



The Mexican Non-toxic *Jatropha curcas* L., Food Resource or Biofuel?

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Research

Abstract

Jatropha curcas L. is a promising natural resource which has been promoted globally for biodiesel production by policy makers and researchers in tropical and subtropical countries. However, both *J. curcas* seeds and oil have been found to be toxic to humans and domestic animals when consumed. A non-toxic genotype of *J. curcas* has been reported from some rural communities in southern Mexico, suitable for human consumption. This non-toxic germplasm has been used in traditional Totonacan cuisine in Mexico. However, increasing demand for *J. curcas* to be used in biofuel production is exerting pressure on the non-toxic genotype. In this work we analyze the possible origins and dispersal of non-toxic *Jatropha* by the Totonaca culture; the traditional uses of *J. curcas* seeds as a food; its status with respect to the Mexican commercial forestry regulations; and the risks associated with the demands of biofuels on this Mexican germplasm.

Introduction

The Mexican Jatropha curcas

Jatropha curcas L. is a small tree whose seeds are considered a bioenergy resource due to their high oil content (Achten *et al.* 2008). This species has been associated almost exclusively with oil production because its seeds contain phorbol esters, which are toxic to humans and many animals (Heller 1996). However, in rural communities of southern Mexico there is a genotype with very low or no detectable levels of phorbol esters (Martínez-Herrera *et al.* 2004, Schmook & Sánchez 2000). This variety is known as **piñón manso** (mild peanut) by local people, who eat the seeds after they are roasted or cooked. Nevertheless, cultivation of toxic *J. curcas* within Mexico is now led by biodiesel demands, which places the non-toxic **piñón manso** at risk. The aim of this paper is to

provide a review of the possible routes of dispersal, the geographical distribution, and the culinary uses of non-toxic *J. curcas* in Mexico. Concerns about the dangers of intercropping toxic and non-toxic forms and the lack of clear policies to define the future of the germplasm are also discussed.

Methods

Collection of information

This research was based on peer-reviewed publications and academic documents (thesis, conference proceedings and research published by universities) concerning the uses and distribution of the non-toxic *J. curcas* in Mexico. Additionally, we included information collected during 1995 in the states of Veracruz, Tabasco, Yucatán, Campeche, Quintana Roo, Chiapas, Oaxaca, Guerrero, Colima and Nayarit; and from 2008-2011 in the state of Veracruz (Figure 1). We collected data from 349 provenances of *J. curcas*, and interviewed 146 individuals who

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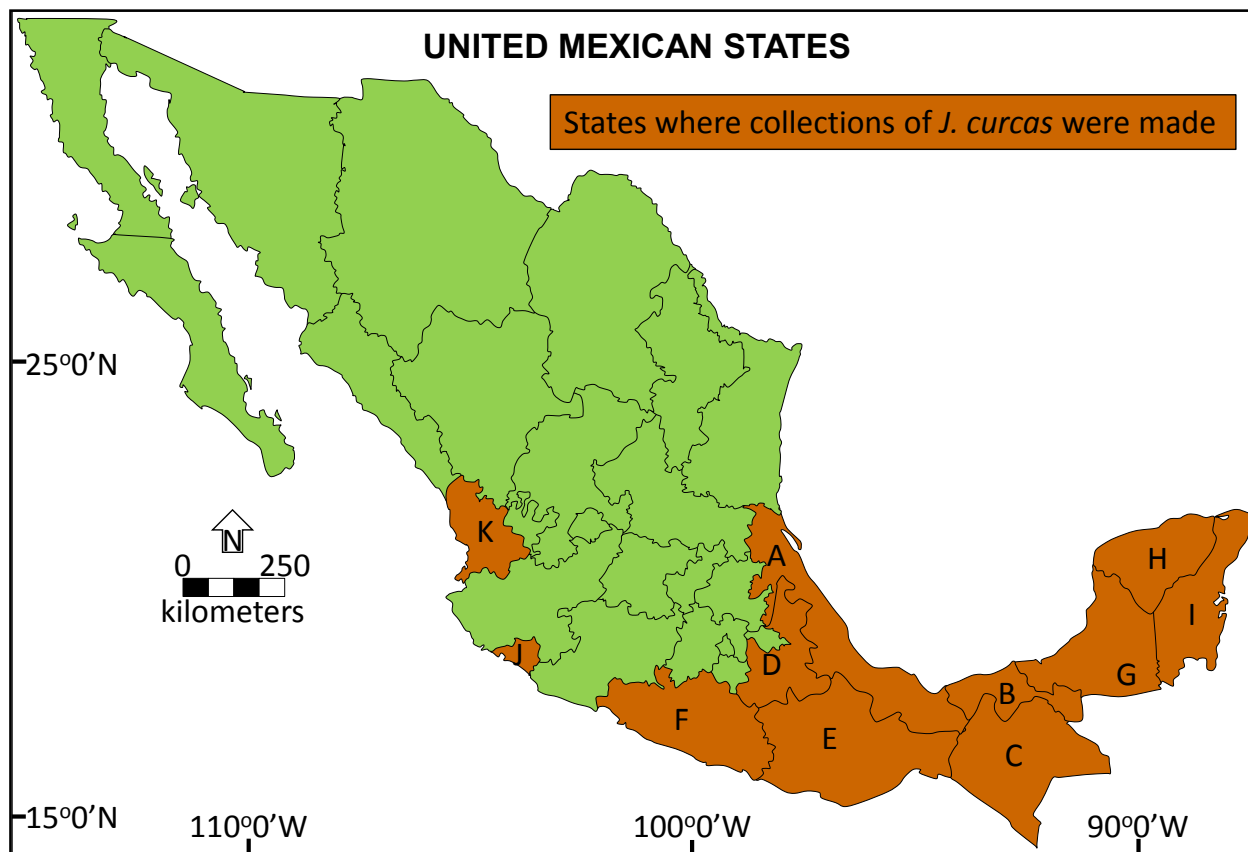


