A bibliometric analysis of global research on bamboo from 1992 to 2011

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Abstract

The study was mainly conceived to evaluate the global scientific output of bamboo research and to assess the characteristics of the research tendencies and performances. Data were based on the online version of Science Citation Index Expanded, Web of Science from 1992 to 2011. Publications referring to bamboo were assessed by distribution of document types, languages, categories, journals, source institutions, and source countries. The five indicators, the number and ranking of total articles, first author articles, corresponding author articles, independent articles, and collaborative articles, were applied to evaluate country and institution performances. Research tendency was investigated by statistically analyzing the distribution of words in article titles, abstracts, author keywords, and *KeyWords Plus* in four periods. Results showed the bamboo research mainly focused on the Web of Science category of multidisciplinary materials science. *Journal of Applied Physics* published the most articles. The China ranked first in the five publication indicators except the item of internationally collaborative article. "Carbon", "nanotubes", and "properties" were the most frequently used words in article titles, abstracts, author keywords, and *KeyWords Plus*. Topics related to carbons, nanotubes, and adsorption were the foci in bamboo research. Researchers paid more attention on carbon. Besides, most cited articles were also presented.

Keywords: Bibliometric, Web of Science, USA, Chemical Engineering, Research Trends

1. Introduction

Bamboo is one of the fastest-growing plants in the world, due to a unique rhizome-dependent system. Bamboos are economic and cultural significance in South Asia, Southeast Asia and East Asia, being used for building materials, as a food source, and as a multiuse product. In China, bamboo as panda diet has been attractive for many years. In 1982, Dierenfeld et al. investigated that two giant pandas were used to assess the utilization of bamboo as a feedstuff [1]. Several bamboo relative researches also focused on the conservation of panda, such as "bamboo loss endangers giant pandas in China" [2], "bamboo flowering and pandas" [3], and "bamboo regeneration after flowering in the Wolong giant panda reserve, China" [4]. There is a long history of use of bamboo as construction. "bamboo - its use in the construction of roofs and bridges" [5] and "bamboo as construction material" [6] were investigated. Bamboo has long been investigated for textiles use. In 21th century, the "structures of bamboo fiber for textiles" [7], "modification of natural bamboo fibers for textile applications" [8], and "bio-processing of bamboo fibers for textile applications: a mini review" [9] were studied. Bamboo can also be used in manufacture of Chinese ceremonial paper [10]. Bamboos were carbonized and activated as activated carbon for water treatment. The activated carbon was used to treat wastewater which contains arsenic [8,11], quinolone [12], organic materials from TNT red water [13], and Cr(VI) [14].

The Science Citation Index Expanded (SCI-Expanded) [15] is the most frequently used database for a broad review of scientific research. In recent years, the bibliometric method was applied to the analysis of scientific publications and research trends in scientific topics, for example, desalination [16], and adsorption [17]. In this study, a traditional bibliometric method, analysis of basic publication items such as document types, languages, and journals and their categories was used to describe the latest advances in bamboo research. Five indicators, numbers of total articles, independent articles, collaborative articles, first author articles, and corresponding

author articles were used to evaluate the publication outputs of countries and institutions. Distribution of words in article titles, author keywords, *KeyWords Plus*, and words in abstracts in different periods was applied to map the global research trends. The *KeyWords Plus* in the SCI-Expanded database is additional search terms extracted from the titles of articles cited by authors in their bibliographies and footnotes [18]. These investigations will provide some additional insights into the current state of bamboo research during the time span from 1992 to 2011 and can help researchers to broaden their view on bamboo research and to establish future research directions.

