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PAULOWNIA ELONGATA AN ALTERNATIVE FOR A SUSTAINABLE INTEGRAL DEVELOPMENT

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Abstract: The cultivation of **Paulownia**, its arrival in Mexico began in the 1990s and to date it has still been somewhat uncertain or experimental in terms of its use and demonstration. Few universities and research institutes have tried to study its agronomic and environmental characteristics. It is a species that would allow us to reverse environmental pollution a bit. **Paulownia** has the following characteristics: rapid growth, a good generator of large biomass, it can also reach a height of up to approximately 30 meters and a good consumer of carbon dioxide, it is a good windbreak barrier, its leaves have a crude protein concentration that ranges from 16 to 20% and a digestibility of 65%, to be used in small ruminants. It is not an exclusive tree, its wood is very useful, of high quality, the tree can be felled at an age of 6 to 10 years and it is not necessary to replant, it sprouts from its stock. Its handling is very simple; fire resistant. Take advantage of purified water, even residual. Cultivation of this species is very simple and resistant to adverse conditions. During its cultivation, treated or even residual water can be used; It is useful for the regeneration of eroded soils. When it reaches its maximum growth, its demand for water is minimal, it is a great consumer of CO_2. This way, it is concluded that it is a species that can be considered in urban reforestation programs, due to its great capacity to adapt and coexist easily with other species..

Keywords: Paulownia, Characteristics, Alternative, Sustainable Development.

INTRODUCTION

Inadequate management of forest resources in arid, semi-arid and non-arid zones is one of the main causes of desertification. For this reason, the almost immediate need for reforestation of such areas is planned, complemented by a rational management of tree resources. However, the lack of basic knowledge about the ecology, genetics and physiology of the species, as well as the sociological aspects of human settlements in these areas have led to the failure of numerous reforestation attempts in various parts of the world.

Historically on our planet, man, in order to satisfy the food needs of a constantly growing population, has focused his actions towards increasing production, regardless of the effort to conserve natural resources, which is why today. One of the changes that is demanded with greater insistence in development policies at the national and international level, is the one related to reversing the processes of loss and deterioration of natural resources that have been caused by the productive processes, to satisfy needs for food and other goods and services.

The irrational use of renewable natural resources has caused serious alterations to ecosystems, when the limits of capacity to sustain human life have been reached in some locations. The misuse and exploitation of available resources have endangered the sustainability of agricultural and forestry production ecosystems.

For what at present, the priority interest is to raise the productive level in the areas that have been destined for agriculture and livestock, however, human settlements have caused a series of important ecological imbalances that have caused a serious deterioration to the environment, vast to mention, the change in the physical-chemical characteristics of the soil, modifications in humidity, climate changes in regions that are overexploited, due to excessive logging, overgrazing and / or fires to mention.

If we add to this the lack of effective sustainable development, in the different regions of the country, due to the fact that the new model of economic development

promotes the benefits of the market as a facilitator of development, then let us remember that one of its main assumptions is that competitive markets lead to optimal resource allocations. In this sense, the model has proven not to be fast enough, and sometimes frankly ineffective, to achieve the objectives of beneficial economic development for its population and for the evolution of the main economic aggregates.

Therefore, this document aims to highlight the qualities of the Paulownia elongata tree, where its use ranges from forage to ornamental and as a real solution to climate change.

BACKGROUND

The tree ***Paulownia elongata*** is a species that has been in China for approximately 2,600 years and when this country opened its doors to the world after the Chinese revolution, an Australian company began to collect the different existing species of Paulownia, with the purpose of carrying out different works on their species. characteristics and use in the improvement of the environment. This species can be considered as an alternative in reforestation programs due to its characteristics, because it is a tree that is tolerant of very poor soils or soils degraded by erosion, high resistance to drought, accelerated growth, resistance to pests and diseases, resistance to fire, likewise reduces air speed, soil evaporation and increases the relative humidity of the soil and air. In addition to this, it is a tree that can be used to obtain wood for the manufacture of furniture, its leaves can be used as an alternative for obtaining fodder and its flowers can be used for environmental decoration in the home or room. in offices.

