Bioclimatic zoning of moringa (Moringa oleifera Lam.) in the Iberian Peninsula for biofuels.

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INTRODUCTION AND OBJECTIVES

The world energy consumption has increased in recent years, particularly in those regions undergoing a rapid development. Traditional energy supply from fossil fuel sources presents mainly two troubles: these sources are finite, and their impact on the environment is high. These circumstances require the development of alternative sources of energy, among which we propose to include biomass for energy.

Moringa oleifera (MO) is a tree native from the southwest of the Himalayas, that from ancient has spread through southern Asia and Africa. With the Nao de Manila, this plant was introduced in America, where it has recently spread widely across the continent, from southern U.S. to northern Chile and Argentina. In Spain, this plant is starting to be cultivated in the subtropical zones of the peninsula and also in the Canary Islands.

Its multiple uses make MO an attractive crop in different fields of human or animal feeding, cosmetic and pharmaceuticals. As a producer of biofuels, MO seeds provide an oil that may be easily transformed into biodiesel, and its leaves, peels and pods may be used to produce bioethanol. According Foidl, a ton of MO fresh biomass can produce over 34 I of bioethanol, that is, about 20,000 I of ethanol/ha/year when using high densities of plantation (one million plants per ha).

The objective of this study is to define MO bioclimate, considering the different climatic variables that limit the development of existing biotypes, and last, to map feasible implantation sites in the Iberian Peninsula.

MATERIALS AND METHODS

There is no much scientific information about MO, and this fact restricts the possibility of further studies. We are aware that if we had had more information about this species our study would have been achieved with greater accuracy, however, our work is presented below.

First, information on climate data that determine MO natural and artificial distribution, is collected:
- Frost is a factor that excludes the existence of MO. Average temperature of the minimum values below -1 °C has been considered during December, January and February.
- MO does not survive when temperature rises above 48 °C. This factor is applied to the summer months.
- If monthly average temperature (AT) > 8 °C during winter months, the risk of frosts is low, so the plant can survive, but does not grow unless AT > 13 °C.
- If AT > 13 °C during autumn and spring, the plant is able just to develop.
- When AT is between 25 °C and 35 °C, plant growth and production of pods and leaves are both optimized.
- As for precipitation, MO does tolerate drought; it requires 500 mm per year, but is able to survive with about 300 mm.

Second, we asked from AEMET data of the Climatic Atlas of the Iberian Peninsula and Balearic Islands.

Third, we elaborated temperature and precipitation maps, considering the climatic requirements of MO according to the references we had. For data analysis, the software we used was ArcMap application of 9.3 ARGIS.

RESULTS

Maps resulting of compounding the weather data from the Iberian Peninsula, with the specific constraints of MO as regards climate and precipitation:

![Fig 1: Monthly average temperature of the minimum values above -1 °C in winter](image1)
![Fig 2: Average temperature of the coldest month between 6 °C and 18 °C](image2)
![Fig 3: Average temperature of the warmest month above 22 °C](image3)
![Fig 4: Average temperature above 8 °C in winter](image4)
![Fig 5: Average annual temperature above 13 °C](image5)
![Fig 6: Average temperature above 13 °C in autumn](image6)
![Fig 7: Average temperature above 13 °C in spring](image7)
![Fig 8: Average temperature above 25 °C in July and August](image8)
![Fig 9: Rainfall above 300 mm](image9)
![Fig 10: Rainfall above 500 mm](image10)

CONCLUSIONS

Growing MO can result highly profitable when using it for biofuels, especially bioethanol.

MO main limitations are the risk of frost and extreme aridity. Attending to temperature, MO can be a plant of great interest to be cultivated in the southern regions of the peninsula: the lower valleys of the Guadalquivir, Guadiana and Taño, and the Mediterranean coast. MO can be influenced by the proximity to the Atlantic coast.

This plant will need water close to the Mediterranean coast, and in some dry zones inside the valleys of the Guadalquivir and Guadiana. In zones considered as BEST, irrigation is necessary only in the early stages. As a tree, MO can be a source of biodiesel, and in degraded land can be used to avoid losses of soil, and for restoring landscapes.

When used to produce green biomass for ethanol, MO will need watering.

BIBLIOGRAPHY