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Hydroponic foods: an alternative for the feeding of domestic animals

Forrajes hidropónicos: una alternativa para la alimentación de animales domésticos

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Data of the Article

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Abstract

Currently, in critical times of confinement, hydroponics is a viable alternative that allows the production of plant biomass derived from the initial development of plants in the stages of germination and early growth of seedlings from feasible seeds, it is the sowing of soilless cultivation, this method facilitates the productive, sustainable, and ecological development of plants. Hydroponic crops are developed in a medium or culture system fed by a nutrient solution that offers the precise food for the entire period of growth of the forages, free of pesticides andfungicides with this we get healthy food for the feeding of domestic animals. In addition, it allows the use of simple or complex structures to produce fodder, taking advantage of spaces or areas such as terraces, infertile soils, rugged terrain, technical or traditional greenhouses. Based on this idea, techniques were deployedthat are supported by using substrates, or methods with contributions of nutrient solutions, always considering the needs of the plant such as temperature, humidity, water, and nutrients. Based on practice, the benefits per unit of planted area are high due to greater consistency, productivity, safety, and efficiency in the use of water, light, and nutrients, and it is also economically viable that deserves to be considered by small and medium- sized companies. rural producers of domestic animals.

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Resumen

En la actualidad en tiempos críticos de confinamiento la hidroponía es una alternativa viable que permite la producción de biomasa vegetal derivada a partir del desarrollo inicial de las plantas en las etapas de germinación y crecimiento anticipado de plántulas a partir de semillas factibles, es la siembra de cultivo sin suelo, este método facilita el desarrollo productivo, sostenible y ecológico de las plantas. Los cultivos hidropónicos se desarrollan en un medio o sistema de cultivo alimentados por solución nutritiva que ofrece el alimento preciso para todo el período de crecimiento de los forrajes, libre de pesticidas y fungicidas con esto conseguimos alimentos saludables para la alimentación de animales domésticos. Además, permite utilizar estructuras simples o complejas para la producción de forrajes aprovechando espacios o áreas como terrazas, suelos infértiles, terrenos escabrosos, invernaderos tecnificados o tradicionales. A partir de esta idea se desplegaron técnicas que se apuntalan a utilizar sustratos, o métodos con aportes de soluciones de nutrientes, tomando en cuenta siempre las necesidades de la planta como la temperatura, humedad, agua y nutrientes. Fundados en la práctica, los beneficios por unidad de área sembrada son altos debido a una mayor consistencia, productividad, inocuidad y eficacia en el uso de los recursos agua, luz y nutrientes, además es económicamente viable que merece ser considerada por los pequeños y medianos productores rurales de animales domésticos.

Palabras clave:

Agua,
biomasa vegetal,
nutrientes,
técnicas.

Introduction

In our country, the supply of food during the dry season is a major drawback, which is why hydroponic green forage (HGF) production methods are used, a high-quality forage. In addition, it does not require complex production technology, it only takes 10 to 15 days to produce up to 4 kg of fresh food by sowing 1 kg of seed, without spending a large amount of money, food that can be produced in any time of the year, due to the minimum consumption of water. Feeding for domestic animals, mainly in periods where forage production is insufficient[1]. This technology plays a very important role in global agricultural development, since at this moment, more than 40000 ha of greenhouses are recognized under hydroponic systems throughout the world, expanding more and more[1]. In a study, *Avena sativa* HGF was provided, the diets were: natural field hay (NFH) 100% (D_0) and NFH+1.2 Kg HGF/goat/day (D_1). The NFH hay was supplied ad-libitum. Two experiments were carried out: determination of total dry matter consumption (TDMS), hay consumption (HC), HGF consumption and total digestibility apparent in vivo of the dry matter consumed (DMC)[2]. To remedy this drawback, the HGF production technique represents an unconventional alternative method, very significant to use in a small area of land, to obtain forages of good nutritional quality throughout the year[3-5], the HGF production of oats, the optimal planting density of 5.0-6.4 kg/m^2. On the other hand, it has been integrated into different animal production systems to replace certain components of the diet partially or totally[6], the latter being important, since it encompasses the costs Feeding of rabbits based on commercial concentrates (CC) is high[7].