Figure 1. Mexican states where the authors collected *Jatropha curcas* L. during 1995 and 2008-2011. (A) Veracruz, (B) Tabasco, (C) Chiapas, (D) Puebla, (E) Oaxaca, (F) Guerrero, (G) Campeche, (H) Yucatán, (I) Quintana Roo, (J) Colima, and (K) Nayarit.

possess trees in their gardens or in small-scale plantations. We gathered information on perceived toxicity and whether seeds were consumed by humans, and we determined toxicity in some collected seeds.

Results

Origins and current distribution

The genus *Jatropha* is native to Mexico, where there are approximately 45 species, 77% of which are endemic (Rodríguez-Acosta *et al.* 2009). *J. curcas* was probably first exported from Central America to Africa around 1800. It was initially introduced to the Cabo Verde Islands and Guinea Bissau in western Africa, and subsequently distributed across tropical and subtropical Africa and Asia. All the exported provenances are reported to be toxic to humans (Heller 1996). Dispersed non-toxic provenances of this species have been found only in Mexico (Heller 1996, Martínez *et al.* 2006) in the states of Veracruz, Puebla, Morelos, Michoacán, Oaxaca, Guerrero, Chiapas, Quintana Roo and Yucatan (Martínez *et al.* 2006, Schmoock & Sánchez 2000, personal collections). Since 2007, non-toxic *J. curcas* from Veracruz, Puebla and Morelos were

taken for cultivation to the state of Sinaloa (Félix 2011). Therefore, it could be present in other Mexican states as well.

During collections and interviews, we did not find non-toxic *J. curcas* in any wild source. In addition, in the states of Tabasco, Yucatan and Quintana Roo, only immigrants from Veracruz were cultivating **piñon manso**. Immigrants typically belonged to the Totonaca cultural group, and had these plants in their gardens. During 2010-2011 collections in Veracruz we found that 42% of the non-toxic provenances were located inside the current area of Totonaca influence (Figure 2); this was the highest number of non-toxic locations in the State.

Discussion

Totonacas and piñon manso

Totonaca culture (Figure 3) started around 1500-1600 B.C. (Murillo 2007). Once Totonacas mixed with the Zoques at the beginning of the first century (Williams 1984), they gained a wider area of influence that included the current states of Veracruz, Puebla, Oaxaca and Chiapas (Figure 4). This way they could disperse their cul-

