AQUAPONICS: LEADWAY TO A SUSTAINABLE BIOINTEGRATED SAFETY PRODUCTION OF PLANT AND FISH IN AQUACULTURE

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ABSTRACT

Biosafety of food consumed at household level is the key to sustainable health, and part of such food consumed come from aquaculture as source of aquatic food. Most of the aquatic food produced, such as plants and fishes, could be of a serious public health concern as a result of poor water quality used to raise them. However, aquaponics, as a new concept is undergoing awareness in Nigeria as a sustainable tool to drive organic aquaculture as biosafety tool for protein production to every household. Aquaponics system has been considered as bio-integrated tool to foster the growth of vegetable and rearing of fish together thus maintaining good water quality. This will secure biosafety of aquatic products for future generation. Therefore, the paper reviewed the principles of operation, various growing techniques and different grow media used in aquaponics system, plant pests and diseases control in aquaponics system, advantages of aquaponics culture system, plants and fishes grown in aquaponics system. Aquaponics, therefore, encourages proper land usage and water conservation efficiency, and its possible role as eco-friendly technique is appreciable in plants and fishes production in aquaculture.

Keywords: Aquaponics, organic aquaculture, Nigeria, plant, fish, water quality

INTRODUCTION

Biosafety of food consumed at household level is the key to sustainable health, and part of such food consumed come from aquaculture as source of aquatic food. Most of the aquatic food produced, such as plants and fishes, could be a serious public health concern as a result of poor source of water quality used to raise them. However, aquaponics as a new concept is undergoing awareness in Nigeria as a sustainable tool to drive organic aquaculture as biosafety tool for protein production to every household. Aquaculture has been on the frontline of public concerns regarding sustainability (Martins et al.2010), for a long period of time; and is now the fastest growing food- producing sector, accounting for almost 50% of the world's food fish (FAO, 2006; Li et al.2012). Aquaculture provides approximately 20 million of the 140 million metric tons of fish and shellfish consumed in the world annually (Gordon, 2004). The remaining 120million metric tons are harvested from naturally existing populations, principally from marine fisheries, many of which are at their maximum sustainable yields, are in decline, or have completely collapsed (Gordon, 2004). The term sustainable agriculture was explained as integrated systems of combining plant and animal production using ecologic applications (Xie and Rosentrater, 2015).The long term goals of sustainable agriculture have already been defined by NALC (1990) as: meeting human food needs; be environmentally friendly; making full use of non-renewable resources; sustaining both economy and ecology; improving life quality for not only farmers, but for the community and the society.

Aquaponics is a biointegrated food production system that links recirculating aquaculture with hydroponic vegetable, flower, and/or herb production (Gordon, 2004; Diver 2006) It is a very productive and ecologically sound food production system, where fish waste provides a nutrient source for nitrifying bacteria, which in turn convert toxic waste of the fish to useful nutrients for plants (Al-hafedh et al, 2008). Mineralized solid waste is also used for the plants' benefit. Thus, plants associated with nitrifying bacteria provide a natural filter to eliminate toxic waste of the fish. This creates a mini ecosystem where both plants and fish can thrive. It further maximizes production and uses less water than is used to produce the same quantity of fish and vegetables in traditional practices. A brief history of aquaponics and its evolution have been provided by Jones (2002). Helfrich (2000) also examined food production through hydroponics and aquaculture.

The operation of aquaponics systems provides the possibility and opportunity to produce fresh food in the backyard and building roof, which means urban people have more chance to consume local food. While some hobbyist operate small scale aquaponics outdoors, such as in the backyard or on the building roof, most commercial aquaponics operators, however choose greenhouse or other indoor facility to control the environment (Licamele, 2009), in order to maintain food quality and safety, as well as to pursue maximum production yield. Therefore, the paper reviewed the principles of operation, various growing techniques and different grow media used in aquaponics system, plant pests and diseases control in aquaponics system, advantages of aquaponics culture system, plants and fishes grown in aquaponics system.. Aquaponics, therefore, encourages proper land usage and water conservation efficiency, and its possible role as eco-friendly technique is appreciable in plants and fishes production in aquaculture.

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AQUAPONICS PRINCIPLES OF OPERATION

Aquaponics serves as a model for sustainable food production by following principles:

1. the products from one system serve as food or fuel for a second biological system;
2. the integration of fish and plants is a type of polyculture that increases diversity and by this means, enhances stability of the system;
3. biological water filtration removes nutrients from the water before it leaves the system;
4. the sale of greenhouse products generates income that supports the local economy.

Nutrient wastes from tanks are used to fertilize production beds via the water. The roots of plants and associated rhizosphere bacteria remove nutrients from the water. These nutrients, generated from the feces of fish, algae and decomposing feed, are contaminants that could otherwise increase to toxic levels in the tanks. Instead they act as liquid fertilizer for hydroponically grown plants. In turn, the hydroponic beds function as bio-filters, and the water can be re-circulated to the tanks. Bacteria in the gravel and associated with the roots of the plants have a critical role to play in the cycling of nutrients; without these organisms, the system would stop functioning (Rakocy, 1999a; Diver, 2000).

