# Development of a low-tech bioponic method using mineralized chicken and goat droppings to produce lettuces

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## Introduction

Bioponics is a form of hydroponics that uses organic materials as fertilizers. This method appears to be an excellent alternative method for growing vegetables in areas with soils that are polluted, degraded or unsuitable for agriculture. It avoids the use of mineral chemical fertilizers, which are often expensive or inaccessible in more remote regions or in developing countries. Trials have been conducted since 2020 to develop a low-tech method for producing bioponic nutrient solution from chicken and goat manures. This poster will focus on two trials carried out in the C-RAU. This research is done as part of the SWIM project in collaboration with Oxfam and AFAD, which aims to develop innovative and sustainable farming methods in Sahrawi refugee camps, located in Algeria (Sahara desert).

## Materials and Methods

Manures first underwent a microbial "digestion", before being used as nutrient solutions to grow plants. This digestion was done in two stages: (1) first an anaerobic fermentation stage of 7 days, resulting in nutrient rich solutions, (2) followed by an aerobic mineralization stage of 21 days, via oxygenation of the solutions. Between the two, solutions were filtered and diluted based on the total mineral nitrogen concentration. The 1st trial tested a concentration of 65 mgN/L for chicken and goat manure solutions, while the 2nd trial tested two different concentrations for a chicken manure solution: 65 mgN/L and 140 mgN/L. The resulting solutions were then used on lettuce (*Lactuca sativa*) in bioponics, and compared to a conventional chemical solution.

## Results

**Nutrient solutions:** Goat feces resulted in solutions less concentrated in minerals than those made with chicken manures, especially in nitrogen, in addition to have higher amounts of organic residues that were difficult to filter. For chicken manures, the aerobic digestion stage was crucial, as it transformed the high levels of ammonium into nitrate, the preferred form of nitrogen for plants. In the 2nd trial, having a more concentrated solution for the aerobic digestion resulted in important nitrogen losses (72.6 ± 2 % of N losses). This was probably due to microbial overgrowth caused by higher amounts of organic residues.

| | | | Mineral concentration (mg/L) | | | | |
|---|---|---|---|---|---|---|---|
| | pH | EC (mS/cm) | N-$NO_3$ | P | K | Ca | Mg |
| Chicken | 6.5 ± 0.2 | 0.47 ± 0.05 | 39.1 ± 15.2 | 20.3 ± 1 | 58.2 ± 1.2 | 38.1 ± 8.2 | 11.6 ± 0.3 |
| Chemical | 5.4 | 1.3 | 130 | 46.6 | 202.8 | 86.1 | 34.2 |

Tab 1. Physico-chemical composition of the chicken manures solution of trial 2 (65 mgN/L) at the end of the aerobic stage, in parallel with that of the chemical solution

**Yields**: In the 1st trial, goat feces based solutions resulted in lettuces of about 50% of the fresh yields obtained with a chemical solution, while this percentage reached 70% on average for the chicken feces solution. In the 2nd trial, the two solutions of different concentrations resulted in yields similar to those with a chemical solution.

**Lettuces quality**: Manure based solutions overall resulted in lettuces of better nutritional quality than that of the chemical, i.e. leaves with lower nitrate concentration, and higher Ca, Mg, Fe, Mn and Zn concentrations. At the microbiological level, all lettuces were safe for consumption.