2. Materials and Methods

The data were based on the online version of the SCI-Expanded database. According to *Journal Citation Reports* (*JCR*), it indexes 8,336 journals with citation references across 176 scientific disciplines in 2011. The database was searched under the keyword "bamboo" in terms of topic (title, abstract, author keywords, and *KeyWords Plus*) within the publication year limitation from 1992 to 2011. Document information including names of authors, title, abstract, author keywords, *KeyWords Plus*, contact address, year of publication, categories, and names of journals publishing the articles were downloaded into spreadsheet software. Additional coding was performed manually for the number of origin country and institution of the collaborators, and impact factors of the publishing journals. The impact factors were taken from the *Journal Citation Report* (*JCR*) published in 2011. Articles originating from England, Scotland, Northern Ireland, and Wales were reclassified as being from the United Kingdom (UK). Articles from Hong Kong published before 1997 were included in the China category. Collaboration type was categorized and determined by the addresses of the authors as: single country articles with addresses from the same country; internationally collaborative articles with author addresses from more than one country or territory [19]; single institution articles with addresses from the same institution; and inter-institutionally collaborative articles with author addresses from more than one institution [20]. Keywords were defined as comma-separated items of one or more words. All keywords, both those reported by authors and those attributed by the Web of Science, as well as words in title and abstract were identified and separated into 5-year span (1992-1996, 1997-2001, 2002-2006, and 2007-2011), then their ranks and frequencies were calculated. A word cluster analysis was performed in the combination of the words in titles, author keywords, *KeyWords Plus*, and words in abstracts, in which different words with identical meaning and misspelled keywords were grouped and considered as a single keyword [19,21].

3. Results and Discussions

3.1. Document Type and Publication Language

The distribution of document type identified by Web of Science was analyzed. From this study, 12 document types were found in the total 4,313 publications during 1992-2011. Journal articles (3,752) were the most-frequently used document type comprising 87% of the total publication, followed by proceedings papers (296; 6.9%). The others were less significant, including reviews, meeting abstracts, notes, letters, editorial materials, news items, corrections, addition corrections, book reviews, and book chapters. Articles were identified and further analyzed, since the journal article was dominant in the document types and peer-reviewed and included whole research ideas and results [22]. The emphasis of the following discussion was to determine the pattern of scientific production, research activity trends of institutions and countries, and the trends of research subjects. Ninety-seven percent of all these journal articles were published in English (3,508). Similar with other fields [19,23], English was the dominant language. The followed languages were Chinese (77), Japanese (55), Spanish (41), Portuguese (31), German (17), and French (13). Some other languages that are less used were as follows: Russian, Korean, Croatian, Polish, Turkish, and Finnish.

3.2. Characteristics of Publication Outputs

The publications of bamboo research were displayed in Figure 1. The annual number of articles increased from 58 articles in 1992 to 496 articles in 2011. The first bamboo related paper in SCI-Expanded database was a letter "Bamboo manna" published in *Nature* [24].

"Bamboo" [25] was published as the first article related to bamboo in SCI-Expanded.

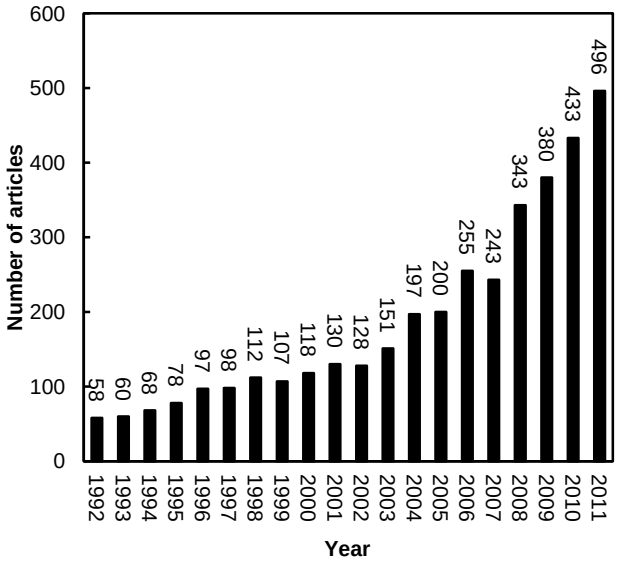

Figure 1. The publications of bamboo research by year.

