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The Potential of Liquid Organic Fertilizer for Hydroponic Nutrition: A Systematic Literature Review

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Abstract
Nutrients are the main component in a hydroponic system. Liquid organic fertilizer has the potential to be a source of hydroponic nutrition because it can be made from agricultural waste through a fermentation process using local microorganisms. The aim of the research is to analyze articles that use the theme of liquid organic fertilizer and describe various topics that are relevant and have novelties to be developed in future research. The bibiometric analysis used in the research used the 2019-2023 literature. The data collection method uses dimensions with the keyword "liquid organic fertilizer" to obtain 500 papers published in 2019-2023. The data was sorted into 300 articles for further analysis with the help of VOSviewer 1.6.19_Mac software. The research results show that the theme of liquid organic fertilizer implemented in scientific articles has become a serious concern and has had high interest value for researchers over the last 4 years. Several new topics that need to be studied further to support the development of liquid organic fertilizer as nutrition in hydroponic systems to support sustainable agriculture include: local microorganisms (mol), biostimulants, cocopeat, chicken manure. Elsevier is a publisher in the main ranking which publishes articles and is widely cited. Keywords with different topics are needed to analyze articles to get new ideas and innovations in developing knowledge and technology that supports sustainable agriculture.

Keywords: Biostimulants, Chicken Manure, Local Microorganisms

Introduction

The development of urban farming as a result of increasingly limited agricultural land has encouraged the development of hydropoic cultivation systems to increase. Hydroponics is a farming technique without using soil to produce quality vegetable and fruit products (Niu and Masabni 2022), crop production method using controlled nutrient solutions (Cifuentes-Torres et al. 2021) soilless farming techniques to overcome climate change, water scarcity and the ever-increasing need for food (Khan, Purohit, and Vadsaria 2020), techniques for cultivating plants on natural or artificial substrates and providing nutrients using controlled nutrient solutions (Velazquez-Gonzalez et al. 2022), farming system using nutrient solutions and without pesticides (Sathyanarayana et al. 2022).

Nutrients are the main component in a hydroponic system. Hydroponic nutrients that are commonly used and available on the market are in the form of inorganic chemicals consisting of macro and micro nutrients dissolved in stock A and B (Gustiar et al. 2022). However, one of the disadvantages of using chemical nutrients is that they are expensive (Dewi and Rahayu 2019)

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Using liquid organic fertilizer as nutrition in a hydroponic system is an alternative to anticipate the high price of AB mix. Organic fertilizer can be made through the fermentation process of agricultural waste. Agricultural waste contains nutrients needed for plant growth so it can be used as nutrients for hydroponics. The current use of agricultural waste is not optimal and is often thrown away and causes environmental pollution

Research on the use of agricultural waste as liquid organic fertilizer has been carried out, including: fish farming waste(Ahmed et al. 2021); biogas digestate (Takemura et al. 2020), tofu wastewater (Anggraini et al. 2020), vermicompost (Arancon, Owens, and Converse 2019); sargassum (Fajrisani et al. 2020), goat manure (Sunaryo et al. 2018), peanut and onion bulb waste (Wondu G, Zekeria Y, and Kumar 2020), banana waste (Haryanta, Sa'Adah, and Thohiron 2022), industrial waste (Phibunwatthanawong and Riddech 2019).

Application of liquid organic fertilizer as a source of nutrients for vegetable plants in hydroponic systems such as lettuce (Ahmed et al. 2021), spinach (Jin et al. 2020), tomato (Magwaza et al. 2020), pak choi (Churilova and Midmore 2019); mustard (*Brassica juncea* L)(Fauziah, Kameswari, and Setia 2022), red spinach) (Anggraini et al. 2020)

Literature Review

Liquid organic fertilizer is fertilizer derived from animals or plants that has undergone fermentation (Niu and Masabni 2022). Agricultural waste such as cow urine, coffee processing liquid waste, tofu processing liquid waste and coconut water can be used as liquid organic fertilizer because they contain nutrients that plants need. According to (Vebriyanti et al. 2022), cow urine contains 1.0% N. Tofu processing wastewater contains 0,27% N, 2,85 ppm P_2O_5, 0,29% K_2O dan protein 1,68% (Telaumbanua et al. 2019), coconut water contains K, Na, Ca, P, Fe, Cu, S, Mg (Sulistiya 2021), Goat faces contain 46.51% C, 1.41% N, 0.54% P and 0.75% K (Anggraini et al. 2020)

Utilization of agricultural waste as liquid organic fertilizer requires bioactivators to speed up the decomposition process of organic material. Microorganisms from the bacteria and fungi groups can be used as bioactivators. Endophytic fungi can be used as bioactivators because they are capable of producing lignocellulotic enzymes (Syamsia et al. 2019). The advantages of using endophytic fungi are: being able to produce IAA and Gibberellin hormones (Syamsia, Idhan, and Firmansyah 2020), dissolving phosphate(Syamsia et al. 2015), so that it can enrich the organic fertilizer produced.

