Plant Foods for Human Nutrition **52:** 31–36, 1998.
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Edible provenances of *Jatropha curcas* from Quintana Roo state of Mexico and effect of roasting on antinutrient and toxic factors in seeds

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Received 23 September 1997; accepted in revised form 24 February 1998

Abstract. Seven seed samples of *J. curcas*, both in raw and roasted state, sold in some villages in Quintana Roo state, Mexico for human consumption were analyzed for physical characteristics, nutrients and antinutrients. The average seed weight varied from 0.53 to 0.74 g and kernel weight as proportion of raw seed weight was from 61 to 66%. The contents of crude protein, lipid and ash of kernels from raw seeds were 27–30%, 55–62% and 3.7–5.2% respectively. The levels of antinutrients in meal from the raw seeds were: trypsin inhibitor activity (14.6–28.7 mg trypsin inhibited/g), lectin (25.6–52.2 unit; one unit is the reverse of minimum amount of mg meal/ml assay which produced haemagglutination), saponins (1.9–2.3% as diosgenin equivalent) and phytate (8.4–10%). Phorbol esters in kernels from raw seeds were not detected in four samples and in other three samples it ranged from 0.01 to 0.02 mg/g as phorbol-12-myristate 13-acetate equivalent. Roasting of seeds inactivated almost 100% of trypsin inhibitor activity. Although lectin activity reduced on roasting, it was still present in high amounts. Saponins, phytate and phorbol esters were not affected by roasting.

Key words: *Jatropha curcas*, Roasting, Lectin, Trypsin inhibitor, Phorbol esters, Non-toxic jatropha

Introduction

Species of the genus *Jatropha* are known to be very toxic. *Jatropha curcas*, also known as 'physic nut, purging nut, big purging nut, American purging nut, piñoncillo, Habb-El-Meluk, black vomit nut', depending on the region, is a member of the Euphobiaceae family. In Mexico it is known as piñon or piñoncillo by the people living or coming from Veracruz state, or as sikil-té by the Mayas in Yucatan Peninsula. The Mayan families usually have one tree in their gardens whereas some people from Veracruz plant it as living fences around their garden or fields [1]. It is a shrub or small tree which can reach a height of up to 8 m. The plant grows quickly, survives in poor stony soil and is resistant to drought. It is considered to have originated in Central America but presently grows in most of the tropics [2]. The seeds of *J. curcas* are a good source of oil. Although the seed cake (meal) is rich in

protein, it is toxic to rats, mice and ruminants and, therefore, cannot be used as an animal feed. Several cases of *J. curcas* nut poisoning in humans after accidental consumption of the seeds have been recorded. Symptoms such as giddiness, vomition and diarrhea have been reported [3].

Recently the nutritive potential and toxic characteristics of different provenances of *J. curcas* were investigated. A mixed sample of seed obtained from different trees in the Papantla region of Veracruz state in Mexico were found to be non-toxic. Phorbol esters were present in minute amounts in kernels of this mixed sample of seeds, but trypsin inhibitor, lectin and phytate were present in significant amounts, and their levels were similar or higher than those in toxic varieties. The nutritive value of meal from the non-toxic provenance, derived from the chemical composition, was similar to the toxic varieties and compared well with those in some conventional seed meals [4]. In another part of Mexico (Quintana Roo state; approximately 1200 km southeast from Veracruz state), like in Veracruz state, seeds of *J. curcas*, after roasting, are also consumed by humans. The consumption of raw seeds is considered to produce cramps and uneasy feeling in the stomach. The objectives of the present investigation were to evaluate the levels of various antinutritional and toxic factors present in seeds obtained from Quintana Roo state compared to those from Veracruz state, and to study the effects of roasting on antinutritional and toxic factors.