3.3. Web of Science Categories and Journals

Distribution of journal and Web of Science categories has been studied for research topics [26]. Based on the classification of categories in *Journal Citation Reports* 2011 edition, the publication output data of bamboo research was apportioned among 159 SCI categories during 1992-2011. Web of Science categories containing more than 300 articles were multidisciplinary materials science (422; 11%), plant sciences (388), forestry (315), and ecology (306). Figure 2 shows the top five Web of Science categories with the most publications. The plant science was leading the first position in 2012. Otherwise, the multidisciplinary materials science took the lead from 2000 to 2011, except for the year of 2009. However, since 2003 the number of articles in forestry was smooth-growing and ranked third in 2011 (Fig. 2). Articles were published in a wide range of 1,238 SCI journals. In the bamboo relative research, *Journal of Applied Physics* published the most articles (62; 1.7%), while *Forest Ecology and Management* ranked second with 60. Close on *Ecological Research* with 46, *Journal of Applied Polymer Science* had 43; *Applied Physics Letters* published 42; and *Mokuzai Gakkaishi* had 39. The percentage of the top journal was low, which indicates the breadth of article distribution in bamboo research. This phenomenon also appears in other research areas, such as *Plant Physiology* (2.5%) in photosynthesis [27], *World Development* (3.0%) in financial crisis research [28], and *Marine Pollution Bulletin* (8.4%) in estuary pollution [29]. Three articles were cited more than 300 times. "Kinetics and mechanism of removal of methylene blue by adsorption on various carbons: a comparative study" in *Dyes and Pigments* [30], "nanoparticles and filled nanocapsules" in *Carbon* [31], and "the production and structure of pyrolytic carbon nanotubes (PCNTs)" in *Journal of Physics and Chemistry of Solids* [32] which had been cited 412, 312 and 304 times from their initial publication to 2011. The pioneer researches were obviously involved into materials science on bamboo research.

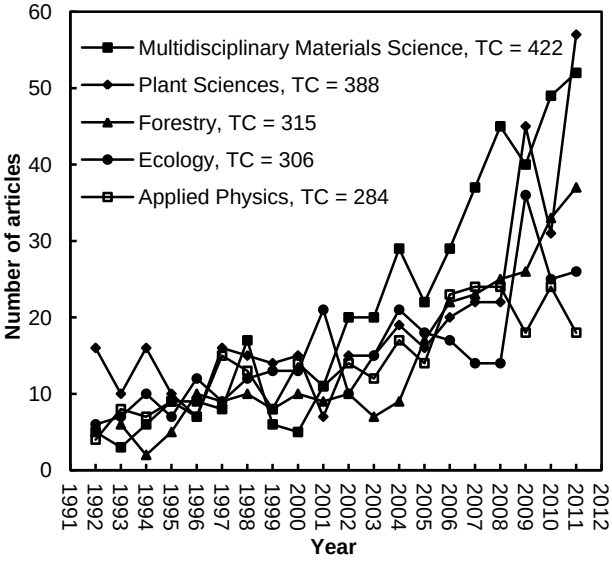

Figure 2. Comparison of growth trends of the top five productive Web of Science categories.

3.4. Distribution of Countrywide Articles

The contributions of different countries/territories were estimated by the location of the affiliation of at least one author. In recent years, Ho developed five bibliometric indicators to evaluate the research performances including countries' performances [23,33,34]. Among the bamboo relative articles, 114 of them did not have information on author address. Of all the articles with author's addresses, 3,632 (99.8%) articles were country independent articles from 87 countries and six (0.165%) articles were internationally collaborative articles from ten countries. Comparing with other areas, the collaboration rate was much lower than others, such as 14% of biosorption technology for water treatment [35], 16% of desalination research [16], 18% of financial

crisis research [28], and 14% of acupuncture research [33]. The China, the Japan, and USA had a high productivity in terms of total, independent, internationally collaborative, first author, and corresponding author articles. Domination in articles from the mainstream countries was not surprising since this pattern also occurred in other scientific fields [19]. The China exhibited its predominance in global bamboo research and showed the greatest counts of world articles, comprising 21% of the total articles. In addition, the China published the most single-country articles, first author articles, and corresponding author articles with 21% for each indicator. Half of the top ten most productive countries, China (775), Japan (580), India (370), Taiwan (238) and South Korea (115) were Asian countries (Table 1). A comparison of the publication trends of the top seven countries with the articles during 1992-2011 is shown in Fig. 3. The number of articles in China increased in recent years, which can be partly attributed to that Chinese national treasure, the panda, lives on bamboo. "The sequence and de novo assembly of the giant panda genome" [36] was the most frequently cited article in China. This article is a country independent article.

