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Research Hot Spots of Black Peanut

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Abstract Taking the research papers on black peanut in National Knowledge Infrastructure (CNKI) as data sources, we determine the research hot spots on black peanut using word frequency analysis, and analyze the main research directions that change over the years. The results show that the relevant researches on black peanut are mainly concentrated in six themes (study of varieties, physiological property, cultivation management, development prospects, relationship with agriculture, and molecular level); varieties, physiology, cultivation and other aspects are the focus of current research hot spots; the researches on selection and breeding of variety and various physiological and ecological mechanisms, still need a breakthrough.

Key words Black peanut, Word frequency analysis, Research hot spots

Black peanut is very rich in nutrients. Compared with the ordinary peanut, it is rich in selenium, arginine, grease, protein, *etc.*[1-2]. At the same time, the seed coat contains large amounts of anthocyanins[3], having good effect of nutrition and health, thus black peanut is good health food. Therefore, the researches on black peanut receive much concern. Word frequency analysis is a bibliometrics method using the frequency of key words or theme words in the literature on a research area, to determine the research hot spots and development trends of this area[4]. According to data obtained by the journal retrieval, we analyze the research hot spots and trends of black peanut using word frequency analysis, in order to provide a reference for related research institutions and personnel.

1 Data sources and research methods

1.1 Data sources We take the research papers on black peanut in CNKI as data sources. Retrieval method: theme = black peanut + theme = black-particle peanut + theme = black-coat peanut + theme = color peanut; year = 1980 – 2012; update = all data; range = all journals; match = exactness. The retrieval time is April 8, 2012. We get 235 relevant literatures. Removing repeated literatures, we conduct research on 166 literatures having authors and key words.

1.2 Research methods The statistical and graphic analysis can be conducted using Excel 2003 software and VBA Programming.

(i) Collecting the original key words, and conducting classification and summarization in counting mode, to get the frequency of original key words.

(ii) Converting English key words into the corresponding terms, for example, converting "black peanut" into "heihuasheng".

(iii) Classifying and sorting the original key words, for example, converting "planting", and "cultivation mode" into "cultivation management"; converting "weight per 100 shucks", and "100-seed weight" into "yield and yield increase"; converting "pollution-free" into "food safety"; converting place names involved into "region"; converting various specific types of soil into "soil"; converting the words on growth and the appearance of the black peanut involved into growth physiological property, including plant type of peanut, pod shape, kernel size, color, *etc.*

(iv) Calculating the frequency of key words, and conducting sequencing according to the frequency of key words.

(v) Obtaining the proportion of a key word to the total key words in the same year, namely the frequency of key words. In order to facilitate research, we neglect some words not closely related to this study (although the frequency of some may be high), such as black corn, black fungus, black sesame seeds, black beans, black rice, black date, color vegetables, greening tree species, fruits, environmental beautification, fruits and vegetables, ornamental plants, green plants.

(vi) Summarizing the research topics for analysis.

2 Results and analysis

2.1 Theme analysis We concentrate all key words involved in the research literatures over the years for word frequency analysis; conduct sequencing according to the frequency of key words, in order to identify the main content of the study. Top 30 key words in the literature retrieved in terms of word frequency can be seen in Table 1.

From Table 1, the total frequency of top 30 key words in the related researches on black peanut accounts for 70.31% of that of total key words, reflecting the focus and hot spot of related researches on black peanut. Among the key words, the frequency of quality and physiological property is the highest, reaching 14.9%; the frequency of gene transfer technology is the lowest, only 0.21%. According to the research content, it is mainly grouped into 6 themes. (i) Study of varieties: peanut varieties, selection and breeding of variety, variety trials, soil, detection and identification. (ii) Physiological property: growth

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and physiological property, quality and physiological property, yield and yield increase, resistance. (iii) Cultivation management: cultivation management, fertilizers and fertilization, pest control, region. (iv) Development prospects: development prospects, food, nutrition and health, health effects, peanut products, food safety, processing, enterprise. (v) Relationship with agriculture: agriculture, adjustment of agricultural structure, crops, cash crops, Chinese Academy of Agricultural Sciences, agricultural products, farmers. (vi) Molecular level: gene transfer technology.