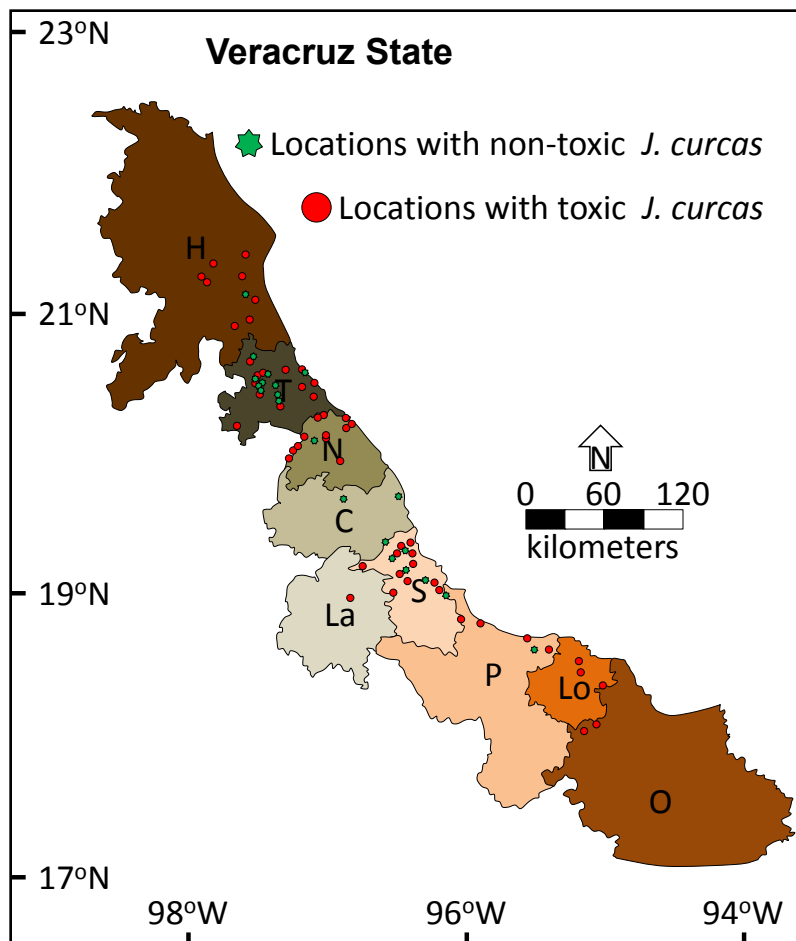


Figure 2. Toxic and non-toxic provenances of *Jatropha curcas* L. found in the State of Veracruz, and the cultural regions within the State. Cultural regions: (C) Capital, (H) Huasteca, (La) Las Montañas, (Lo) Los Tuxtlas, (N) Nautla, (O) Olmeca, (P) Papaloapan, (S) Sotavento, and (T) Totonaca.

tural use of plants through the states to which they moved. Nowadays the Totonaca cultural group has reduced its area of influence and is currently concentrated in the region of Totonacapan, which includes a small part of the states of Veracruz and Puebla (Figure 2). This region is highly fertile; it has a tropical climate, and contains diverse native plants. Such plant biodiversity has allowed this culture to develop an extensive use of ethnobotany, reflected in its unique and rich gastronomy. Notably, the Totonaca ethnobotanical history includes the first use of vanilla, which is native to this region (Aguilera 2004). Totonaca is the only culture documented as using the roasted and ground seeds of **piñon manso**. They use the term **xuta** or alternately **aishte** to refer to the seeds (Gomez-Pompa *et al.* 2009). The roasted seeds are eaten alone, used to prepare sauces called **pipian**; or mixed with sugar or honey to prepare sweet desserts called **pepitorias**. Seeds are also ground and used in corn based meals called **platonile** or **púlacles**; ground seeds were previously used to elaborate another sweet dessert called **mazapan** (Gomez-Pompa *et al.* 2009). **Mazapan** is currently made of peanut, as the flavor of piñon manso is similar to the peanut. These traditional dishes are eaten around harvest times or during celebrations, such as birthdays and weddings (Aguilera 2004, Gomez-Pompa *et al.* 2009).



Figure 3. The Totonaca culture. (A) Totonacan men exhibiting the flying man ceremony. (B) Pyramid of the Niches, a 6-12th century Totonacan temple. (C) People of a Totonaca cultural group showing how to cook **piñon manso** (*Jatropha curcas* L.).

Possible routes of distribution of non-toxic *Jatropha curcas*

Piñon manso is closely associated with the area of influence of the Totonaca culture, as evidenced by our interviews and



Figure 4. Possible routes of dispersal of non-toxic *Jatropha curcas* L. in Mexico and its association with the Totonaca culture. States with *J. curcas*: (A) Veracruz, (B) Tabasco, (C) Chiapas, (D) Puebla, (E) Oaxaca, (F) Guerrero, (G) Campeche, (H) Yucatán, (I) Quintana Roo, (J) Colima, (K) Nayarit, (L) Michoacan, (M) Jalisco, (N) Morelos, (O) Tamaulipas, (P) Sinaloa, and (Q) Sonora.

prior research interviews with local growers (Aguilera 2004, Martinez *et al.* 2006, Schmoock & Sánchez 2000). Given that the Totonacas had extensive botanical knowledge, it is possible that they discovered, propagated and preserved the non-toxic genotypes in their gardens, as is customary today (personal observation). Dias *et al.* (2012) concede that *J. curcas* was known and used by the Zoques (once mixed with Totonacas). However, they inferred only medicinal purposes possibly transmitted by the Olmecs, a mother culture. Currently, in the Olmec region within the state of Veracruz, *J. curcas* is still used to treat skin diseases, but we did not find non-toxic plants in this region (Figure 2). Therefore, we consider that this germplasm was probably dispersed throughout southern Mexico by Totonacas during their migrations (Figure 4). This explanation is congruent with the fact that only Totonacas elaborate dishes with the seeds (Aguilera 2004), and that only Totonacan immigrants from Veracruz had non-toxic *J. curcas* in their gardens. The higher number of non-toxic versus toxic plants found during our collections in the Totonaca region, and their absence from other studied regions, could indicate that Totonacas propagated

the non-toxic trees and eliminated the toxic ones as part of a domestication process (Gomez-Pompa *et al.* 2009).