Local microorganisms can also be used as bioactivators in making organic fertilizer. Local microorganisms are fermented solutions made from various locally available resources, both from plants and animals (Hadi 2019). Banana peel can be used as local microorganisms because they contain *Bacillus* sp, *Aeromonas* sp, *Aspergillus niger*, *Azospirillium*, *Azotobacer* and cellulolytic microbes (Budiyani, Soniari, and Sutari 2016). Bamboo shoots contain *Azotobacter* and *Azospirillium* (Sani, 2013; (Sutrisno et al., 2021). Sugarcane bagasse contains yeast, photosynthetic bacteria, *Azotobacter* Sp, *Lactobacillus* Sp ((Kurniawan, 2018);(Saputri, Aziz, and Dewilda 2021). Pineapple skin contains *Azotobacter* Sp, *Rhizobium* Sp., *Azospirilium* SP., *Pseudomonas* SP., *Bacillus*, Sp (Abdullah dan Mat (2008)(Ramadhani and Nuraini 2018).

Research Method

The method used in this research is the bibliometric method which consists of several stages, namely: creating keywords, searching for and selecting articles, validating, analyzing data (Fitriani & Soebagyo, 2022; Mujahidah & Soebagyo, 2022; Saviraningrum & Soebagyo, 2022). The keywords used in this research are "liquid organic fertilizer" to obtain published data for 2019-2023. Obtained 500 papers with a total of 4,642 citations, citations per year 1,160.50

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citations per paper 9.28, authors per paper 3.11, h-index 30, g-index 62, hi, norm: 16, hi, annual 4.00, hA-index: 19. Next, the data is validated based on publication type, publisher, quotation, theme map, author and other bibliographic data. Data were analyzed using VOSviewer 1.6.19_Mac.

Minimum number of occurrences of a term: 3 of the 2857 terms, 300 meet the threshold. The minimum number of terms is 3 out of 2857 terms and 300 meet the threshold. For each of the 300 terms, a relevance score will be calculated. Based on this score, the most relevant terms will be selected. The default policy is to select the 60% most relevant terms. Number terms to be selected 180. Tea, raw material, lignate substrate, mineral wool, crispa, commercial fertilizer, program, dan, raft, usa, example,thesis, remote area, ml l, training, lack, efficacy, role, hand , non, work, cost, experiment, number, chinensis, chapter, effort, perspective. Some of the 128 items in your network are not connected to each other, The largest set of connected items consists of 123 items (12 clusters).

Results and Discussion

Bibliometric analysis used the keyword "liquid organic fertilizer" for 300 articles published in 2019-2023. VOSviewer was used to obtain Networking Visualization, Density and Overlay and produced 12 clusters as follows: the first Cluster decribed anaerobic digestate, animal waste, bio-organic fertilizer, biogas digestate, brassica rapa, commercial liquid fertilizer, fish waste, hydroponic culture, hydroponic production, liquid form, liquid organic fertilizer, organic agriculture, organic nutrient, organic substrate, perlite, vegetable waste, vermicompost, vermicompost tea. The second cluster described biomass, conversional fertilizer, fertigation, fresh weight, hydroponic crop, hydropnic crop production, hydroponic farm, hydroponic lettuce, lactuca sativa, lactuca sativa var, liquid digestate, nitrification, organic fertilization, romaine lettuce, root growth, root length, soil cultivation, urban agriculture, and wastewater. The Three clusters describe agriculture, biofertilizer, biostimulant, EM4, feasibility, horticulture, hydroponic experiment, hydroponic plant, hydrothermal carbonization, irrigation, nutrient recovery, nutrient source, phosphorus, sewage sludge. The four clusters describe AB mix nutrition, brassica juncea L, hydroponic solution, hydroponic technique, hydroponic wick system, kangkong plan, mustard plant, pacoy plant, plant cultivation, poc, raft hydroponic, seaweed, and seed. The five clusters describe *Amaranthus hybridus* L, bos taurus, Brassica cinensis L, Coffea arabica L, coffea ground, cow, cow urine, hydroponic nutrition, liquid organic fertilizer, mole, spinach, utilization. The six clusters describe biogas slurry, cucumber, environment, foliar application, fruit quality, liquid organic fertilizers, mineral fertilizer, organic, *Solanum lycopersicum*, strawberry. The seven clusters describe banana eel, bioorganic liquid fertilizer, chicken manure, fertilizer solution, ground nut husk, hydroponic farming, leafe, onion bulb, quality organic fertilizer. The eight clusters described acid fertilizer, agriculture, crop production, culture, hydroponic technology, hydroponics culture, implementation, soilless culture. The nine clusters described barley, ecoenzyme, height, hordeum vulgare l, hydroponic nutrient, ipomea reptans poir. The ten cluster AB mix fertilizer, *Brassica meeting* L, liquid organic fertilizer, pakcoy. The eleven clusters electrical conductivity, hydroponic medium, tofu liquid waste, tofu wastewater. The twelf cluster described cocopeat, planting media.