This species has shown great qualities throughout its history, which is why man today has made the most of it, in obtaining wood, making furniture, and as fodder, because it is a fast-growing vegetable, it is that is to say, under normal conditions it grows 2.5 cm per day, so it is seen as a good alternative in programs for agricultural activity, in other words, to be used in reforestation by local, municipal, state and federal authorities, as well as a source feeding in small ruminants, as it is a vegetable that has been shown to have a crude protein concentration of 17 to 21%, equaling the queen of forages (alfalfa).

It belongs to the Scrophulariaceae family and whose cultivation, despite not being traditional in Mexico, has interesting potential. It is trees that are tolerant of very poor soils or soils degraded by erosion, high resistance to drought, resistance to pests and diseases, resistance to fire, likewise reduces air speed, soil evaporation and increases the relative humidity of the soil and air, in addition to this it can be used to obtain wood for the manufacture of articles (furniture); its leaves can be used as a forage alternative in times when forage is scarce in the area (Villalobos, 2006; Gutiérrez and Ocaña, 2009).

Pantaenius and Dalton in 1994 mention that in order to reach an acceptable level of profitability for this species, it is required, among other conditions, to have 80 to 100 trees per hectare at the time of the final cut with straight, cylindrical stems free of knots in the 4.5 to 5 meters from the base of the stem.

The CPII in 200 mentions that in soils of medium to low fertility the required stem of Paulownia does not reach the ideal growth in the first year, for which reason the recipe and management of the selected regrowth is used. This way, evaluating the response to the application of fertilizers at the time of planting is presented as an adequate strategy in order to reach the commercially required stem during the first year; or, otherwise, during the growing season after the recipe (CPII, 2001).

Zhu Zhao-Hua in 1992 mentions that the Paulownia trees that are cultivated are mostly

clones that were developed by Australian and North American scientists, who after 10 years of research resulted in resistant clones, since this type of tree in wild conditions In Chinese villages they are very susceptible to damage from pests and diseases.

Due to the large size of its leaves, this type of tree is "also beneficial for the production of vegetables, since, intercropped, it contributes to increasing the vegetable harvest by 30% and 15% the grain harvest, according to Navarro in 1998. The advantages of cultivating this species were confirmed in the early 1970s by the Chinese researcher Zhu Zhao-hua, who discovered the use of this tree by ancient Chinese peoples to counteract the ravages of natural disasters (Zhu Zhao -Hua, 1992).

Navarro in 1998 mentions that highly adaptable production such as Paulownia constitutes "a way out of one of the great environmental problems facing the world", especially in a country like Mexico, where "reforestation provides for the planting of 400 million trees and only eight percent of them Survive."

The irrational use of renewable natural resources causes serious alterations to ecosystems, endangers the sustainability of ecosystems. At present, therefore, it is a priority to raise the productive level in the areas that have been designated for agriculture and livestock and to increase the general environmental quality (Jiménez, 2001).

The results that have been reached are the following, ***Paulownia*** has rapid growth, it has the capacity to develop in poor or eroded soils, it can be considered as an ornamental plant, it is a good biomass generator, it can reach a height of up to 14 m, and it can also be used as a windbreak barrier. Its leaves are useful as forage in small ruminants, because it contains a crude protein concentration ranging from 16 to 20% and its digestibility is 65%, suitable for agroforestry systems. Its wood is very useful and of high quality, it can be felled at 6 or 10 years, it is not necessary to replant, it regrows from the vine. Cultivation of this species is very simple and resistant to adverse conditions. During its cultivation, treated or even residual water can be used; It is useful for the regeneration of eroded soils. When it reaches its maximum growth, its water demand is minimal., ***Paulownia*** is a great consumer of $\mathbf{CO_2}$. This way, it is concluded that it is a species that can be considered in urban reforestation programs, due to its great capacity to adapt and coexist easily with other species.

During the development of the cultivation in the institution, Bromatological Analyzes have been carried out in order to know the percentage of protein that the Paulownia leaves keep, then the following table is presented where it indicates the bromatological study carried out in 2005, by the Bromatology Laboratory of the Faculty of Higher Studies of the National Autonomous University of Mexico.

