TRENDS IN CULTURED MEAT: A BIBLIOMETRIC AND SOCIOMETRIC ANALYSIS OF PUBLICATION

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Abstract

Cellular agriculture is been considered as a mechanism to minimize future negative impacts of the estimated world population growth for the coming decades. Among the alternatives of this technology, the development of meat grown in the laboratory stands out. Numerous researchers have been making efforts to develop this scientific field today. However, few studies have tried to map the intellectual panorama and emerging themes in the scientific literature of this scientific field. Thus, this research aims to analyze from the perspective of the bibliometric and sociometric analysis the scientific publications on meat cultivated within the perspective of cellular agriculture, indexed in the Web of Science database. We analyzed 91 publications on cultured meat, combining mapping data, patterns of co-citation and collaboration from scientific journals and authorship. We also analyze emerging issues in the research on meat cultivated. We noted that, given the participation of authors and co-authors from different areas of knowledge, there is not a pattern in the composition of collaboration networks. Also stands out the multidisciplinary nature of the studies on cultured meat, transposing different disciplines and analytical approaches. Those aspects concerning the environmental, cultural impact, technical viability of its productive process and impacts on traditional livestock production appear as latent constructs in this new food biotechnology.

Keywords: artificial meat; in vitro meat; synthetic meat.

1 Introduction

It is estimated that the global population in 2050 will be composed of 9 billion individuals, only projections indicate that food production will not follow this growth and is therefore insufficient (Bonny et al., 2017; Fao, 2017). Thus, it is necessary to develop alternative sources of food, especially protein, judging by the expectation of a growing demand for protein sources by the population in the order of 73% the next decades (Fao, 2017).

Faced with this, cultured meat is one of the possible sources of proteins of the future. Its emergence derives from regenerative tissue engineering, based on precursor cell culture. Therefore, its production process occurs entirely in the laboratory, through in vitro cultivation of stem cells taken from the interior of the living animal muscle (Post, 2017). After the launch of the first burger produced with meat farmed in the world, still on an experimental scale, in August 2013, different terms are used to designate this "new meat". Some terms are synthetic meat (Marcu et al., 2015), "artificial" (Hocquette et al., 2015; Bonny et al., 2017; Sodhi, 2017), "in vitro" (Carruth, 2013; Dilworth and McGregor, 2014; Schaefer and Savulescu, 2014; Mattick et al., 2015; Wilks and Phillips, 2017; Acevedo et al., 2018; Lee, 2018), "laboratory meat" (Galusky, 2014). In addition "cultured meat" (Verbeke et al., 2015; Hamdan et al., 2017; Bryant and Barnett, 2018; Siegrist, Sütterlin and Hartmann, 2018; Servick, 2018), being this nomenclature used in this study.

The cultured meat integrates the emerging scientific field of cellular agriculture, that even in the initial stage, searches to develop products of animal origin with little or no involvement of the animal itself (Stephens et al., 2018). Thus, "cultured meat technology crosses the industrial context of biomedicine and agrifood" (Stephens, King, and Lyall, 2018, p.368) and becomes a new concept of food biotechnology (Enrione et al., 2017).

The arguments that foment and explain the production of cultured meat are based on aspects related to food security in the medium and long term (Laestadius and Caldwell, 2015), animal welfare (Milburn, 2016; Croney et al., 2018; Shriver and Mcconnachie, 2018) and environmental preservation (Tuomisto and Mattos, 2011; Mattick, Landis and Allemby, 2015). Moreover, some possible benefits are not unanimous in the scientific community, so their consumption will depend on the conflict of values at the individual and collective

level (Hocquete, 2016).

Thus, the tissue engineering and edible fats are the subjects of at least two patents issued in the United States (Vein, 2004; Van Eelen, 2007) and others two patents additional of application (Challakere, 2009; Forgacs, Marga and Jakab, 2013). Therefore, the maximization of the efforts of the private sector to enable the commercial production of this product (Mattick, Landis and Allemby, 2015) reflects the exponential growth of startups (Specht et al., 2018).

However, some obstacles are still being faced. With regard to technical barriers, there is a need for the development of new cell lines with differentiation potential (Specht et al., 2018), the identification of alternatives for the use of completely synthetic culture media, similar to those developed for medical purposes (Post, 2012). Beyond that, aspects concerning the economic viability of the production process are highlighted, given that the cost of certain elements, such as scaffolding, for example, are still high (Datar and Betti, 2010), making the product extremely expensive in the short term (Bhat and Bhat, 2011).

After coping such obstacles, verifying all the properties of the cultured meat and overcoming the legal barriers, it is tried to introduce it in the market with quantity and reasonable price (Post, 2017). For Verbeke et al. (2015), the cultured meat production will cause adverse social consequences in what concerns the minimization of agricultural activities, loss of rural livelihoods and the extinction of social traditions. The authors promote skeptical reflections about the “inevitable progress" as well as emphasize the lack of stability of scientific knowledge in relation to this agro-food technology.