ADVANTAGES OF AQUAPONIC CULTURE OVER TRADITIONAL CULTURE SYSTEM

A number of advantages of aquaponics for greenhouse managers include:

a. water carrying feaces from fish is a source of organic fertilizer that allows plants in the system to grow well;
b. hydroponics is viewed as a method of bio-filtration that facilitates intensive recirculating aquaculture;
c. aquaponics is seen as a method to introduce organic hydroponically-grown products into the market place, because the only fertility introduction is feed, and all of the nutrients pass through a biological process;
d. food-producing greenhouses, yielding two products from one production unit, are naturally appealing for niche marketing and green labeling;
e. in arid regions where water is scarce, aquaponics is an appropriate technology that allows food production with re-used water;
f. aquaponics is a working model of sustainable food production in which plant and animal systems are integrated, and the recycling of nutrients and water filtration are linked;
g. in addition to its commercial applications, aquaponics has become a popular training aid in integrated bio-systems in vocational agriculture and biology classes (Rakocy, 1999a ; Diver, 2000).

An additional advantage of aquaponics includes improved efficiency in the use of water, especially in areas with a limited supply of water (McMurtry et al, 1997).

PLANTS IN AQUAPONIC SYSTEM

More than 30 types of vegetables have been raised in integrated systems on an experimental basis (Rakocy et al. 1992). Lettuce, herbs, and specialty greens (spinach, chives, basil, and watercress) have low to medium nutritional requirements and are well adapted to aquaponics systems, whereas fruiting plants (tomatoes, bell peppers, and cucumbers) have a higher nutritional demand and perform better in a heavily stocked, well-established aquaponic system (Diver 1996, Rakocy, 1999a).

FISH GROWN IN AQUAPONICS SYSTEM

Various fish species presently used in aquaponics systems includes Nile tilapia, *Oreochromis niloticus*; hybrid tilapia, (*Oreochromis urolepis hornorum* and *Oreochromis mosambicus*); koi carp, *Cyprinus carpio*; hybrid carp, (*Ctenopharyngodon idella* and *Aristichthys nobilis*); Channel Catfish (*Clarias gariepinus*), hybrid striped bass, (*Morone chrysops* and *Morone saxatilis*); and goldfish, *Carassius* sp. (Selock, 2003). Rainbow trout, *Oncorhynchus mykiss*,Australian barramundi, *Lates calcarifer;* and Murray cod, *Maccullochella peelii peelii*, as well as various crustaceans such as red claw crayfish, *Cherax quadricarinatus*, have also been grown in aquaponics systems (Diver 2006) in other tropical region of the world.

PLANT PESTS AND DISEASES CONTROL

Aquaponics plants are subject to many of the same pests and diseases that affect field crops, although they seem to be less susceptible to attack from soil borne pests and diseases. Because plants may absorb and concentrate therapeutic agents used to treat parasites and infectious diseases of fish, these products cannot be used in aquaponics systems. No pesticides or antibiotics are used at any stage; therefore, the aquaponics production system can be regarded as a part of the organic agriculture (Rakocy, 1999). Pests can be hand-picked while proper management procedure can prevent diseases outbreak.

VARIOUS GROWING TECHNIQUES IN AQUAPONICS SYSTEMS

Aquaponics systems use several common components and the grow bed (the hydroponic part of the system) is obviously one of the most crucial (Aragon, 2016).There is many different variations of Aquaponics systems (Mader, 2012).Two main types of growing systems are usually used:

1. Growing in trough/ gutter with floating water (Nutrient film Technique), which are usually found in hydroponic setups.
2. Growing in flowing board (Deep Water Channel), which are long, deep troughs that hold the floating rafts, that the produces (plants) is grown on.

GROW MEDIA USED IN AQUAPONICS PRODUCTION

Different media are used in Aquaponics production, all of which have their advantages and disadvantages. Here are some of the most popular forms of Aquaponics grow media: expanded shale, expanded clay (Hydroton), river stone, gravel, crushed stone and Synthetic media (Brook, 2017). Organic media like, saw dust, *Urena lobata*, and *Luffa* species (Sponge gourd) can also be used in aquaponics production system. The function of any chosen grow media is to support the plant and filter the waste water for reuse.

CONCLUSION

Aquaponics system can be used in areas where there is little or no water, no use of chemicals thus food are safe for consumption, incomes from two different end, the fishes and plants, more production seasons and water can be reused thus no wastage of any kind. Aquaponics, therefore, encourages proper land usage and water conservation efficiency, and its possible role as eco-friendly technique is appreciable in plants and fishes production in aquaculture.

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