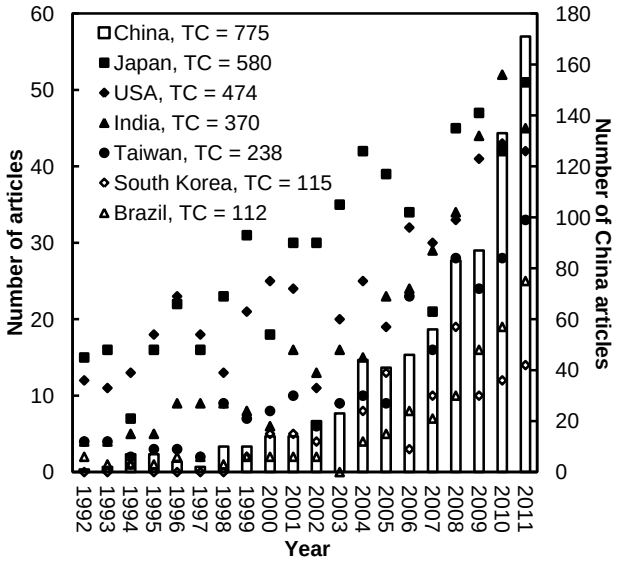

Figure 3. Comparison of growth trends of the top seven productive countries in 2011.

3.5. Distribution of Institution Analysis

The contribution of different institutions was estimated by the affiliation of at least one author. Of the 3,638 articles with author addresses, 3617 (99.4%) were independent articles and 21 (0.577%) were inter-institutionally collaborative articles. Similar to the international collaborative rate, the inter-institutional collaborative rate was also much lower than the fields 62% of global climate change [37], 53% of atmospheric simulation [38], acupuncture research [33], photosynthesis [27] and 37% of desalination research [16]. The top ten institutions were ranked by the number of total articles (Table 2). This included five indicators: total number of articles, single-institution articles, inter-institutionally collaborative articles, first author articles, and corresponding author articles [20]. The percentage of institution independent articles among the total articles for each institution (%S) was also considered. Of the top ten institutions, four were from Japan, three from China and Taiwan, and one from India. The Chinese Academy of Sciences (China) published the most articles (124) and completed the most independent articles as well as the most first author and corresponding author articles. It should be noted that the Hokkaido University (Japan) ranked 4st in total articles, but ranked top one in inter-institutionally collaborative articles. The result of the institutions' output should be interpreted in the context of bias. Both the Chinese Academy of Sciences and the Indian Institutes of Technology had over 100 branches in different cities in their country. The articles of these two institutions were pooled as one heading, and articles divided into branches would result into different rankings [39]. The top ten most productive institutions were all from Asia

3.6. Paper Titles and Author Keywords Analysis

The title and author keywords of an article always include the information that the author would most like to express to the readers directly, therefore analysis of the word distribution in article titles and author keywords in different periods have been used to evaluate research trends [19,40]. The title of an article can be used to identify the subjective focus and emphasis specified by authors. The analysis distribution of article titles in different periods was applied in mapping environment related research trends in aerosol [40], atmospheric simulation [39], water resource [41], and medical related research in lung cancer research [22]. The title words of bamboo-related articles were statistically analyzed in this study. In the