Going beyond, Hamdan et al. (2017) corroborate that cultured meat promotes ethical, philosophical and religious discussions. Therefore, one does not have a consensus of what this product is in fact and what it can cause, making it endowed with dubiety (Majima, 2014), including those of an ontological (Stephens, 2013; Dilworth and Mcgregor, 2015; Mouat and Prince, 2018) and deontological nature (Shriver and Mcconnachie, 2018).

Indeed, this new technology is characterized by ambiguities, because while sometimes it is considered as an alternative to food in the near future, on the other hand, raises concerns regarding unknown risks in relation to food safety, environment, and consumer acceptance, for example. Ethical and moral issues also emerge, especially under the religious aspect and the possibility of production and consumption of cultured human meat (Majima, 2014).

In counterpoint, Bonny et al. (2017) indicate that the future of the conventional meat industry is conditioned to the adoption of new technologies and agricultural systems, judging by the controversy that is involved. Another relevant aspect corresponds to the increasing changes in the market and the maximization of the demands of the consumers. For the authors, the development and implantation of innovative strategies in the meat industry are fundamental to maintain its competitiveness against the cultured meat. Notwithstanding, Siegrist, Sütterlin and Hartmann (2018) corroborate that the acceptance of the cultured meat by consumers is conditioned to the way in which it will be explained and presented to the market.

In spite of the scientific growth on cultured meat in the last years, few studies have focused their objectives in the understanding of the intellectual panorama of emergent themes in the scientific literature on this field.

The maximization of scientific and technological collaboration at the world level has assumed a lot of importance that "there is a perceptible need urgently to study such processes in order to acquire fundamental knowledge to organize future research and its application to science and technology policies" (Kretschmer et al., 2015, p.359). The "bibliographical analysis, together with the use of the sociology of science, offers an adequate perspective about definitions, borders, and studies in a scientific field" (Khasseh, Soheili, and Chelak, 2018, p.320).

In this context, this research aims to analyze, from the perspective of the bibliometric and sociometric analysis, the scientific publications on the cultured meat highlighted in cellular agriculture. For this, we use the three classic laws of bibliometry and demonstrate through networks of cocitation and collaboration between magazines, authors, co-authors, and terms, circumscribing the modern bibliometry proposed by Garfield (2006) (Thompson and Walker, 2015).

This is justified by the relevance of such practices in outlining research and demonstrating research bias on an emerging and scientifically incipient subject. Also stands out the multidisciplinary nature of the studies on cultured meat, transposing different disciplines and analytical approaches.

2 Methodology

2.1 Bibliometric and Sociometric Analysis

The bibliometry or bibliometric analysis makes it possible to examine the characteristics and the establishment of patterns about a particular field of study (Geng et al., 2017), or, according to Pehar (2010, p.1), it is "an area of quantitative study of written communication, which applies a set of modern methods and techniques of mathematical formalization and statistics". For Huai and Chai (2016), it is a branch of information science associated with statistics, which has acquired greater visibility through increased in the volume of scientific production.

However, over time, the occurrence of this type of study revealed the existence of written communication behavior models that established patterns of analysis, known as Laws of Bibliometrics. Therefore, three classical laws govern this method, namely: Lotka's Law, Bradford's Law and Zipf's Law (Hood and Wilson, 2001). The first law, also known as the Inverse Square Law, postulates that a limited number of individuals have a high amount of scientific production in a specific area of knowledge, while a large number of researchers have a little contribution (Chung and Cox, 1990). Rousseau and Rousseau (2000) corroborate that Lotka's Law conceives an inverse exponential scale between the numbers of scientific publications by the author.

However, to analyze the collaboration among the authors, there is the sociometric, whose focus consists of the study of the structure of the groups through the network of interpersonal relations (Moreno, 1941). The relevance of such an analysis is based on the role played by the networks research in the production of new knowledge, considering that the cooperation among researchers constitutes as a contribution to "determine the cognitive and social structure of the scientific fields and has a positive influence in the research" (Bordons et al., 2015, p.135).

Independently of the field of knowledge, the researchers make judgments about who wrote about what, whose result is expressed, in a practical way, in their citations (Korom, 2019). The analysis of co-citations networks allows the identification of structural patterns in the way the main authors position themselves on a given theme, showing similarities in their judgments (White and Mccain, 1998).

In its turn, Bradford's Law or Dispersion Law (Rousseau and Rousseau, 2000) basically circumscribes that journals that present the largest number of publications on a given subject tend to establish a nucleus of supposedly higher quality and relevance in this area of knowledge (Bradford, 1934). Lastly, the Zipf's Law or Minimum Effort Law corresponds to the frequency of occurrence or incidence of words in the text, so to enable the identification of relevant terms in what concerns a certain theme (Adamic and Huberman, 2002).

2.2 Data research

It was collected articles on meat cultivated within the perspective of cellular agriculture in the Web of Science - Clarivate Analytics. As the subject or theme of this study does not have a single consolidated term that defines it (Verbeke et al., 2015), the following search orientation was determined using a set of keywords. Thus, the search strategy addresses the following terms using Boolean operators: ("artificial meat" OR "synthetic meat" OR "laboratory meat" OR "cultured meat" OR "in vitro meat" OR "cultured beef") in TOPIC of the database Web of Science, published until the date of 5th July 2018. This screening resulted in 139 publications, which were then restricted to articles as document typology.