Morphological similarity between toxic and non-toxic *Jatropha curcas*

We observed sufficient morphological variation among provenances of *J. curcas* to make it impossible to distinguish between toxic and non-toxic plants, fruits or seeds (275 different accessions located and more than 4500 plants observed —unpublished data). Likewise, descriptions of *J. curcas* plants throughout the state of Veracruz (Aponte 1978, Cano 1978, 1986) did not find taxonomic differences between toxic and non-toxic plants located within the Totonaca, Nautla and Capital cultural regions of Veracruz (Figure 2). Both genotypes are located in these regions, as we found in our collections between 1995-2010 (Figure 2), compounding the difficulty of distinguishing the genotypes. Interviews with farmers revealed that some individuals tend to know only about one form, and are not aware that both, the toxic and nontoxic forms, are present in the region.

The non-toxic germplasm at risk

Piñón manso is little known outside its cultural environment, primarily because the majority of plants have remained in family gardens known and used mainly by the Totonacas (Figure 5B,C). But, this germplasm is now threatened by projects that would cultivate toxic seed on a large scale. Seeds would be imported under claims that there is no Mexican germplasm identified yet as yielding high oil content, or that there is not enough seed commercially available in the country (García *et al.* 2011, Solís 2011). In addition, *J. curcas* is mainly seen as a biofuel source in Mexico (Figure 5D); the National Forestry program promotes its cultivation solely as a biofuel crop, and does not consider differences between planting toxic or

non-toxic provenances in its regulations (SEMARNAT 2011).

Open questions about toxic and non toxic *Jatropha curcas*

We now face several questions relevant to places where both toxic and non-toxic *J. curcas* are being cultivated:

1. How will we evaluate *J. curcas*, as biofuel or as a food crop?
2. How will lay people differentiate between toxic and non-toxic plants given their morphological similarity?
3. What changes may face the culture of eating seeds?
4. Why is there no regulation of toxic and non-toxic germplasm?



Figure 5. Possible uses for non-toxic **piñón manso** (*Jatropha curcas* L.) cultivated by the Totonacas. **(A)** *J. curcas* seeds, **(B)** Tamales, a dish made from ground *J. curcas* seeds, **(C)** **Pepitorias**, a desert made from *J. curcas* seeds, and **(D)** Biofuels produced from *J. curcas* seed oil.

5. What is the future of the non-toxic germplasm in Mexico?

The answers we can infer at this time are as follows:

1. In Mexico *J. curcas* is almost exclusively evaluated as an oil source, and the national programs to plant the species do not consider the non-toxic germplasm.
2. There is no method or research to visually differentiate toxic and non-toxic plants and seeds; only expensive chemical analysis to detect phorbol esters can determine toxicity, and this method is out of the reach of most of Mexican producers.
3. Interbreeding poses no known risk to non-toxic *J. curcas* because non-toxic plants produce non-toxic seeds independent of the surrounding pollen (Chang-wei *et al.* 2007). However, it is highly probable that if toxic and non-toxic plants are intercropped, the risk of accidental ingestion of toxic seeds will increase; and preventive measures will be necessary to discourage local producers from eating *J. curcas* seeds; therefore the tradition of eating the non-toxic seeds could disappear. As *J. curcas* seeds are often consumed in Mexico, rigorous containment measures should be adopted in the cultivation of toxic provenances to prevent accidental human consumption.
4. Since non-toxic *J. curcas* has not been known outside a restricted area until recently, regulations to protect this germplasm have never been considered.
5. The future of the non-toxic genotype is uncertain in Mexico at this moment, however, it is currently available though the Internet, and because the seeds are not under the protection of any law, this germplasm has been probably already transported to countries outside Mexico.

Conclusions

Piñón manso, a non-toxic Mexican germplasm of *Jatropha curcas*, has been associated with the Totonaca culture. It has been dispersed and transformed by them, and used in their cuisine. However, like many facets of Native American cultures, non-toxic *J. curcas* is at risk of being lost. In this case by the increasing demands of the emerging biofuel industry and lack of knowledge by policy makers about this unique resource.

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