Materials and methods

The raw and roasted seeds of *J. curcas* were purchased from seven different farmers in the state of Quintana Roo. These farmers either eat or sell the roasted seeds for human consumption. Samples NC 5 and NC 6 were from Sacxan village, and NC 9, NC 16, NC 45, NC 50 and NC 51 from Sergio Butron, Cocoyol, Francisco Botes, Ramonal and Juan Sarabia villages, respectively. All these villages are in Othón P. Blanco municipal area of Quintana Roo state in Mexico. The altitude of these places is 0 m from the mean sea level. The mean temperature lies between 24 °–26 ° C and the annual rain fall between 1200 mm and 1500 mm. There is no standard procedure for roasting the seeds. The seeds are generally roasted on an iron plate (30–40 cm diameter) kept on an open fire; the temperature of the hot plate is difficult to ascertain. The seeds (50 to 80 in number) are roasted at one time for about 15 min with several turnings of seeds with a wooden spoon.

The crude protein (CP; N $\times$ 6.25), lipid (L) and ash were determined using the AOAC [5] procedures. In the seed meal (kernels deoiled using petroleum ether of bp 40–60 °C), tannins, trypsin and amylase inhibitors, saponins, and phytate were analyzed by methods described by Aderibigbe et al. [6],

Table 1. Physical characteristics of *Jatropha curcas* seeds

Sample	Average seed weight (g)	Kernel wt. (% of seed wt.)
NC 5 raw	0.60	65.6
NC 5 roasted	0.59	66.7
NC 6 raw	0.57	61.2
NC 6 roasted	0.53	64.6
NC 9 raw	0.62	63.1
NC 9 roasted	0.61	65.0
NC 16 raw	0.59	63.5
NC 16 roasted	0.59	64.1
NC 45 raw	0.74	61.9
NC 45 roasted	0.71	62.2
NC 50 raw	0.63	64.1
NC 50 roasted	0.61	65.0
NC 51 raw	0.64	62.1
NC 51 roasted	0.62	62.5
A mixed sample of raw seeds from different trees from Veracruez[a]	0.65	63.5

[a] Makkar et al. [4]

cyanogens and glucosinolates by Makkar and Becker [7] and lectin by a haemagglutination test in which agglutination of trypsinized cattle erythrocytes is determined using the meal extract diluted sequentially two-fold [8]. The method of Makkar et al. [9] was used for determination of phorbol esters.

All analyses were conducted at least in duplicate by taking a representative sample of each provenance. The values reported are average of two values. The individual value did not deviate from the mean by more than 5%.

A handful of seeds (8–10 in number) was taken from each raw or roasted sample. The weight of each handful of seeds and the number of seeds in it were used to calculate the average weight of seed. Average kernel weight as percent of seed weight was calculated by removing shells carefully and recording the weights of kernels and shells.

Results and discussion

Physical characteristics of seeds are presented in Table 1. The average weight of raw seeds varied substantially (0.53 to 0.74 g), but the kernel weight as a proportion of the raw seed weight did not vary to the same extent (61–66%). Among the samples investigated, the seed weight of only one tree (NC

Table 2. Chemical composition of *Jatropha curcas* kernels[a]

Sample	Dry matter of kernel (%)	Crude protein[a] (%)	Lipid[a] (%)	Ash[a] (%)
NC 5 raw	91.7	27.3	59.2	4.7
NC 5 roasted	94.9	26.8	61.4	5.2
NC 6 raw	92.3	29.0	55.3	5.2
NC 6 roasted	94.9	28.6	55.8	5.2
NC 9 raw	93.7	28.4	60.7	4.0
NC 9 roasted	95.7	26.3	62.2	3.6
NC 16 raw	93.0	29.5	56.4	5.2
NC 16 roasted	93.3	28.9	59.5	5.1
NC 45 raw	92.4	26.8	61.7	4.3
NC 45 roasted	95.5	26.1	59.7	4.6
NC 50 raw	92.5	28.0	61.4	3.7
NC 50 roasted	94.9	27.9	60.1	4.4
NC 51 raw	91.5	29.7	61.2	4.3
NC 51 roasted	95.1	28.2	61.3	4.3
Raw kernel (edible) from a mixed sample of seeds from different trees from Veracruez[b]	94.2	27.2	58.5	4.3

[a] Data are on dry matter basis.
[b] Makkar et al. [4]

45) was higher than that of the non-toxic provenances (mixed sample) from Veracruz state (0.74 vs 0.65 g), and the kernel weight as a proportion of the raw seed weight was slightly higher for only one tree (NC 5; 65.5 vs 63.5%) [4]. The higher average weight of raw seeds compared to the roasted, and the higher kernel weight as a proportion of the total seed weight for the roasted seeds was due to loss of water from the seeds during roasting, more so from the shells (Table 2). The color of seed-shells and kernels after roasting varied from light brown to dark brown, and the taste was similar to roasted peanuts.