To ensure that the analyzed publications would be composed exclusively of articles that addressed the subject of the cultured meat in the way that this study proposes, that is, obtained by in vitro culture of cells withdrawn of the live animal, it was made a reading of scientific documents. We classified as adherent or not to the scope of the investigation, and those that were classified as not adherent (concerning the vegetable protein or embedded products, sub-processing of meat, laboratory tests and experiments with conventional meat, among other forms of use of the terms), were excluded. Therefore, the portfolio analyzed was composed of 91 valid documents.

2.3 Data analysis

To analyze the data, we consider a set of elements that characterize the scientific publications, such as year, journal and authors, among others. The results obtained were analyzed by means of univariate statistics (absolute and relative frequency) and compared with what is postulated by the Laws of Bibliometrics, in order to identify patterns and to trace possible biases for this subject in the academic scope. We also developed co-citation networks and cooperation among authors, characteristics inherent in the modern bibliometry (Thompson and Walker, 2015), with the aim of ascertaining the interdisciplinary visions that develop the studies on cultured meat. For this, we use the systematic processing of data through the UCINET Software.

The co-citation analysis allows representing the intellectual structure of different disciplines and research areas, becoming a type of research that has been gaining ground over the years (Khasseh, Soheili, and Chelak, 2018). This indexing service is currently maintained by Clarivate Analytics, is that for analysis the VOSviewer Software was used, it is characterized as the standard tool for the generation of co-citation networks (Korom, 2019). For science, the literature is organized according to its specialties, so that manuscripts are said to be similar if they are cited by the same articles (Leydesdorff, 2011; Zupic and Čater, 2015; Korom, 2019).

Then, the production of maps structured through the VOS mapping technique was used, according to Korom (2019). It is composed of three steps, developed by the VOSviewer Software: normalization, mapping, and clustering. The first step refers to the strength of the association among the most and least cited connections, while the second step corresponds to the adjustment of the low-dimensional Euclidean space (Van Eck and Waltman, 2010). Finally, the last step is based on the procedure developed by Waltman, Van Eck and

Noyons (2010), which assigns "nodes" to a cluster, that is, a set of closely related nodes.

3 Results and Discussion

3.1 Time distribution, journals, and co-citation networks.

From the obtained portfolio, we verified that the first publication about cultured meat happened in 2008, whose central scope consisted in reflections on the possibility of this technology to save animals and satisfy meat eaters, simultaneously. However, we observe a strong positive trend line regarding the temporal distribution of publications on this subject, as demonstrated by Figure 1.

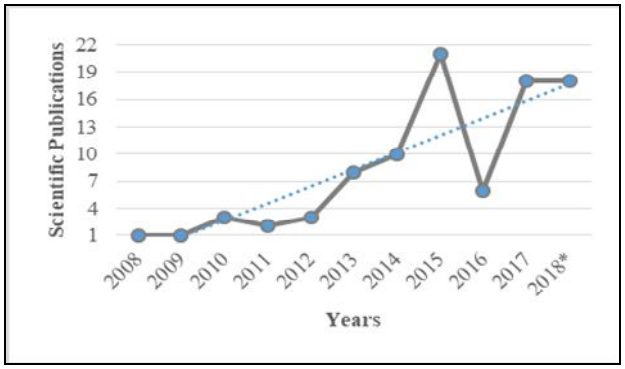

Figure 1. *Publications on meat cultured*

*The data was collected according to Web of Science published until the date of 5th July 2018. The number of publications on meat cultured (black bars) showed periods of difficulties. We also observed a strong positive trend line in relation to the time distribution of publications on the subject (dotted line).

We found that as of 2013 the number of publications was considerably maximized, corresponding to about 89.00% of the total. This can be justified because, in August of that same year, the first hamburger produced with cultured meat was prepared and tasted on a television program, "was staged as a hybrid science media event somewhere between a press release, experiment and cookery show" (O'Riordan, Fotopoulou, and Stephens, 2017, p.149).

The responsibility for creating this product is Dr. Mark J. Post from Maastricht University in the Netherlands, that through technique and principles of muscle tissue engineering, cultured in vitro stem cells taken from live bovine skeletal muscle until edible filaments were formed (Mattick, Landis and Allemby, 2015). According to Post (2014), the generation of bioartificial muscles based on satellite cells has been studied for over 15 years but has never been used for producing meat.

We observed an exponential growth in the interest of researchers on this subject, approaching it in different ways in practically all areas of knowledge. This phenomenon can be verified through analysis of the places where these documents are published, totaling 56 different journals. Although 80.36% of these contributions with only one publication, 46.43% of the total journals have Journal Citation Reports (JCR) greater than 2.00.