HGF is the result of the germination of cereal grains such as oats, barley, corn, rice, wheat and/or sorghum, being ready for harvest in periods between 9 to 15 days after sowing. The mineral nutrient solution makes it possible to increase biomass production per m^2, improve nutritional quality and optimize forage harvest time. HGF is defined as obtaining forage biomass in short cycles at harvest[8,9] and geoponic green forage (GGF) are crop alternatives for feeding cattle, because they constitute a quality green forage, free of weeds, pests and diseases[10,11], as well as innocuous, with high palatability[10,12,13]. The HGF is suitable for feeding livestock, especially during times of scarcity[10], which allows the yield for the weight consumed, in the assimilation of the feed. There are different characteristics of HGF production, the basic technique is the germination of grain seeds in high sowing conditions to obtain 20 to 30 cm of forage in 8 to 12 days[9,11,14], this is watered with water benefited with essential mineral nutrients, called nutritive solution[12,15-18], in protected situations some environmental variables intervene such as light, temperature and humidity[19].

Therefore, it is critical to develop methods alternative forage production, aimed at saving water, high production per m^2, quality of nutrients, transfer flexibility and minimal negative impact on the environment[20,21]. On the other hand, the effect of the pea-barley and pea-wheat associations was observed in six proportions of hydroponic crops on the percentage of dry matter (DM), organic matter (OM) and crude protein. (CP), and plant height, as well as in the production of green forage, DM, OM and PC[13].

To assess the production of HGF from oats, its cost, and its influence on the improvement of weight gain, studies with 21 male New Zealand breed animals with an average weight of 1179 g, 8 weeks old, made up of three treats-T_1 (HGF of oats without nutrient solution), T_2 (HGF of oats with nutrient solution and

T_0 (cut oats), each treatment consisted of 7 repetitions, the experimental unit was of an animal under study. At HGF was made inside an 18 m^2 greenhouse covered internally with 65% black shade cloth and carrying out a series of procedures such as: selection, washing, pre-germination, germination, sowing the seed in plastic trays, irrigation of the sowing with nutrient solution and water, to end the harvest on day 12 to be consumed by rabbits[22]. The objective of the bibliographic review was the compilation of studies carried out on the alternative of the use of HGF feeding domestic animals in rural areas.

Developing

Different forage species have been used to produce HGF, among them grasses and legumes. Several studies evaluated the quality of the HGF in corn *Zea mayz* L.[23], sorghum *Sorghum bi-color* L.[24], barley *Hordeum vulgare* L.[10], wheat *Triticum aestivum* L.[13], rice *Oriza sativa* L.[18], and in mixtures of cereals and legumes[13]. However, only a minimal number studied the quality of the HGF in response to the application of nutrient solutions, for example: in corn[25], wheat[18], barley[10] and sorghum[24]. The intensive production of HGF in a protected environment is not susceptible to climate change, allows effective programming of water use and a frequent production throughout the year[26], in addition to a decrease in fertilizers, agrochemicals and labor[27].In several studies an absolute control of non-nutritive water was used, in other investigations microbiological indicators were evaluated reaching similar values to other indicators in the application of nutrient solution in irrigation[23], which generates uncertainty regarding the need to use mineral nutrition in the production of HGF. To establish the yield, chemical composition, nutritional value of the forage oat crop, under situations of the Puno highlands, the samples were analyzed to determine the chemical composition of the forage using the Weende analysis method, as well as the determination of fiber neutral detergent (FND) and acid detergent fiber (ADF) using the Van Soest method, with these results the nutritional values of digestible dry matter (DDM), dry matter consumption (DMC), Relative Forage (RF) and Net Lactation Energy (NLE)[28]. Studies carried out to assess the production of HGF in the Morocho Blanco and Amarillo maize varieties, subjected to different levels of silicon under greenhouse conditions located in the Botana experimental farm of the University of Nariño at 1 ° 9'29.86” LN, 77 ° 16'33.85” WL, 2780 masl. A 2x3 factorial experiment was used, where one factor corresponded to the corn varieties and the other to the levels of silicon applied to the nutrient solution (0, 0.025 and 0.5 mL/L) for a total of six treatments and three repetitions. The variables evaluated were plant height and green forage yield[24].

