Comparative Study of Fertilizer Production Processes Using Nanocarbon.

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Abstract. The contemporary landscape of agricultural research has been notably marked by a burgeoning interest in the manifold advantages offered by nanotechnology. Noteworthy among these advancements is the integration of nanocarbon within fertilizers, a venture that has exhibited promising outcomes. Remarkably, China has emerged as a vanguard in the realm of Nanofertilizer development, underscoring its commitment to pioneering innovative agricultural solutions. This current study undertakes a comprehensive and in-depth analysis, focusing on a comparative evaluation of fertilizer production methodologies that incorporate nanocarbon. Specifically, the patents CN102206124 and CN102816003 take center stage in this scrutiny. A meticulous dissection of these processes encompasses an assessment of their respective merits, demerits, converging features, and points of divergence. Evidently, the prospect of bolstering agricultural productivity through the strategic integration of nanoparticle-infused fertilizers holds substantial promise. However, it is incumbent upon us to acknowledge the paucity of comprehensive investigations regarding the potential ecotoxicological ramifications of these nanoparticulate agents. While the promise of heightened crop yield beckons, a cautious and deliberative approach is indispensable, grounded in a thorough comprehension of the potential ecological repercussions associated with these pioneering interventions. In light of these considerations, it becomes clear that further research is imperative to unravel the intricate dynamics underpinning the nexus between nanotechnology-facilitated agricultural practices and the broader ecological framework. This, in turn, will empower stakeholders to make informed and responsible choices, thereby harnessing the full potential of these innovative strides to usher in a new era of sustainable agricultural progress.

Keywords. Nanofertilizer, Agriculture, Toxicity, Patent.

1. Introduction

In this study, we embark on a comprehensive analysis of nanocarbon-based fertilizers, with a primary focus on patents CN102206124 and CN102816003. Our aim is to evaluate and compare the advantages, disadvantages, missing information, differences and similarities, while also emphasizing the importance of considering their environmental impact. This investigation seeks to shed light on the potential benefits and challenges posed by nanocarbon-enhanced fertilizers, with a keen awareness of their implications for sustainable agriculture and environmental preservation.

By comprehensively understanding the characteristics and benefits offered by nanocarbon fertilizers, it is possible to explore their potential to increase the efficiency and sustainability of agriculture, promoting more responsible and environmentally friendly agricultural practices.

In the context of their use as fertilizers, research has found, germination rates were higher for seeds containing nanocarbons, analytical methods indicated that this substance is capable of penetrating the thick seed coating and favoring the absorption of water inside the seeds. [1]

Other studies have shown that the use of zeolite in agriculture represents a good nanotechnological option, as a slow-release fertilizer, soil corrective,

efficient use of irrigation water and as a substrate for plant growth in soil. [2]

However, it is crucial to emphasize that the scientific literature still lacks long-term studies on the use of nanocarbon fertilizers, which are vital for comprehensively assessing the broader implications. These studies are pivotal in unraveling the potential long-lasting environmental impacts and evaluating any potential health-related consequences that might arise from the extended application of nanocarbon-enhanced fertilizers. Therefore, it is necessary to avoid hasty conclusions and promote a cautious approach to this issue.

This study presents a comparative analysis of fertilizer production processes using nanocarbon, focusing on patents CN102206124 and CN102816003 (available at: Patentscope and Patent Search Analysis). [3] [4]

The objective of this study is to evaluate the advantages and disadvantages of each of these patents, identify their differences, Furthermore, this study undertakes a thorough examination of the preparation methods outlined in these patents, aiming to elucidate their intricacies and applicability. In tandem, we accentuate the imperative of assessing the environmental repercussions of these production processes, contextualized within the contemporary landscape where environmental preservation stands as a paramount concern.

It should always be remembered that this study will not resolve doubts regarding safety related to human health and the environment. As there is a lack of specific studies on human nutrition and the environmental impact associated with the use of these fertilizers, it is possible that there are unknown negative impacts in both aspects.

2. Methodology

In the methodology used in this study, an online search was conducted on a Chinese patent database (Patent Search and Analysis) and a global database (Patentscope) using the keywords 'nano fertilizer' to identify relevant patents related to the topic; [5] [6] This patent was selected: CN106518505. The patent was based on six patents, (only in the Chinese patent database is it possible to verify this) of which two of them are on fertilizers with nanocarbon. The main patent (CN106518505) which was inspired by these two, has a brilliant invention, it transforms the nanocarbon of trash into fertilizer. [7] The negative impacts of trash on the environment are evident, such as pollution of water bodies, soil degradation, and threats to wildlife. By repurposing nanocarbon from waste materials into valuable fertilizers, we could address these issues while also promoting resource efficiency and circular economy principles. A detailed comparative study was conducted between the selected patents. This process aims to facilitate a comprehensive analysis of the advantages, disadvantages and methods of preparation present in each of the patents. Additionally, it will help identify any missing information and highlight the differences between the patents, enabling a more thorough understanding.

3. Results and Discussion

In this current investigation, two relevant patents were analyzed that describe the application of nanocarbon-based fertilizers, highlighting their advantages and disadvantages. Table 1 presents the main differences, missing information, advantages, disadvantages and methods of production of these Chinese nanofertilizers.

The first patent, CN102206124, highlights several advantages of this type of fertilizer. Notably, it demonstrates a substantial reduction in the volatilization of Greenhouse Gases (GHG), thus generating significant environmental benefits and contributing to the ongoing efforts to mitigate climate change. Moreover, the application of these fertilizers has revealed a remarkable enhancement in the fertilization rate—between 50% and 70% higher than that achieved through conventional fertilization methods. This increase in fertilization efficiency bears the potential to substantially amplify agricultural productivity, addressing the ever-growing demand for food while optimizing resource utilization.