Therefore, we perceive the relative importance of the scientific journals where the theme is being published (Garfield, 2006), inferring that these are considered the knowledge of significant impact for science, this is, are available in journals with high citation index (Podsakoff et al., 2005). We highlight that 4 journals contribute with 34.07% of the total of publications, which is in line with the postulated by the Bradford's Law, and are therefore considered as endowed with a nucleus of quality and superior importance with regard to the cultured meat. We present Appendix 1 that summarizes the description of the main journals.

Regarding the analysis of co-citations, we presented the Appendix 2, whose elaboration considered as a unit of analysis the cited authors that have at least seven co-citation links. So, which applies to 82 out of the 3,016 authors identified by VOSviewer, which reflects, consequently, in 82 vertices, each one corresponding to an only one author (Van Eck and Waltman, 2019).

In the network illustration, the size of the labels and circles of each author is proportional to the total strength of the links, so that some markers are invisible to avoid overlapping. In relation to the coloring of the links, the cluster to which the author belongs determines this, and the distance between two authors elucidates the strength of the relationship in terms of co-citation (Van Eck and Waltman, 2010). This is, the proximity of the citations indicates the frequency with which they tend to be listed simultaneously in the investigated studies (Korom, 2019).

Thereby, Y. H. P. Zhang has a tendency to be cited together with N. Pelletier but is hardly mentioned in bibliographies with W. Verbeke. This, in turn, presents a bias to be listed with a large set of other authors, with different themes. Therefore, authors located in the central area of the figure are probably those considered as having more relevance in a certain scientific field or research theme, because they present manifold co-citation links, in different clusters.

In this perspective, we highlight the author M. J. Post, with 72 citations and the total strength of the links equivalent to 1,249. The predominance of this author is justified by the scientist who developed and introduced the first burger in vitro culture of bovine cells in the world. Thus, the pioneering publications of M. J. Post are basic references in studies on meat cultivated in any area of knowledge, independently of the panorama or phenomenon investigated.

The lower part of the figure can be understood as the

literature that provided subsidies for pioneering studies on cultured meat. In this set of co-citations, we have the author N. Pelletier (10 citations), with investigations about environmental impacts and evaluation of the life cycle of different types of meat produced through different productive strategies in conventional environment, which has been used as justification for the search for alternative forms of animal protein production for human consumption. We also highlight the work of J. Bartholet (9 citations), published in 2011, which proposed insights of meat production in the laboratory from previous studies. His research traced historical aspects of in vitro meat production, such as the efforts of Willem Van Eelen , a former prisoner of war, whose work resulted in the first patent for a method of producing cultured meat requested in the Netherlands in 1999 (Jönsson, 2016).

On the other hand, the upper part of the figure contemplates authors who deal with the theme studied under different aspects. We see that the author, M. J. Post, logically, presents strong co-citation links with the other clusters. Also, around Z. F. Bhat (52 citations) gravitate authors referenced in a multidisciplinary way, which can be explained by the fact of the works of this author – mostly literature reviews – to present a general overview of cultured meat, explaining its challenges and prospects, which crosses different domains of writing.

Already Verbeke (60 citations) is highlighted by his empirical research on market analysis and consumer behavior in relation to this new food biotechnology.

Despite this, we noticed the highlight of I. Datar (44 citations), P. D Hopkins (44 citations) and N. Stephens (37 citations. The first author presents possibilities for the construction of an in vitro meat production system. However, the second proposes cultured meat as a way to meet human satisfaction concomitantly the preservation of animal life. Finally, the last predominant author in this cluster focuses his investigations on the ontological ambiguities of the production and consumption of cultured meat, as well as in the technical, sociopolitical and regulatory challenges for the introduction of the product in the market.

3.2 Collaboration network among authors

With regard to the provisions of Lotka's Law, we verified that the portfolio of studies analyzed, in its entirety, has the participation of 182 authors, with different levels and affiliations. However, 80.77% of the individuals are responsible for only one publication and 3.85% of the researchers account for 36.26% of the manuscripts. Through this inverse square, we can identify that the restricted set of preponderant researchers characterize themselves as those who have a specialty in the said subject (Chung and Cox, 1990).

Leading this select group of individuals we have, logically, the pharmacologist Mark Post of Maastricht University (Netherlands), answering for six publications about this theme.

Despite his line of research is predominantly technical, related to vascular physiology and tissue engineering, in addition to manuscripts on the viability of in vitro meat production, the author also contributes with reflections about the socio-environmental impacts of cultured meat. In turn, the agricultural engineer Jean-François Hocquette, a researcher at the National Institute of Agricultural Research (France), contributes five articles about cultured meat. His research line includes the growth and animal metabolism and among his interests of study, we highlight the muscular biology while a contribution to the quality of the beef. Therefore, his publications about this theme refer to the implications of cultured meat for the future of the meat industry.