Advantages of hydroponic cultivation. Hydroponic cultivation is generally associated with large extensions of greenhouses for the cultivation of plants and the use of the most complex technology, however, the origins of hydroponics were simple. The technological advance in hydroponic crops lies in the minimum use of space, low water consumption and maximum production and quality. The application of nutrients in high and low concentration solutions through irrigation will not affect the fresh benefit or the bacteriological quality of the green hydroponic corn forage. These roots are subsequently replaced by a permanent root system that emerges from the nodes of the stem. The root system is combined by lateral roots, the appearance of highly differentiated roots (called absorbent hairs) considerably increases the absorption surface[29].

Efficiency in production time. The HGF production has a cycle of 12 to 20 days, depending on the situations of temperature, light, humidity, among others.

Forage quality: harvested at 12 days and with about 20 to 30 cm in height, the HGF is rich in vitamins A and E, it contains carotenoids, in addition, significant amounts of iron, calcium, phosphorus, its digestibility is high due to low presence of lignin and cellulose. Safety: with the HGF the animals do not eat weeds, mistreated grasses or organic remains of animals, in this way the metabolism and absorption of the food is optimal[21]. Another reasoning commonly used to determine forage quality is digestibility. The FND content is a quantification of the indigestible fraction. In the HGF, the FND depends on the harvest time, yielding lower values in the initial stage and higher values in the final stage. The fiber requirement of cattle is a significant factor in several physiological processes. The FND is the best indicator of fiber requirements for healthy fermentation in the rumen[18].

Hydroponic forage is obtained from the germination of seeds or grains; Due to its high protein content, it can be used as a nutritional supplement for different animal species[13], a calculation of the soluble fiber/insoluble fiber ratio, high DM digestibility, and energy contribution[30]. The intensive obtaining of HGF in sheltered environments is less sensitive to climate variations, it allows a programmed and periodic production throughout the year, with an efficient use of water[26], reduction of fertilizers, agrochemicals, labor[27].

Supply in animals as food. The tests carried out are based on the use of agricultural development, livestock, because agricultural crops are used to complement animal feeding, common elective methods are used, such as the HGF of corn, a minimum amount of food due to the lack of knowledge in our area, but it is generously examined internationally due to its easy handling and high nutrient content[31].

The productive performance of the hydroponic green corn forage used in the livestock production system was evaluated. Using a completely randomized design and a two-factor arrangement, nine treatments were repeatedly evaluated four times. Measurement variables: plant height, hydroponic green feed benefit, DM, and crude protein (%)[32]. The application of mineral nutrients through the solution will not affect the yield of fresh forage or the microbiological indicators and shows the potential of using green hydroponic corn feed as a food source in the rearing, handling, and production of animals[12]. Using the HGF production technique, 15-25 t of DM[20] can be harvested annually. Comparing with another study, they show that the benefit is like that of alfalfa, sorghum, or corn, but the area is smaller, only 100 times, and they do not demand pesticides. To obtain from 1 to 8 kg of DM of feed for cattle using forage species me Using conventional methods, 1 m^3 of irrigation water is used, while using this same volume of water in the production of HGF, around 100 kg of DM of forage of good nutritional quality are obtained to supply in various types of livestock[1].