following analysis, the meaningful and important analysis of author keywords were displayed, and words in title were also analyzed to support and supplement for research trends and emphases. All single words in the titles and abstracts of solid waste related articles were analyzed statistically. Some prepositions and common words such as "of", "the", "and", and "during" were discarded because they were meaningless for the analysis. The 30 most frequently used substantives in titles were grouped in 4 five-year periods (Table 3). Except searching keywords, "carbon" was the most frequently used in the titles. In 1994, "carbon stock and cycling in a bamboo phyllostachys-bambusoides stand" was reported [42]. A high impact soil related article was "growth model of bamboo-shaped carbon nanotubes by thermal chemical vapor deposition" [43]. In addition, the rank and percentage of "nanotubes" increased steeply from #388 (0.28%) during 1992-1996 to #4 (7.1%) during 2007-2011, similar to the results of analysis of author keywords (Table 4), in which that of "carbon nanotubes" increased from 0 during 1992-1996 to #4 (2.5%) during 2007-2011. The word "bamboo" is an adjective to describe the nanotubes' shape in some papers, such as "synthesis of bamboo-shaped multiwalled carbon nanotubes using thermal chemical vapor deposition" [44]. Table 4 shows that "carbon nanotubes" had the highest frequency in author keywords. Meanwhile, the rank and percentage of "bamboo charcoal" increased steeply from 0 during 1992-1996 to #3 (2.7%) during 2007-20011, and rank and percentage of "adsorption" increased steeply from 0 during 1992-1996 to #5 (2.3%) during 2007-20011. On the contrary, a decline in the ranking of the author keyword "electromigration" was evident, from #3 (2.5%) during 1992-1996 to #89 (0.32%) during 2007-2011.

3.7. *KeyWords Plus*, and Abstracts Analysis

Distributions of *KeyWords Plus* and words in abstracts in different periods were applied to evaluate research trends of aerosol [40], volatile organic compounds [45], and desalination [16]. The *KeyWords Plus* supplies additional search terms extracted from the titles of articles cited by authors in their bibliographies and footnotes in the ISI database, and substantially augment title-word and author-keyword indexing [18]. Except the searching word "bamboo", the top most frequent *KeyWords Plus* were "growth" (278; 9.0%), "behavior" (134; 4.4%), "mechanical-properties" (131; 4.3%), and "chemical-vapor-deposition" (106; 3.4 %). Furthermore, the rank of "removal" went up markedly from 0 during 1992-1996 to #9 during 2007-2011. The indicator was firstly reported to evaluate the research trends using the distributions of words in abstracts in different periods [45]. As with the distribution of words in article titles, author keywords, and *KeyWords Plus*, "properties" and "carbon", were the most frequently used single words during 1992-2011.

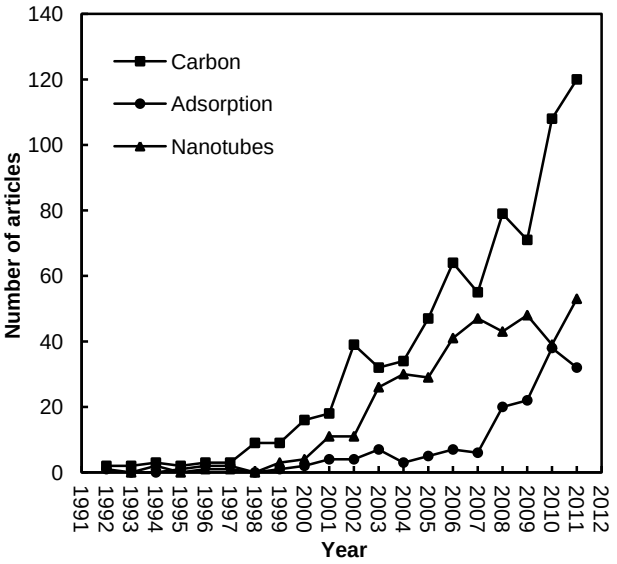

Figure 4. Comparison of trends of carbon, adsorption, and nanotubes.

3.8. Hot Research Topics

The topics listed in Fig. 4 all include their plural forms and other transformations in the article titles, abstract, and author keywords. For example, adsorption included "adsorption" or "sorption" or "adsorbent" or "sorbent" and nanotubes included "carbon nanotubes" or "carbon nanotube" or "nanostructures" or "nanotubes" or "nanomaterials. Figure 4 shows the research trends for the main research topics such as carbon, adsorption, and nanotubes from 1992 to 2011. The number of articles related carbon increased rapidly from 2001. The trend of adsorption relative articles was increased smoothly during 1992-2007, as well as the article number decreased in 2011. Topic related to nanotube had an increasing trend after 2002.