Identification of the theme concept to be researched is expressed in various color codes displayed in each cluster. The color code aims to identify themes that are often discussed in various published studies that have the potential to be used in further research. The size of the nodes in the networking visualization shows keywords with dominant quantity, the closeness between nodes and the thickness of the interconnected lines indicate a strong relationship between keywords. The color of the nodes displayed on the map represents keyword clusters that contain elements of events based on words or combinations of words that can be intended as research topics. The keywords selected through network visualization in Figure 1 show that there are

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several keywords that frequently appear and are widely used for research on the topic of liquid organic fertilizer, including; hydropnic nutrition, fertilizer solution, wastewater. The choice of the next research theme is based on nodes that are far from the center or based on small node sizes, indicating that the topic has not been widely used as a research topic, such as mole, chicken manur, seed, biostimulant, organic, foliar application and cocopeat

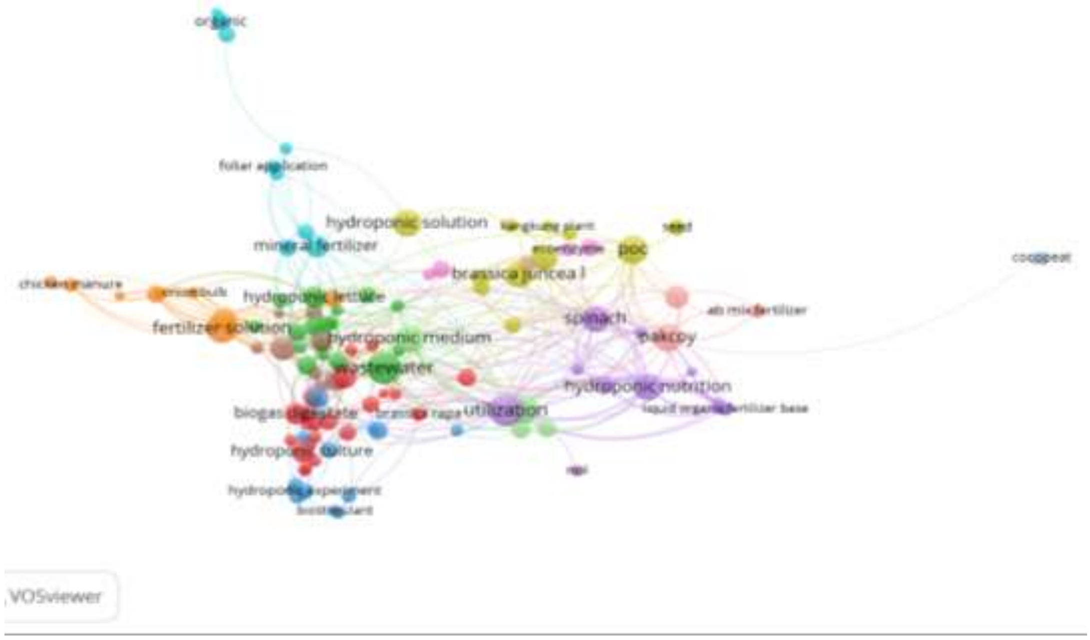

Figure 1. Networking Visualization

Density Visualization is known to be based on colors that indicate the density level of items. A sequence of colors that describes the visualization of density. Low density levels go to high density levels starting from blue to green to yellow. The greater the number of items and the heavier the item, the color will turn yellow, the fewer the number of items and the lower the weight of the item, the color will turn blue.