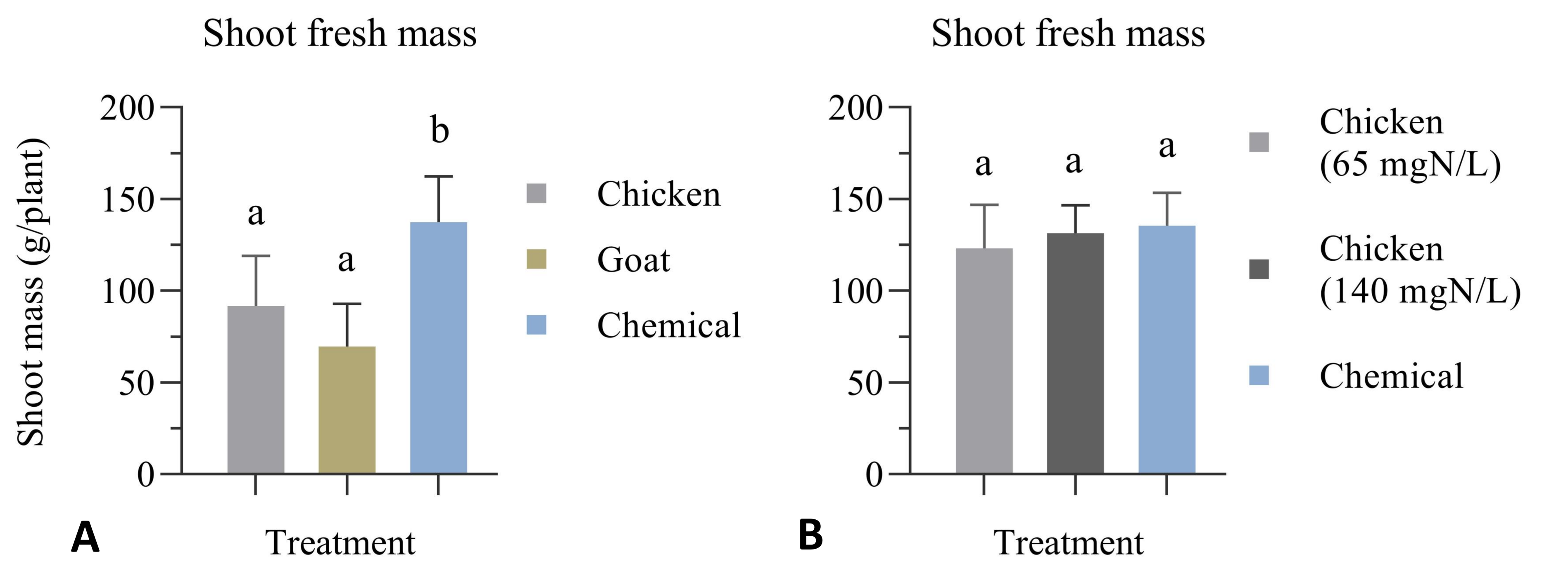


Fig 1. Means bar charts of the yields in trial 1 (A), and trial 2 (B). Identical letters indicate no significant difference ($p < 0.05$) between treatments according to Tukey's multiple range.

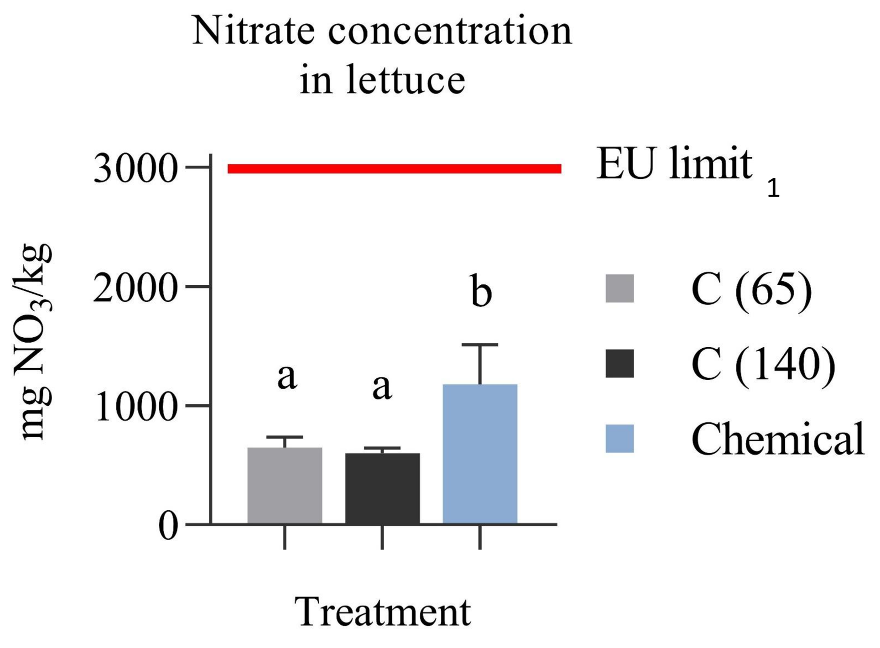


Fig 2. Means bar charts of shoot nitrate concentration (trial 2). 1 CE No 1258/2011


Fig 3. Photos of (A) trial 1 in the C-RAU (Belgium); (B) a trial in Rabouni (Algeria)

## Conclusions and perspectives

These trials show that it is possible to grow quality lettuces in bioponics with a simple and low-tech method using manures. Chicken manures appear to be more suitable as fertilizers, in comparison to goat feces. However, the quantities of fertilizers used for the bioponic solution must be controlled to avoid mineral losses. Trials are carried out in refugee camps in Algeria (Fig 3) to test and adapt the method to the local context. More generally, the principles of this technique can be developed in a more high-tech way and on a larger scale, notably as a way of recovering agricultural wastes and/or processing livestock effluents, which can be sources of pollution.

IHC 2022
ANGERS – FRANCE