Table 1 Top 30 key words in the literature in terms of word frequency %

Key word	Frequency	Key word	Frequency	Key word	Frequency	Key word	Frequency
Quality and physiological property	14.90	Fertilizers and fertilization	2.54	Agriculture	0.78	Enterprise	0.28
Cultivation management	8.19	Yield and yield increase	2.47	Adjustment of agricultural structure	0.71	Resistance	0.28
Peanut varieties	6.71	Pest control	2.12	Peanut products	0.56	Cash crops	0.28
Growth and physiological property	6.13	Detection and identification	2.19	Food safety	0.56	Farmers	0.28
Development prospects	4.38	Nutrition and health	1.62	Crops	0.42	Green industry	0.21
Region	3.60	Health effects	1.62	Agricultural products	0.42	Gene transfer technology	0.21
Selection and breeding of variety	2.97	Soil	1.41	Chinese Academy of Agricultural Sciences	0.35		
Food	2.61	Variety trials	1.13	Processing	0.42		

2.2 Interannual variation analysis of each theme According to the word frequency statistics of key words involved in the research literatures over the years, we conduct analysis on the frequency of 6 themes changing over the years, in order to identify changes in the research themes. Variation in the relevant research theme on black peanut in the period 1999 – 2012 can be shown in Fig. 1, and "Total" in the figure is the summation of frequency of 6 themes.

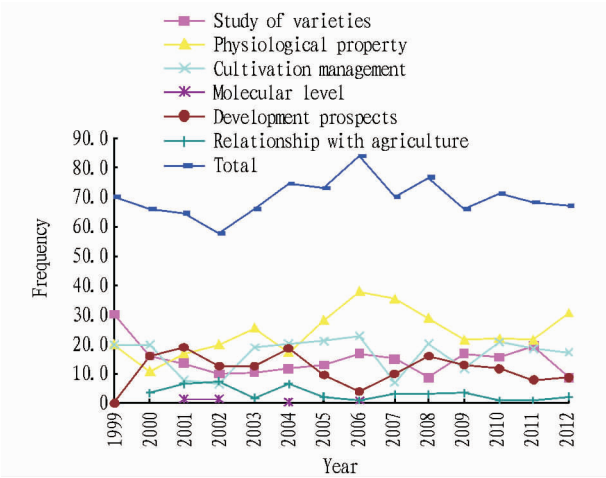

Fig. 1 Variation in the relevant research theme on black peanut in the period 1999 – 2012

Fig. 1 shows that the highest total frequency of 6 themes appeared in 2006, reaching 83%; the lowest total frequency of 6 themes appeared in 2002, also reaching 57.5%, an average of 69.65% per year, indicating that these 6 themes have always been the hot spot of research. Each theme fluctuates to some extent. In terms of the general trend and the average frequency, the ranking in descending order is as follows: physiological property (23.95%), cultivation management(16.61%), study of varieties (14.68%), development prospects (11.32%), relationship with agriculture (3.25%), molecular level (1.00%). There are only three years of data on the molecular level research. The differences in the average frequency of these 6 themes reflect different degrees of attention that these themes have received in previous studies. The higher the average frequency, the higher the degree of attention received. Therefore, the research focus on black peanut is as follows: physiological property, cultivation management, study of varieties, development prospects, relationship with agriculture , molecular level.

2.3 Variation analysis of research content of each theme To further clarify the focus of the research theme, we list the frequency of main key words of each theme in Table 1 according to year for research. Summary results of main key words/frequency in the period 1999 – 2010 can be shown in Table 2.

2.3.1 The theme of study of varieties. The frequency of black peanut variety is always high, and there are differences in annual researches on it. Table 2 shows that the frequency of "peanut varieties" is always high, but the main key words involved are of less significance, such as peanut varieties, quality and physiological property, Heifeng, Black Pearl, Donghuahao, *etc.*; the key words on "selection and breeding of variety" include genetic breeding, introduction, stability, homogeneity, adaptability, *etc.*, with relatively stable frequency; there are no data nearly half of the year on "variety trials", "detection and identification", "soil", *etc.*, and even if there are data in some years, the frequency is not high. It indicates that the theme of black peanut varieties is the research hot spot, of which "selection and breeding of variety" is the focus.