The researcher Neil Stephens, part of the Brunel University London, is the author of five publications about this subject. This situation can be justified by the fact that, despite acting in the area of biomedicine sociology, the cultured meat is one of the elements of its Big Tissue and Society project (financed by Wellcome Trust). In contrast, we have researchers Carolyn Mattick his teacher Braden Allenby, who account for the authorship or co-authorship of five and four articles on cultured meat, respectively. Both work in the area of environmental engineering and environment at Arizona State University and refer their contributions to the implications of cultured meat while emerging technology.

Finally, we highlight the Indian authors Hina Fayaz Bhat and Zuhaib Fayaz Bhat, affiliated in the Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir and the Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu respectively. Both contribute with four articles about cultured meat and their research work is circumscribed in the field of veterinary science and microbiology, with interest in cancer biology and molecular biology, in addition to the proteomics of animal fibers and their benefit.

However, grouping or allocating individuals that make up a necessary set of skills becomes relevant to maximize positive social attributes, making the project or work well executed (Gutiérrez et al., 2016). This situation is evidenced when addressing a thematic with different interfaces, with ambiguities and that permeates different areas of knowledge, as is the case of cultured meat (Stephens, 2013; Dilworth and Mcgregor, 2015; Stephens et al., 2018).

Therefore, under a sociometric approach, we checked off the 182 authors responsible for the analyzed portfolio, 18 developed all their publications without the

participation of other researchers, that is, they do not have and are not part of co-authorship. Yet, being that "the network of co-authorship of scientists represents a prototype of complex networks in evolution", especially when we circumscribe a field of study or emerging phenomenon (Barabasi et al., 2002, p.590), we present in Appendix 3, the collaborative networks among authors that published about cultured meat.

Frequently employed in the social sciences (Wasserman and Faust, 1994), the collaboration network or social network represents the different quantifiable interactions among individuals, considered as the "nodes" of the network (Barabasi et al., 2002). Thus, we can visualize the extent of the network and its composition, identifying the key authors, that is, those that relate to the largest number of other authors.

However, the preponderant authors previously presented do not have an exact standard for the composition of their collaboration network. We find that M. J. Post, N. Stephens, and J. F. Hocquette correspond to central authors in their collaborative networks, composed of individuals scattered around the world. In turn, C. S Mattick and B. R. Allenby have a reduced collaboration network compared with authors, which had a smaller number of publications, as N. J. Genovese, for example. We can explain this because both researchers at Arizona State University, members of the same study group, shared the authorship of their articles with each other. A similar situation occurs with H. F. Bhat and Z. F. Bhat, whose collaboration network is composed only of S. Kumar, also a researcher from India in the SKUAST-Jammu biotechnology department.

3.3 Analysis of predominant terms

According to Korom (2019), although researchers use a distinct vocabulary in academic writing, there is a greater similarity among studies of which belong to the same area of knowledge when compared to those who have different specializations in research. Therefore, analyze the text, that is, the predominant terms, becomes a relevant tool to determine domains or predominance of different investigations (Griffiths and Steyvers, 2004).

We developed a co-occurrence network of terms based on textual data using the VOSviewer Software. For this, we select the title and the abstract as fields from which the items were extracted, considering the method of counting binary with a minimum number of five recurrent terms. Thus, we have 89 terms that reach the minimum limit of occurrence, whose degree of relevance is calculated. Defining and illustrating by pattern, the most important 60% (Van Eck and Waltman, 2019), this is, 53 terms. After, we excluded those words that, despite answer the established criteria did not denote a direct relation with the subject investigated. Accordingly, terms as "paper", "article" and "participants", for example, are deleted. Appendix 4 presents the network of predominant terms, totalizing 43 words, where each represents a vertex.

Similar to the co-citation network, in the network of predominant terms the size of the labels and circles is proportional to the total strength of the links, which makes some markers invisible because of overlap. Equally, aspects as the coloring of links and the distance between circles determine the strength of the relationship among the terms and the frequency with which they are used together in the manuscripts, respectively (Van Eck and Waltman, 2010; Korom, 2019).

So, we observed that in Cluster A the terms "culture", "stem cell" and "health" are accentuated, with 15, 14 and 11 occurrences, respectively. When we verified the other terms that gravitate around these, we suggest that this cluster addresses aspects concerning the environmental and cultural impact of the production and consumption of cultured meat, and mostly a concern for human health.

On the other hand, the Cluster point questions about the technical viability of cultured meat production, so that the most frequent terms refer to "cell" with 18 occurrences and "analysis", accounting for 17 occurrences. Nevertheless, we can infer that Cluster C has a perspective related to the future market of this biotechnology product and its impacts on traditional livestock production. Thus, we emphasize the terms "food", "livestock", "protein" and "demand", representing, 23, 12, 12 and 11 occurrences, respectively.

We also show that, even though there is a grouping of recurrent and highly relevant terms, the cultured meat is a subject that permeates different areas of knowledge, whose different interfaces have aroused researchers' interest over time. So, understanding the characteristics of such studies can help us to anticipate the possible future reality that these scientific investigations circumscribe.

4 Conclusions

Despite being a relatively new subject, the cultured meat has aroused the interest of researchers in recent years. Its multidisciplinary nature contributes and receives contributions from different areas of knowledge, so different theoretical constructs emerge that complement each other. Among these, we highlight aspects related to cellular biology, cultural elements, ethical reflections and potentialities for the future.