4. Conclusions

It was found 4,315 publications related to bamboo with 12 document types during 1992-2011. Thirteen languages were used in 3,752 articles that were published in 1,238 journals listed in 136 SCI categories. *Journal of Applied Physics* with the impact factor 2.168 in the fields of applied physics published the most articles related to bamboo. The Web of Science category multidisciplinary materials science published the most articles and had the most rapid growth after 2005. The China ranked first with respect to four indicators, namely total, single country, first author, and corresponding author articles followed by the Japan and USA. The bamboo relative topic was the area-depended research. The Chinese Academy of Sciences (China) was the most productive institution, but Hokkaido University (Japan) published more inter-institutionally collaborative articles. Based on the distribution and changes of words in article titles and abstracts, author keywords, *KeyWords Plus*, and word cluster analysis, carbon, nanotubes, and properties were the main topics in bamboo research, of which carbon will continue to be a focus in the future. The Kannan and Sundaram published the most highly cited article "kinetics and mechanism of removal of methylene blue by adsorption on various carbons: a comparative study" [30].

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Table 1. Top 10 most productive countries based on total number of articles during 1992-2011

Country	TA	TAR (%)	SAR (%)	CAR (%)	FAR (%)	RAR (%)	%S
China	775	1 (21)	1 (21)	3 (17)	1 (21)	1 (21)	99.9
Japan	580	2 (16)	2 (16)	3 (17)	2 (16)	2 (16)	99.8
USA	474	3 (13)	3 (13)	1 (33)	3 (13)	3 (13)	99.6
India	370	4 (10)	4 (10)	N/A	4 (10)	4 (10)	100
Taiwan	238	5 (6.5)	5 (6.6)	N/A	5 (6.5)	5 (6.5)	100
South Korea	115	6 (3.2)	6 (3.2)	N/A	6 (3.2)	6 (3.2)	100
Brazil	112	7 (3.1)	7 (3.1)	N/A	7 (3.1)	7 (3.1)	100
UK	96	8 (2.6)	8 (2.6)	3 (17)	8 (2.6)	8 (2.6)	99
Germany	91	9 (2.5)	9 (2.5)	N/A	9 (2.5)	9 (2.5)	100
Australia	62	10 (1.7)	10 (1.7)	N/A	10 (1.7)	10 (1.7)	100

AP: total number of articles; SAR, single country article rank; CAR, internationally collaborative article rank; FAR, first author article rank; RAR, corresponding author article rank; %S: percentage of independent collaborative articles in total country articles

Table 2. Top ten most productive institutions based on total number of articles during 1992-2011

Institution	TA	TAR (%)	SAR (%)	CAR (%)	FAR (%)	RAR (%)	%S
Chinese Academy of Sciences, China	124	1 (3.4)	1 (3.4)	6 (4.8)	1 (3.4)	1 (3.4)	99
Zhejiang University, China	70	2 (1.9)	2 (1.9)	N/A	2 (1.9)	2 (1.9)	100
National Chung Hsing University, Taiwan	50	3 (1.4)	3 (1.4)	N/A	3 (1.4)	3 (1.4)	100
Hokkaido University, Japan	48	4 (1.3)	4 (1.2)	1 (14)	4 (1.2)	4 (1.2)	94
National Taiwan University, Taiwan	43	5 (1.2)	5 (1.2)	N/A	5 (1.2)	5 (1.2)	100
Academia Sinica, Taiwan	33	6 (0.91)	6 (0.91)	N/A	6 (0.91)	6 (0.91)	100
Forestry and Forest Products Research Institute, Japan	32	7 (0.88)	7 (0.88)	N/A	7 (0.88)	7 (0.88)	100
Kyoto University, Japan	31	8 (0.85)	8 (0.83)	6 (4.8)	8 (0.82)	8 (0.82)	97
Indian Institutes of Technology, India	30	9 (0.82)	8 (0.83)	N/A	8 (0.82)	8 (0.82)	100
Tsinghua University, China	23	10 (0.63)	10 (0.64)	N/A	10 (0.63)	10 (0.63)	100
University of Tokyo, Japan	23	10 (0.63)	11 (0.61)	6 (4.8)	11 (0.60)	11 (0.60)	96