Table Number 2 highlights that the contents of the concepts studied are similar between the different sampling dates, it highlights that they were similar within the study period; In addition, the crude protein contents stand out, below 20 %, an amount that is reported in other studies. The protein, calcium and phosphorus contents can be considered to be constant during the study period and the calcium content stands out for being high.

Approximately one third of the acid detergent fiber is occupied by lignin (table 2), in fact, the content of this component can be considered high and higher than what would be found in grasses from temperate zones, for which reason it would be expected that digestibility of the *Paulownia* was close to the grasses of tropical zones, approximately 50 % (Minson, 1990; Wilson, 1994; Frame, 2005). However, if one considers that *Paulownia* is

%	wet base	dry basis
dry material	93.39	**100**
raw protein	6.61	**0**
crude protein	19.69	**20.83**
ethereal extract	3.29	**3.52**
ashes	7.71	**8.25**
neutral detergent fiber	28.75	**30.78**
nitrogen free extract	34.19	**36.62**
total digestible nutrients	60.29	66.12

Table Number 1: Bromatological Analysis of the leaves of *Paulownia elongata* 2015.

Source: bromatology laboratory of the FES Cuautitlán, 2015.

Date	August, 3	August, 25	September, 20
phenological stage	vegetative	vegetative	60 % of floration
dry material %	66.67	69.32	63.31
total humidity %	32.84	30.68	36.69
ethereal extract %	4.61	6.27	6.75
ashes %	7.64	8.38	9.95
crude protein %	14.26	14.65	13.95
FDN ß %	48.57	42.27	36.85
nitrogen free extract %	24.92	28.44	32.51
Ca %	3.47	4.68	3.50
P %	0.16	0.20	0.13

ß neutral detergent fiber.

Table 2. Chemical composition of *Paulownia elongata* introduced in the UAEM in Zumpango, Edo. de México (2014).

Date	August, 3	August, 25	September, 20
Phenological stage	Vegetative	vegetative	60 % of flowering
NO_2	-	-	-
NO_3	-	-	-
Tannins	-	-	-
Glycosides	+	+	+

-: Absence. +: Presence

Table 3. Presence of toxins in *Paulownia elongata* introduced in the UAEM in Zumpango, Edo. from Mexico.

Source: Vega Granados E and Barrita R. V. 2012. Nutritional characterization of Paulownia elongata leaves.

%	Hayed alfalfa	Hayloft oats	Corn stubble	*Leaves of Paulownia elongata*
MS	90.9	90	90	**100**
HT	9.1	10	10	**0**
PC	19.4	8.2	5.9	**20.83**
EE	1.1	1.3	1.6	**3.52**
C	6.8	6.9	5.9	**8.25**
FDN	46.3	32.5	43.3	**30.78**
ELN	36.2	42.2	46.5	**36.62**
TND	**60.29**	**55.86**	59	66.12

Table Number 4. Nutritional comparison of the Paulownia leaf with the most commercialized Forages in Region II of Zumpango Agricultural Development.

a plant that can be established in arid zones and it can be foraged at all times of the year, this is not an impediment for its use in feeding ruminants.

Table Number 3 highlights that, of the toxins studied, the presence of cyanogenic glycosides must be noted that these compounds constitute the typical defense compounds and plants only synthesize them when they are subjected to stress such as water stress, attack by pests, foliar diseases or product of animal trampling (García, 2004b).

As it can be seen in the previous table, Paulownia has a better crude protein content than alfalfa and corn stubble, which makes us assume that it is a plant species that can be widely accepted in small ruminant livestock production units.

CONCLUSIONS

- One of the advantages of ***Paulownias*** is that they are adaptable, resistant, soil regenerative, ornamental, non-aggressive trees and producers, in addition, of excellent quality cellulose, fodder and honey.
- ***Paulownias*** are considered one of the plant species with the highest biomass production. There are trees that grow taller, but with less trunk thickness and low commercial value.
- All ***Paulownias*** cultivated for commercial purposes are clones, this means that they are identical plants with specific characteristics. It is not convenient for you to use seeds for planting, the seeds of ***Paulownias***, they do not transmit the ideal characteristics.
- It is a good forage alternative for small ruminants, because its percentage of crude protein is similar to that of alfalfa and 66% digestibility.

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