Discussion

In studies carried out, the average benefit of barley was evaluated, which was 32.8 kg/m^2 and a height of 21.7 cm at a density of 3.5 kg/m^2, in a period of eight days[8], a test that was verified in greenhouses in the Autonomous University of Chapingo-Mexico. By combining different levels of sulfur (up to 4 ppm/m^2) as an additive in the production of barley HGF, a biomass of 34.9±0.5 kg/m^2 and stem height of 14.61±1.38 cm was determined, the apparent digestibility of crude fiber and ethereal extract in guinea pigs, establishing that they were significantly influenced by sulfur levels[10]. On the other hand, the effects of different associations between peas and barley and wheat were experimented, it was concluded that the percentages of DM and green forage yield in these associations were statistically similar. The percentages of organic matter and CP (22.37 %) were affected by the association and by the level of the legume/grass ratio, which did not affect the height of the hydroponic crop[13]. Similarly, important factors for HGF production include genotype and time of harvest, in addition to establishing forage quality and development stage, this can also select materials with the highest yield potential[33]. Although irrigation methods recently associated with agricultural systems, such as underground drip irrigation, have been evaluated to produce pastures with lower amounts of water[34], the reality is that water use efficiency (WUE) still maintains low values of 1.6-1.9 kg DM m^{-3} compared to those calculated for the HGF production system. In other studies, the potential of using forage as a food source in animal production was verified[12,35]. On the other hand, the hydroponic oat forage in the feeding of rabbits improved the daily weight gain to (35.09 g), the feed conversion index 5.5, in addition to the weight of the animal to market (3136.5 g) and good profitability[9]. Likewise, in the feeding of sheep for fattening purposes, the use of HGF is shown as a reasonable and economically viable alternative compared to traditional diets[8].

The use of a nutrient solution in hydroponic forage crops predominated the development of the biomass of the shoot to the detriment of the root[36]. Fertilization with an organic nutrient solution increased the yield (≥19 %), as well as the WUE (≥50 %) and nutritional quality[17]. Therefore, the viability of sustainable use of vermicompost leachate in the production of HGF in arid zones is confirmed, which, being a product from livestock (manure), reduces costs and agro-environmental contamination[17,20], twenty. On the other hand, the productive parameters of green forage are higher when grown at 75 % nutrient solution with a harvest time of 12 days, establishing a conversion to biomass of 5.27±0.06 kg[37]. In situations of poor natural lighting, the culture technique with absorbent paper was more efficient for the benefit and the amount of crude protein[38]. In another study published on the Perucuy page, he sustains that when feeding guinea pigs, it is more economical to feed more hydroponic forage with a balanced supplement (S/.3.30) compared to only hydroponic forage (S/.3.56).

Since agriculture is an action of technological transformation, it is essential to develop new technologies that manage to develop and improve the production options available. Therefore, among the superiorities of hydroponics, there are a higher production of the crop, an early stage, the best quality of the products and low production costs[39]. The production of HGF is an alternative to solve feeding problems in the different animal species, since the HGF has sufficient nutritional value to be an ideal nutritional supplement in seasons of food scarcity[40].

Conclusions

Based on the bibliographic review, the production of HGF is currently considered a technology to produce plant biomass obtained from the initial growth of plants in the stages of germination and early growth of seedlings from viable seeds, in some cases developed in a culture medium or system fed by a nutrient solution that provides the necessary food for the entire growth cycle of the plants, thus achieving 100 % healthy forages.

Due to their effective characteristics, they allow to substitute or replace those that are produced in a traditional way and in this way use them in the feeding of animal species. Unlike other forages, FVH, due to its high nutritional value, turns out to be clean and innocuous without the presence of fungi and insects and free from any contamination. The investment required for the cultivation of HGF will depend on the level of production to be obtained. Considering the risks of droughts, other adverse climatic phenomena, the losses of animals and the unit costs of the basic input (seed), HGF is an economically viable alternative that deserves to be considered by small and medium producers of animal species. The breakdown of costs shows the great advantage of this production system.

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Conflicts of interest

The research was carried out by collecting and selecting adequate scientific information.

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Ethical considerations

The research complied with the ethical standards of the information process.

Authors' contribution to the article

Núñez Torres Oscar Patricio carried out the survey of the information and bibliographic compilation, *Guerrero López Jorge Ricardo*, reviewed the final article and support in the writing.

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