Figure 3 shows a density visualization with a large number of items and a high weight on several items or keywords. Several items with yellow nodes mean they have been widely used as themes in previous journal publications, including waste water, hydroponic medium, biogas digestate, ulization, brassica juncea, hydroponic lettuce. So if you want to choose a research topic related to liquid organic fertilizer, it is recommended to choose a theme with low density visualization such as: mole, cocopeat, biostimulatn, chicken manur, foliar application and organic.

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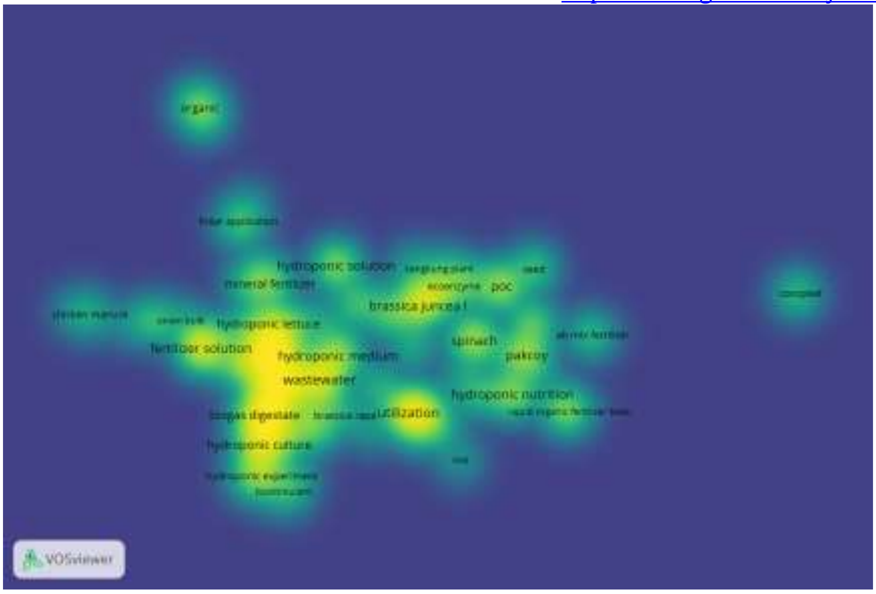

Figure 3. Density

Identification in the form of mapping the development of research topics over time will help researchers to start research based on needs based on time trends. Figure 4 provides an illustration that the research topics most studied in 2020 are hydroponic solution, ulitization, foliar application, chicken manure, in 2020-2021 the topics most studied include: wastewater, biogas digestate, pakcoy, poc, seed and in 2022 the most frequently studied topics are ecoenzym, spinace, lettuce.

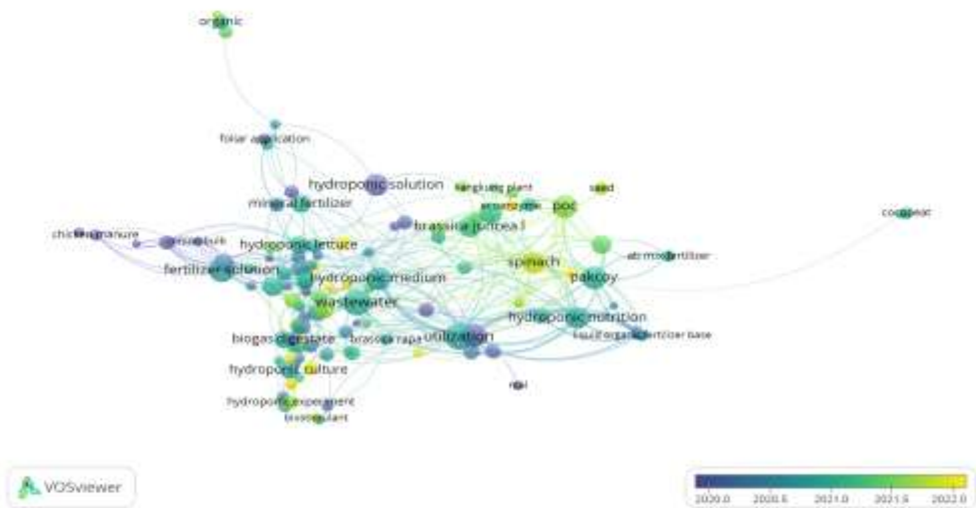

Figure 4. Overlay

The main publisher that has published the most on the topic of liquid organic fertilizer is Elsevier with a total of 191 publications, followed by other well-known publishers such as Springer, MDPI, Taylor & Francis. Elsevier manages 91 journals that have published organic and hydroponic fertilizers (Figure 5).