Another observed advantage was the potential for substantial savings—approximately 30% to 50%—in the amount of fertilizer applied compared to common fertilizers. This reduction in fertilizer usage holds significant importance for farmers, as it directly translates into cost savings. By optimizing fertilizer application, farmers can potentially achieve more efficient resource utilization and financial management. Beyond the financial implications, this reduction also carries profound environmental benefits. A judicious reduction in fertilizer application minimizes the risk of nutrient runoff, ensuring water bodies remain free from pollution. Moreover, it promotes healthier soil ecosystems, supporting better plant growth and nutrient cycling while safeguarding biodiversity. This strategic approach aligns with sustainable agricultural practices that reduce energy consumption, greenhouse gas emissions, and the demand for resource-intensive fertilizer production. Ultimately, it fosters not only economic resilience for farmers but also a harmonious balance between agricultural productivity and environmental stewardship, benefiting both present and future generations. In addition, it was found that this fertilizer have the potential to treat different diseases in different crops.

However, some disadvantages associated with this fertilizer is also identified. Under conditions of high temperature and humidity, this patent tend to decompose easily, which can compromise it's effectiveness.

Furthermore, the nitrogen utilization rate of this fertilizer is low, ranging from only 25% to 30%, and

the period of effect of the fertilizer is relatively short, lasting from 30 to 40 days.

In the case of the second fertilizer, CN102816003, the inclusion of nanocarbon in the fertilizer has been observed to enhance permeability and adsorption properties. This enhancement intensifies the effectiveness of antibiotics, contributing to improved disease control.

When comparing the two patents, it is observed that both fertilizers are nanocarbon-based.

However, significant differences can be seen in relation to the ingredients used. Patent CN102206124 mentions the use of DCD – dicyandiamide (ammonium nitrogen nitrification inhibitor) and ammonia, while patent CN102816003 describes the fermentation of the culture medium by antibacterial bacteria, the mixture with animal feces and the inoculation of bacteria in the fertilizer.

It is important to highlight that both patents have missing information that limits a more comprehensive analysis. Missing information includes the molecular formula, the type of nanocarbon used, the proportions of the substances present, as well as a more detailed overview of the advantages and disadvantages of each method used to design the invention. Additionally, while efforts were made, including consulting with AI language models (ChatGPT, version 3.5, and ChatSonic, which does not have a version, it is always updated and was used in September 15th, 2023), to ascertain the meanings of certain Chinese terms within the patents, it remains challenging to provide a definitive interpretation due to potential variations, nuanced contexts, and the complexity of the Chinese language. [8] [9]

Furthermore, it is essential to underscore the pivotal role of transparency and comprehensive data reporting in patents. Complete and detailed documentation not only enhances the credibility of innovative agricultural solutions but also accelerates further research and innovation in the field. It enables researchers to replicate and validate results, fostering a collaborative environment that can lead to the refinement and advancement of these groundbreaking technologies. Therefore, it is imperative that patent applicants prioritize the inclusion of all necessary information, thus facilitating a more robust evaluation of their inventions and promoting a culture of open scientific inquiry.

4. Final Considerations

The dearth of long-term research on the subject underscores the need to conduct additional studies and rigorous evaluations, both to understand the effects on human health and to assess the environmental impacts before considering large-scale use of these fertilizers in crop production. food and agricultural practices. It is essential to obtain a thorough knowledge of the potential risks associated with the use of these fertilizers, both for human health and for the preservation of the environment.

Due to the lack of information (Molecular formula, type of nanocarbon used, proportions of substances, an overview of advantages and disadvantages of each of the different methods used to make the invention, etc...) essential in both analyzed patents, it becomes if it is not feasible to conduct a comprehensive investigation and reproduce the aforementioned results. It is imperative that Chinese patent applicants adopt effective measures to ensure the integrity and completeness of the data provided, thus allowing other people to reproduce and validate the results described.

In addition, it is fundamental that mechanisms be established for reviewing and improving the patent submission process, in order to guarantee the inclusion of all the necessary information for a careful evaluation. In this way, we will promote an environment that is more conducive to scientific research and technological innovation, in which the transparency and replicability of discoveries are valued and respected.

Thus, this study aims to contribute to the advancement of scientific knowledge in this area, providing relevant information for researchers, farmers and professionals in the agricultural sector interested in using nanocarbon fertilizers as a promising alternative for increasing agricultural productivity, by while seeking to preserve and protect the environment.

Tab. 1 – Comparation between CN102206124 and CN102816003.

	CN102206124	CN102816003
Advantages	GHG volatilization is reduced.	The fertilization rate is 50% to 70% more than conventional. The nanocarbon present in the fertilizer increases the permeability and adsorption of antibiotics, intensifying their effect. It saves about 30% to 50% of the amount of fertilizer applied to the soil compared to ordinary fertilizer. It treats different diseases in different cultures.
Disadvantages	It is easy to decompose under conditions of high temperature and humidity. Generally, the nitrogen utilization rate of this fertilizer is only 25% to 30%, and the effect period of the fertilizer is only 30 to 40 days.	Not clearly written.
Missing information	Molecular formula, type of nanocarbon used, proportions of substances, an overview of advantages and disadvantages of each of the different methods used to make the invention and probably use of non-existent terms.	Molecular formula, type of nanocarbon used, proportions of substances, an overview of advantages and disadvantages of each of the different methods used to make the invention and probably use of non-existent terms.
Differences	Use of DCD, dicyandiamide (ammonium nitrogen nitrification inhibitor) and ammonia ingredients.	Fermentation of the culture medium by antibacterial bacteria. Mix with animal feces. Inoculation of bacteria in fertilizer.

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