Furthermore, the characterization of the publications about cultured meat is relevant to understand the bias of science in this recent theme, and, mainly, to identify its "key researchers" considered as experts in the field. It was also possible to design a collaboration network among such individuals, identifying certain patterns in

their behaviors while authors and predominant lines of research.

Finally, we show that despite the peculiarities inherent in an emerging and scientifically incipient subject, the classical laws of bibliometrics were confirmed. That said, we acknowledge the limitations of the study about the non-dismemberment of the bibliometric and sociometric elements, with the purpose of detailing and quantifying indexes related to the portfolio of publications. This point can be considered as a suggestion for future investigations, even as the possibility of conducting a meta-analysis about consumer acceptance and purchase intention of cultured meat, because, with the exception of reviews and essays about the potential and challenges of this new biotechnology, this construct compiles the largest number of empirical quantitative researches in the analyzed portfolio.

On the other hand, the insertion of other criteria capable of defining a research protocol can favor a systematic review of the literature, which would cause new research insights and propositions for new empirical investigations. In addition, the accomplishment of content analysis of non-scientific literature would also be interesting to understand and evaluate non-academic information being made available to potential consumers of cultured meat. Thus, would be a way of circumscribing strategies, as well as developing public policies and regulation for the meat market of the future.

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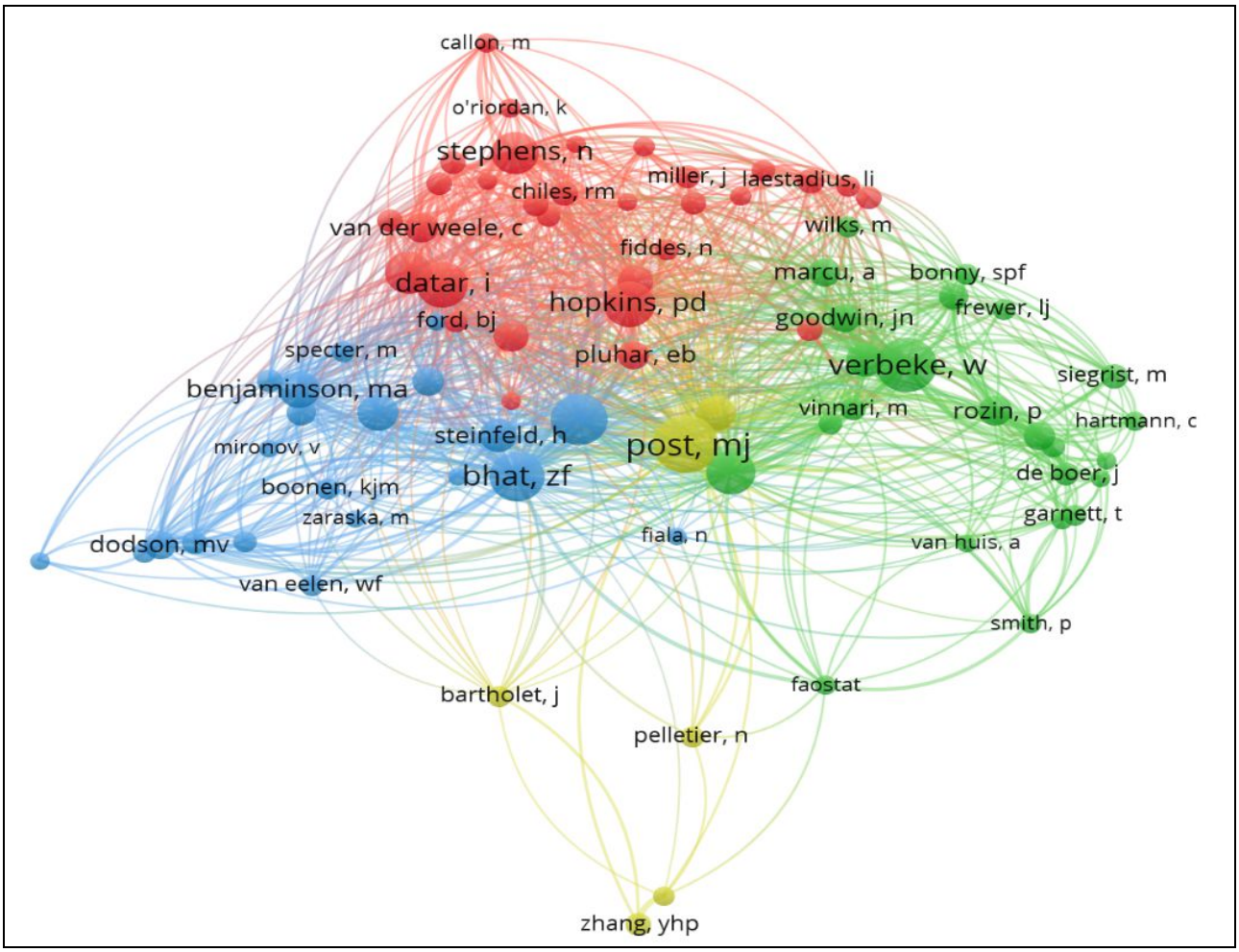
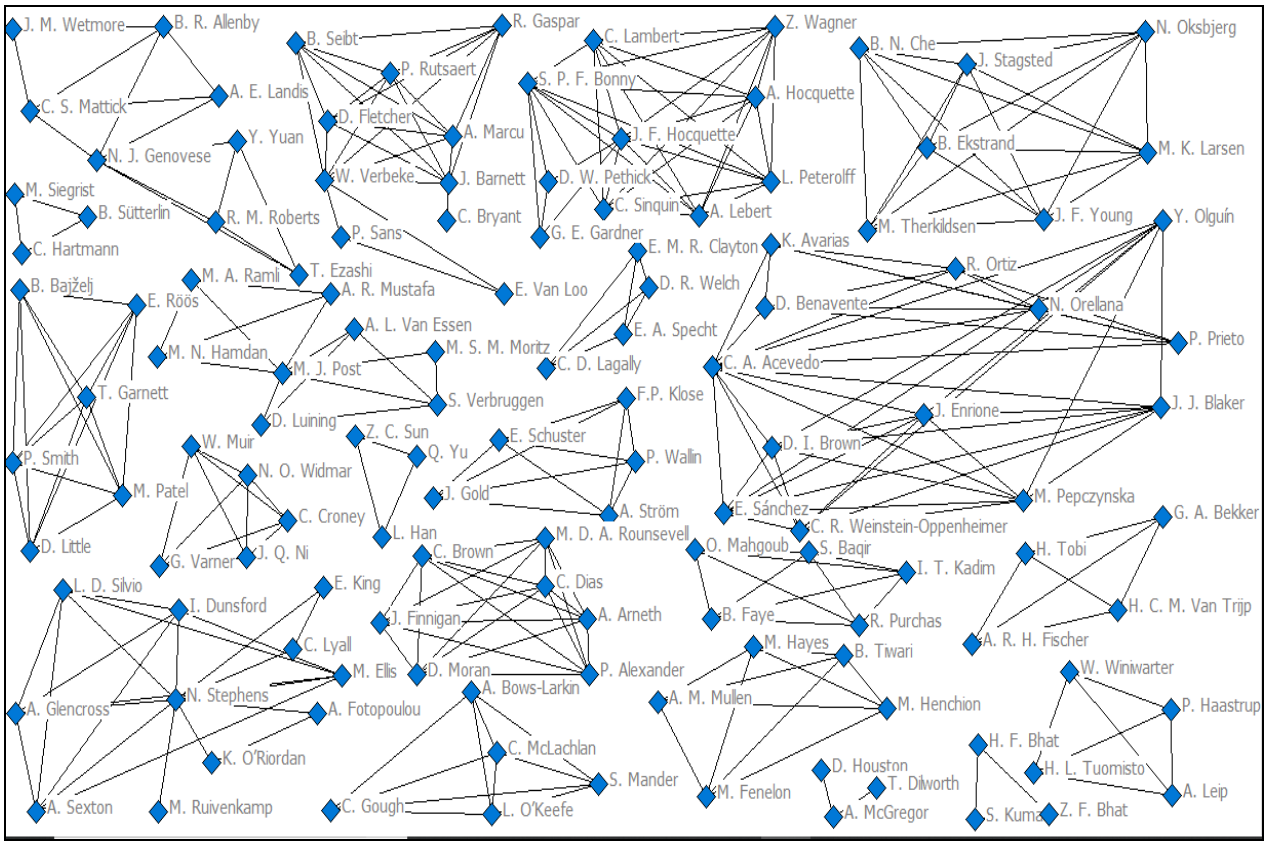
Appendix

Journal	Editor-in-Chief	Publications	JCR	Central Theme
Journal of Integrative Agriculture	J. Wan (Chinese Academy of Agricultural Sciences)	10	1.042	Crop genetics and breeding, germplasm resources, physiology, biochemistry, plant protection, animal science, veterinary science, soil and fertilization, agro-environment and ecology, bio-material and bio-energy, food science, agricultural economics and management, agricultural information science
Journal of Agricultural and Environmental Ethics	J. Burkhard (Institute of Food and Agricultural Sciences)	9	1.240	Ethical questions concerning the responsibilities of agricultural producers, assessment of technological changes affecting farm populations, deployment of intensive agriculture, modification of ecosystems, animal welfare, use of biotechnology, safety, availability, and affordability of food.
Meat Science	D. L. Hopkins (Centre for Red Meat and Sheep Development)	7	2.821	All the factors which influence the properties of mammals meat, large birds (e.g. emus, ostriches) and wild capture mammals and crocodiles, in exceptional cases, of poultry meat too
Appetite	S. Higgs (University of Birmingham)	5	3.174	Psychological, social, nutritional, sensory and cultural influences on apetite, cognitive and behavioural neuroscience of apetite, clinical and pre-clinical studies of disordered apetite, consumer behaviour towards food, psychology and ethnography of dietary habits and history of food cultures