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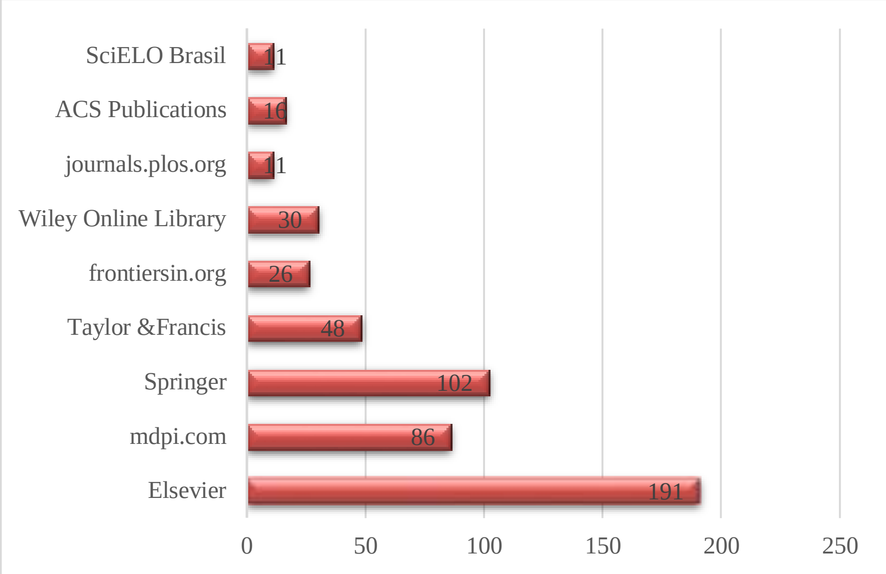

Figure 5. Publizer and Frekuensi Publication

Li Tejo-Tellez, FC Gomez-Merino is the author with the highest number of citations (1,191) with the article title Effects of anaerobic digestion on digestate nutrient availability and crop growth: A review published in 2012, and HM Resh with the article title Hydroponic food production: a definitive guidebook for the advanced home gardener and the commercial hydroponic grower published in 2022 with a number of citations 1.009.

Tabel 2. Sepuluh artikel yang paling banyak dikutip

Title	Author	Years	Cites	Cites per years
Nutrient solutions for hydroponic systems	LI Trejo-Téllez, FC Gómez-Merino	2012	269	24,45
Effects of anaerobic digestion on digestate nutrient availability and crop growth: A review	K Möller, T Müller	2012	1.191	108.27
Plant nutrition and soil fertility manual	JB Jones Jr	2012	331	30,09
Review of Pb availability and toxicity to plants in relation with metal speciation; role of synthetic and natural organic ligands	M Shahid, E Pinelli, C Dumat	2012	410	36,45
Occurrence, fate, and ecotoxicity of antibiotics in agro-ecosystems. A review	L Du, W Liu	2012	406	36,91
Plant factory: an indoor vertical farming system for efficient quality food production	T Kozai, G Niu, M Takagaki	2019	533	133,25
Aminochelates in plant nutrition: a review	MK Souri, M Hatamian	2019	247	61,75
Soilless culture: Theory and practice: Theory and practice	M Raviv, H Lieth, A Bar-Tal	2019	523	130,75
Effective uptake of submicrometre plastics by crop plants via a crack-entry mode	L Li, Y Luo, R Li, Q Zhou, WJGM Peijnenburg…	2020	462	154,00
Hydroponic food production: a definitive guidebook for the advanced home gardener and the commercial hydroponic grower	HM Resh	2022	1.009	1.009,00

Conclusion

The conclusion of this research is that research on the topic of biostimulants, local microorganisms and cocopets has not been widely studied in the last 4 years. There has been a shift in research topic trends from hydroponic solutions, chicken manur, and organic, foliar applications towards the development of waterwater, liquid organic fertilizer, biostimulants and ecoenzymes.

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