TA: total number of articles; SAR, single institution article rank; CAR, inter-institutionally collaborative article rank; FAR, first author article rank; RAR, corresponding author article rank; %S: percentage of independent collaborative articles in total institution articles

Table 3. Top 30 most frequent article title words used during 1992-2011 and in 4 five-year periods

Words in title	TP	92-11 R (%)	92-96 R (%)	97-01 R (%)	02-06 R (%)	07-11 R (%)
bamboo	1394	1 (37)	1 (36)	1 (35)	1 (33)	1 (40)
carbon	367	2 (10)	48 (1.4)	6 (4.8)	2 (13)	2 (11)
nanotubes	263	3 (7.0)	388 (0.28)	9 (3.9)	3 (11)	4 (7.1)
properties	246	4 (6.6)	12 (2.8)	4 (5.1)	6 (5.6)	3 (8.2)
forest	207	5 (5.5)	3 (6.6)	8 (4.1)	4 (6.4)	6 (5.3)
species	207	5 (5.5)	3 (6.6)	7 (4.2)	8 (4.9)	5 (6.0)
growth	176	7 (4.7)	36 (1.7)	3 (5.3)	5 (6.1)	8 (4.4)
structure	140	8 (3.7)	5 (4.7)	2 (5.8)	9 (4.3)	18 (2.6)
characterization	134	9 (3.6)	11 (3.0)	52 (1.6)	10 (3.5)	9 (4.3)
China	124	10 (3.3)	18 (2.2)	44 (1.8)	14 (2.7)	9 (4.3)
synthesis	123	11 (3.3)	174 (0.55)	176 (0.71)	7 (5.4)	13 (3.5)
composites	121	12 (3.2)	104 (0.83)	27 (2.3)	35 (1.7)	7 (4.7)
phyllostachys	117	13 (3.1)	18 (2.2)	13 (3.2)	19 (2.4)	11 (3.6)
poaceae	103	14 (2.7)	8 (3.9)	12 (3.4)	15 (2.6)	21 (2.4)
Japan	102	15 (2.7)	6 (4.2)	15 (2.8)	11 (3.4)	27 (2.1)
mechanical	98	16 (2.6)	104 (0.83)	176 (0.71)	18 (2.5)	12 (3.6)
bambusa	94	17 (2.5)	104 (0.83)	17 (2.7)	13 (2.8)	18 (2.6)
production	85	18 (2.3)	48 (1.4)	44 (1.8)	15 (2.6)	21 (2.4)
chemical	85	18 (2.3)	174 (0.55)	17 (2.7)	21 (2.3)	20 (2.5)
fiber	85	18 (2.3)	66 (1.1)	78 (1.2)	46 (1.6)	15 (3.1)
bambusoideae	82	21 (2.2)	12 (2.8)	30 (2.1)	21 (2.3)	27 (2.1)
natural	79	22 (2.1)	15 (2.5)	52 (1.6)	35 (1.7)	23 (2.4)
characteristics	77	23 (2.1)	174 (0.55)	127 (0.88)	46 (1.6)	16 (2.9)
giant	76	24 (2.0)	36 (1.7)	22 (2.5)	58 (1.4)	24 (2.3)
water	76	24 (2.0)	66 (1.1)	127 (0.88)	35 (1.7)	17 (2.7)
charcoal	76	24 (2.0)	N/A	376 (0.35)	66 (1.3)	14 (3.3)
electromigration	74	27 (2.0)	2 (7.5)	5 (5.0)	84 (1.1)	283 (0.47)
development	72	28 (1.9)	36 (1.7)	22 (2.5)	21 (2.3)	42 (1.6)
soil	71	29 (1.9)	66 (1.1)	176 (0.71)	19 (2.4)	26 (2.2)
pubescens	68	30 (1.8)	48 (1.4)	30 (2.1)	109 (1.0)	25 (2.2)

TA: total number of articles; (%): percentage of words in the titles in total articles

Table 4. Top 30 most frequent author keywords used during 1992-2011 and in 4 five-year periods