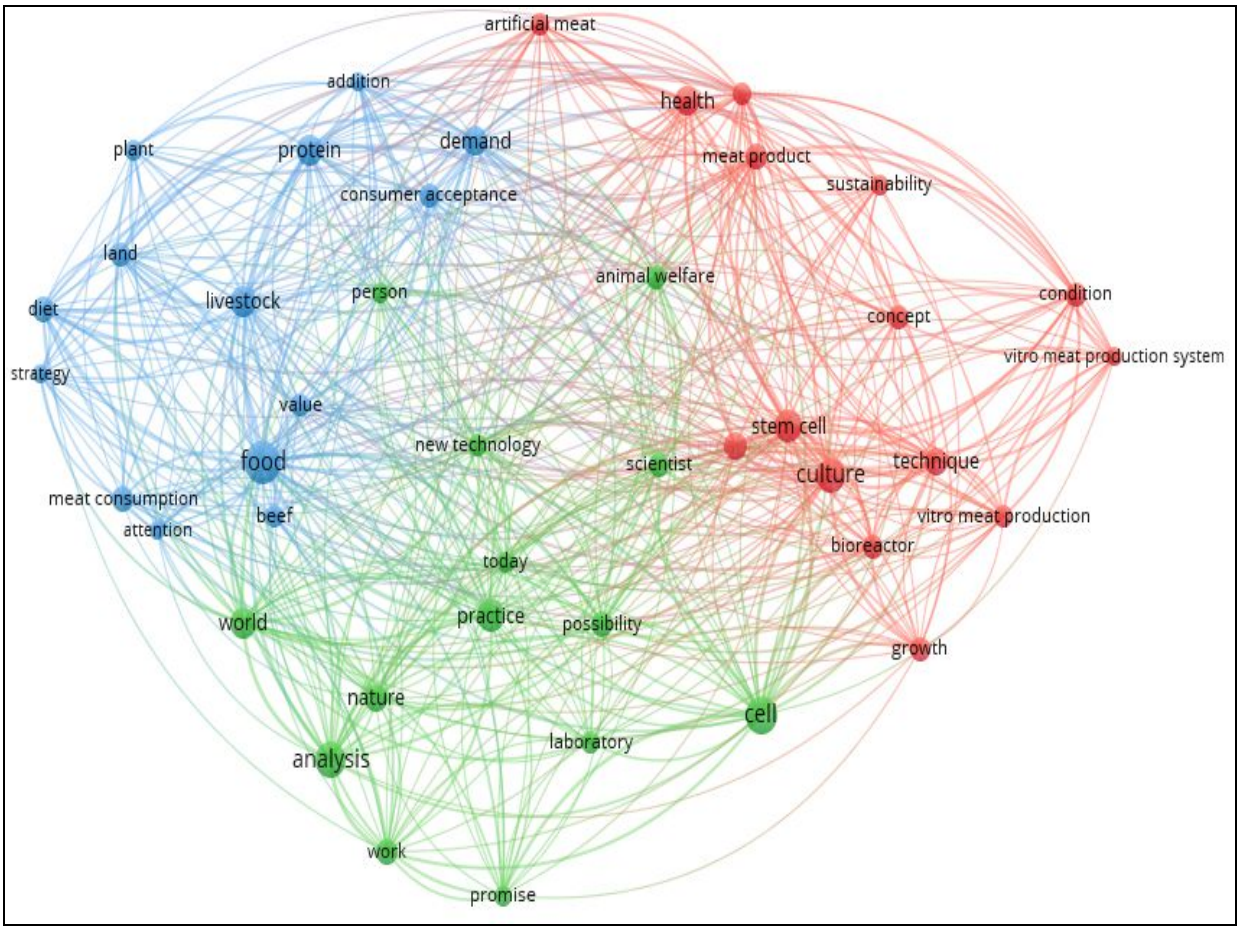
Appendix 1. *Description of the main journals*



Appendix 2. *Co-citation networks*
The visual map generated from the connected rings is composed of 82 vertices and 2.61 links. Each vertex represents a respective author. The diameter of a vertex is proportional to the number of citations. The colors represent the number of authors by clusters, namely: red: 31; green: 24; blue: 21 e; yellow: 6. Links represent cocitation or co-occurrence between these vertices.



Appendix 3. *Collaborative networks of authors who published on cultured meat.*
The network was developed using the UCINET Social Network Analysis Software. Only authors with at least three association links were considered.



Appendix 4. *Network of co-words of predominant terms in cultured meat*
The visual map generated from the connected rings is composed of 43 vertices and 533 links. Each vertex represents a respective terms. The vertex diameter is proportional to the number of citations. The colors represent the number of terms by clusters, namely: red: 15; green: 14 e; blue: 14. Links represent cocitation or co-occurrence of terms between vertices.

Recebido: 26/04/2019

Aceito: 15/07/2019