2.3.2 The theme of physiological property. The theme of physiological property draws the greatest concern in the relevant researches on black peanut. From the annual frequency change trend in Table 2, quality and physiological property, growth and physiological property, yield and yield increase, resistance, receive attention in descending order. The frequency changes in quality and physiological property of black peanut is relatively stable, and the total frequency and average frequency

of it are much higher than that of the other three aspects, indicating that the research on quality of black peanut is the focus of physiological property theme; the annual frequency of growth and physiological property, yield and yield increase of black peanut is also not low, indicating that these two aspects also receive attention of researchers; there are only four years of data on resistance, indicating that it receives less attention.

Table 2 Summary results of main key words/frequency in the period 1999 – 2010 %

Key words	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Average	Total
Peanut varieties	20.00	10.71	2.22	6.25	6.35	5.10	8.14	9.00	8.45	5.80	7.66	5.21	6.82	6.52	7.73	6.71
Selection and breeding of variety	10.00	5.36	8.89	3.75	1.59	1.27	2.33	5.00	4.23	1.45	1.91	3.13	2.27		3.65	2.97
Variety trials						1.91	2.33	1.00	1.41		1.44		1.82		0.71	1.13
Soil					1.59	3.18		2.00		1.45	1.91	6.25			1.17	1.41
Detection and identification			2.22		0.79						2.87	1.04	8.64	2.17	1.27	2.19
Growth and physiological property		5.36	6.67	8.75	7.14	10.19	4.65	3.00	12.68	4.35	3.35	4.17	3.64	8.70	5.9	6.13
Quality and physiological property		3.57	8.89	8.75	17.46	5.10	17.44	29.00	18.31	24.64	16.27	13.54	15.00	17.39	13.95	14.90
Resistance			1.11				1.16					1.04	0.45		0.27	0.28
Yield and yield increase	10.00	1.79		2.50	0.79	1.91	4.65	6.00	4.23		1.91	3.13	2.27	4.35	3.11	2.47
Cultivation management		7.14	1.11	1.25	7.94	11.46	9.30	10.00	5.63	13.04	6.70	9.38	9.55	8.70	7.23	8.19
Fertilizers and fertilization			2.22		0.79	3.18	5.81	2.00		1.45	2.39	7.29	2.27		1.96	2.54
Pest control	10.00	3.57		1.25	4.76	3.18		7.00	1.41	2.90	0.48	1.04	1.82	4.35	2.98	2.12
Region	10.00	8.93	4.44	3.75	2.38	2.55	5.81	4.00		2.90	1.91	3.13	5.00	4.35	4.23	3.60
Gene transfer technology			1.11	1.25		0.64									0.21	0.21
Development prospects		7.14	5.56	2.50	4.76	9.55	4.65		1.41	4.35	6.22	4.17	0.45	4.35	3.94	4.38
Food		3.57	8.89	1.25	2.38	3.82	1.16		2.82	2.90	3.35	2.08	0.91	2.17	2.52	2.61
Nutrition and health		3.57	1.11	3.75	3.17	1.91	1.16			4.35	0.96	2.08	0.91		1.64	1.62
Health effects		1.79	3.33	5.00	1.59	1.91		1.00		2.90	0.96		1.82	2.17	1.6	1.62
Peanut products					0.79	0.64			2.82	1.45	0.96	1.04			0.55	0.56
Food safety							1.16	2.00	1.41		0.48	1.04	0.91		0.50	0.56
Processing						0.64		1.00	1.41			1.04	0.91		0.36	0.42
Enterprise							1.16						1.82		0.21	0.28
Peanut production											0.48		0.45		0.07	0.14
Agriculture			1.11	5.00	0.79	1.91	1.16			1.45					0.82	0.78
Adjustment of agricultural structure			1.11	2.50	0.79	3.18				1.45					0.65	0.71
Crops			2.22			0.64		1.00			0.48			2.17	0.46	0.42
Cash crops						0.64	1.16		1.41				0.45		0.26	0.28
Chinese Academy of Agricultural Sciences		1.79	2.22						1.41		0.48		0.45		0.45	0.35
Agricultural products											2.39	1.04			0.25	0.42

Note: "Average" refers to the average frequency from 1999 to 2012; "Total" refers to the frequency derived from summarizing key words of all years using the aforementioned method.

