large investment in the Brazilian production and the investment in transgenic products work with this code. The consumption of raw soy or even a processed one, in

the form of derivatives, has attracted a great interest from the population, specifically researchers, not only because it is considered an important source of low cost nutrients, but mainly for its ability to reduce the risk of chronic-degenerative diseases.⁴⁰

Although the soy consumption has significantly increased and repeatedly appears linked to health benefits, there are also little known controversies about it. The environmental character of soybean production-related risks, often ignored in soybean definition as healthy and safe food, is also discussed.⁴¹ The use of transgenic seeds, for example, has a negative impact on the habitat as well as health and quality of life of human beings.⁴²

The authors training area

Regarding the initial higher education area (first top level titration) of the first author, obtained by consulting Lattes curriculum, it was observed that most of the articles of the analyzed authors are Nutrition graduates, representing 27.27% of the total, as can be seen in Figure 1. In addition, most of them are teachers or are linked to higher education institutions.

Due to the current dietary patterns changes and their effect on health, leading to high rates of chronic and/or degenerative diseases, the nutrition field has increasingly focused on the relationship between diet and health.⁴³ The author points out that:

[...] this good health-promoting food new concept is emerging as a new frontier in the nutrition professionals challenge and introducing the need of traditional nutrients, as established during all the years of Nutritional studies, however greatly enlarged for the preventive nutrients concept.⁴³

Another major focus area in academic research on functional foods was Food Engineering, representing 22.73% of the total. In CAPES, this field is within the “Food Science” assessment area. Its focus aims in mastering the whole manufacture, preservation, storage and transport of the processed foods processes. Therefore, the area interest on this subject is due to the food industry large investment in functional foods.

For Raud, “functional foods are the powerful food market new trend at the beginning of XXI century”, and a profusion of new products that promise to help in search for a healthier life can be seen on the supermarket shelves.² The demand for such products has stimulated the research to develop products - such as yogurts, margarines, buttermilk,

cereals, mineral water and alike - which promise to contribute to the prevention of diseases such as cardiovascular disease, allergies, intestinal problems, etc.

The *Brazil Food Trends 2020*⁴⁴ report identifies among the “healthiness and well-being” trends, the growth demand for functional foods as a result of the consumer increased concern with nutrition. The document highlights that the functional products consumption has formed different market niches, for instance, beneficial products to the physical and mental performance, cardiovascular health, gastrointestinal health, improving the state of mind (energy) and relaxing, among others.⁴⁴

Another important and already expected factor: most authors are from public institutions, as the subject research is still concentrated in the university environment.

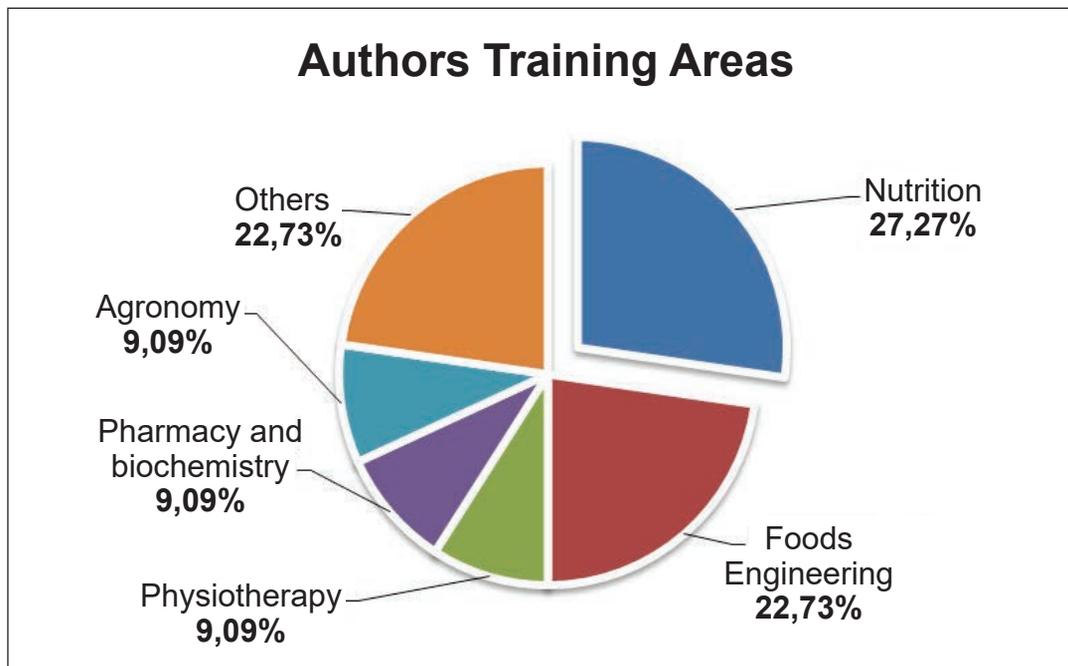


Figure 1. Distribution graphic of the authors training areas. Brazil, 2007-2013.

Source: Research results

Conclusions

Whereas the survey provides important contributions to further characterization of the national scientific production on functional foods, one can see from the data and the analysis made that there is a low number of functional foods publications in the Brazilian journals.

Analyzing the scientific production published in national journals, one can see a few trends: there is quantitative research predominance and investigations using a mixed approach (qualitative and quantitative) are less frequent to address the issue.

Results show a thematic and methodological diversity of the scientific literature on functional foods, as well as the authors concern to address related issues, such as antioxidants, fatty acids, probiotics and prebiotics. This reality shows that works on functional foods are not geared only for topics reproduction, but are considering as well the subjects diversity related to the theme.

Another important point is that the survey indicates that the knowledge production is directed both to the interventions implementation, the functional food products development, and to boost the theoretical development on the subject. This was evident by observing that studies were directed to both the development and thematic reviews on them.

Something that could study further this area would be the research development covering longer periods, in order to identify trends and thematic changes of scientific literature on functional foods, as well as the study of other food types. As seen in this research, functional foods studies do not have much variety, focusing on food such as soybeans.

Another aspect that could contribute to this analysis would be the inclusion of dissertations and theses on the subject, as they are important sources of scientific production.

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