Author Keywords	TP	92-11 R (%)	92-96 R (%)	97-01 R (%)	02-06 R (%)	07-11 R (%)
bamboo	439	1 (15)	1 (23)	1 (21)	1 (13)	1 (14)
carbon nanotubes	74	2 (2.6)	N/A	30 (0.84)	2 (4.4)	4 (2.5)
mechanical properties	54	3 (1.9)	34 (1.0)	77 (0.56)	18 (1.0)	2 (2.7)
bamboo charcoal	49	4 (1.7)	N/A	N/A	18 (1.0)	3 (2.7)
adsorption	48	5 (1.7)	N/A	5 (1.7)	40 (0.71)	5 (2.3)
taxonomy	48	5 (1.7)	7 (2.0)	30 (0.84)	3 (2.4)	8 (1.5)
poaceae	40	7 (1.4)	7 (2.0)	5 (1.7)	4 (1.9)	13 (1.1)
China	40	7 (1.4)	7 (2.0)	77 (0.56)	18 (1.0)	6 (1.7)
composites	36	9 (1.3)	95 (0.50)	13 (1.1)	40 (0.71)	7 (1.6)
morphology	34	10 (1.2)	34 (1.0)	N/A	6 (1.6)	10 (1.3)
microstructure	33	11 (1.2)	95 (0.50)	13 (1.1)	5 (1.7)	17 (1.0)
lignin	32	12 (1.1)	2 (3.0)	13 (1.1)	40 (0.71)	13 (1.1)
bamboo fiber	31	13 (1.1)	N/A	77 (0.56)	13 (1.1)	10 (1.3)
giant panda	31	13 (1.1)	34 (1.0)	77 (0.56)	25 (0.85)	10 (1.3)
activated carbon	28	15 (1.0)	N/A	190 (0.28)	40 (0.71)	9 (1.4)
phyllostachys pubescens	28	15 (1.0)	34 (1.0)	3 (2.0)	161 (0.28)	13 (1.1)
chemical vapor deposition	27	17 (1)	N/A	N/A	6 (1.6)	17 (1)
new species	26	18 (0.92)	95 (0.50)	30 (0.84)	40 (0.71)	13 (1.1)
dwarf bamboo	25	19 (0.88)	95 (0.50)	30 (0.84)	9 (1.3)	25 (0.76)
bambusoideae	25	19 (0.88)	7 (2.0)	77 (0.56)	82 (0.43)	17 (1.0)
electromigration	24	21 (0.85)	3 (2.5)	2 (2.2)	25 (0.85)	89 (0.32)
carbon nanotube	22	22 (0.78)	95 (0.50)	190 (0.28)	8 (1.4)	28 (0.63)
nanostructures	22	22 (0.78)	N/A	N/A	18 (1.0)	20 (1.0)
bamboo shoot	20	24 (0.70)	16 (1.5)	N/A	161 (0.28)	20 (1.0)
cervus nippon	20	24 (0.70)	N/A	3 (2.0)	13 (1.1)	89 (0.32)
SEM	20	24 (0.70)	N/A	190 (0.28)	62 (0.57)	20 (1.0)
pyrolysis	19	27 (0.67)	95 (0.50)	30 (0.84)	25 (0.85)	30 (0.57)
electron microscopy	19	27 (0.67)	N/A	190 (0.28)	9 (1.3)	30 (0.57)
kinetics	17	29 (0.60)	N/A	77 (0.56)	161 (0.28)	24 (0.82)
nanotubes	17	29 (0.60)	N/A	N/A	9 (1.3)	41 (0.51)
moso bamboo	17	29 (0.60)	N/A	30 (0.84)	62 (0.57)	28 (0.63)
gramineae	17	29 (0.60)	16 (1.5)	13 (1.1)	62 (0.57)	65 (0.38)
fibers	17	29 (0.60)	16 (1.5)	190 (0.28)	161 (0.28)	26 (0.70)
periphyton	17	29 (0.60)	N/A	9 (1.4)	25 (0.85)	65 (0.38)
scanning electron microscopy	17	29 (0.60)	95 (0.50)	N/A	13 (1.1)	41 (0.51)
bambusa vulgaris	17	29 (0.60)	N/A	N/A	161 (0.28)	20 (1.0)

TA: total number of articles; (%): percentage of author keywords in total articles