2.3.3 The theme of cultivation management. The theme of cultivation management mainly touches upon the production of black peanut. According to the annual frequency change trend in Table 2, cultivation management, region, pest control, fertilizers and fertilization, receive attention in descending order; the key words concerning cultivation management include cultivation management, technical brief introduction, land consolidation, ridging, covering film, skill, experience introduction, rotation of crops, *etc.*; the key words concerning pest control include herbicides, seedling diseases; the key words concerning fertilizers and fertilization are mainly a specific variety of fertilizers and fertilization methods. It indicates that cultivation management, region, pest control, fertilizers and fertilization and other aspects, related to the production of black peanut, are the focus of the theme of cultivation management. At the same time, it also involves a lot of advanced modern agricultural production techniques.

2.3.4 The theme of development prospects. The theme of "development prospects" is mainly to research the development and promotion of black peanut, processing, use, market demand, nutrition and health, nutrition, food safety, enterprise, packaging, *etc.* The sequencing of key words included in terms of the average frequency in descending order is development prospects, food, nutrition and health, health effects, indicating that the development prospects, nutrition and health role of black peanut (as a kind of food), receive more attention; enterprise, processing, and food safety, receive less attention.

2.3.5 The theme of relation with agriculture. In terms of frequency change in the theme of relationship with agriculture, nearly half of the year, there are no data on several related words, such as agriculture, adjustment of agricultural structure, crops, cash crops, Chinese Academy of Agricultural Sciences, agricultural products, farmers; in the years when there are data, the frequency is not high, and the average frequency is relatively low, indicating that the black peanut (as a kind of crop) plays a small role in agricultural development and industrial structure adjustment of agriculture, receiving less attention.

2.3.6 The theme of molecular level. There are three years of data (2001, 2002 and 2004) on gene transfer technology of black peanut, and the frequency is very low. In the period 2005

–2012, there are no relevant research results, indicating that there are few researches on the molecular level of black peanut.

3 Conclusions and discussions

In terms of the research on changes in the theme of varieties, "selection and breeding of variety" is the focus of the study, which touches upon some black peanut varieties' gene, cultivation, improvement, evaluation, and so on[5-7]; there are few researches on "variety trials", "detection and identification" and "soil". Therefore, we should strengthen the research on the genetic composition and molecular biology; develop marker-assisted selection and transgenic technology, closely combined with the conventional breeding, to improve the breeding efficiency and create new high-quality varieties that can be used on a large scale.

There are rich research results on the physiological property of black peanut[8-11]. In terms of the growth and physiological property, the basic biological researches on the black peanut growth and development laws and the regulatory mechanisms still need to be strengthened, such as photosynthetic physiology with high light efficiency adjustment mechanism, vegetative metabolism and C / N balance mechanism, plant senescence mechanism and regulation principle, and physiological mechanism of high yield. In terms of the quality and physiological property, we should strive to reveal the physiological mechanisms of black peanut quality, such as quality formation law, synthesis of protein and pigment, the enzymatic mechanism of selenium and other trace elements, and regulatory effect of quality property. In terms of resistance, we should focus on researching drought, high temperature, waterlogging, low temperature, and other stress-tolerant physiological mechanisms and regulation principles under stress conditions.

There are many research reports on the cultivation[12-14]. Although there are reports on intercropping and crop rotation of black peanut, it lacks the reports on the spatio-temporal distribution characteristics and optimal regional layout of the black peanut in different ecological regions, the optimal configuration mode and production potential exploitation of the black peanut and other crops, *etc.*

From the above study results, we can find that the research on the varieties, physiology, and cultivation of black peanut is the focus of current research hot spots. There are few researches on processing and development of black peanut[15-16], relationship with agriculture and molecular level at present, but as China's food safety, adjustment of agricultural structure, conversion of modern agricultural science and technology into productivity, *etc.* have received widespread attention, it can be expected that the research on these aspects will draw people's attention. In addition, the analysis method based on word frequency is conducive to finding hot spots, attention degree and other problems, but the importance of the research focus is considered insufficiently, and even it is difficult to effectively distinguish the focus[17]. Therefore, we can also use other literature analysis methods combined with literature full-text for analysis, such as co-word analysis and citation analysis, in order to learn more research information on the black peanut.

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