The contents of crude protein, lipid and ash in kernels from raw seeds ranged from 27 to 30%, 55–62% and 3.7–5.2%, respectively (Table 2). These values are higher than or similar to those in kernels of the non-toxic provenances from Veracruz state [4].

Trypsin inhibitor, lectin, saponins, phytate and phorbol ester contents are shown in Table 3. Except for sample NC 45, trypsin inhibitor and lectin activities in meal from raw seeds were lower than those in meal from the non-toxic provenance from Veracruz state. Saponins and phorbol esters levels from raw seeds were also lower in samples of this study. On the other hand, phytate levels were either similar or higher by 1% unit [4]. Roasting of seeds almost

Table 3. The levels of trypsin inhibitor, saponin, lectin and phytate in meal (oil-free) and phorbol esters in *Jatropha curcas* kernel

Item	Sample				
	Trypsin inhibitor activity in meal[a]	Lectin activity in meal[b]	Saponin in meal[c] (%)	Phytate in meal (%)	Phorbol esters in kernels (mg/g)[d]
NC 5 raw	14.6	25.6	2.3	9.3	nd
NC 5 roasted	nd	12.8	1.9	10.7	nd
NC 6 raw	15.1	25.6	2.2	9.2	0.02
NC 6 roasted	nd	12.8	2.3	9.6	0.01
NC 9 raw	22.3	25.6	1.7	8.7	0.01
NC 9 roasted	0.7	12.8	1.8	9.3	0.01
NC 16 raw	15.1	25.6	1.8	9.7	0.01
NC 16 roasted	nd	12.8	2.5	9.8	0.015
NC 45 raw	28.7	52.2	1.9	9.7	nd
NC 45 roasted	0.5	25.6	2.1	10.1	nd
NC 50 raw	21.1	25.6	2.1	8.4	nd
NC 50 roasted	0.6	12.8	2.1	9.1	nd
NC 51 raw	24.8	25.6	1.9	10.0	nd
NC 51 roasted	nd	6.4	1.9	10.5	nd
Raw kernel (edible) from a mixed sample of seeds from different trees from Veracruez [e]	26.5	51	3.4	8.9	0.11

nd, not detected.
[a] mg trypsin inhibited/g.
[b] [1/(minimum amount of meal in mg/ml assay which produced haemagglutination)].
[c] diosgenin equivalent.
[d] phorbol-12-myristate 13-acetate equivalent.
[e] Makkar et al. [4].

completely inactivated trypsin inhibitor activity and decreased lectin activity. For all samples except NC 51, roasting decreased lectin activity slightly; for meal-extract from roasted NC 51 seeds, agglutination was observed at two dilutions lower compared to raw meal, and for other samples agglutination was observed at one dilution lower (Table 3). Roasting was not very effective in decreasing lectin activity in the seeds. It is interesting to note that phorbol esters, the main toxic agents for jatropha toxicity [3] were not detected in four seed samples and in the other three samples their levels were lower than in those from the non-toxic provenances from Veracruz. Roasting did not affect saponin, phytate or phorbol ester levels (Table 3). In addition to lowering of heat-labile antinutritional factors such as trypsin inhibitors and lectins, heat

treatment should increase protein digestibility [6].
Conclusions: The edible (non-toxic) varieties of *J. curcas* are found not only in Veracruez state in Mexico but are present in Quintana Roo state too. The seeds collected from Quintana Roo state seemed to be of better quality as levels of protein, lipid and ash were higher and antinutritional and toxic factors lower in most samples investigated. Roasting of seeds, as employed by farmers, did not inactivate lectin activity completely and, therefore, consumption of seeds at higher amounts might produce adverse effects. Wide variation exists in levels of nutrients and antinutrients in seeds of edible provenances, which offers promise in selection of seeds and their large scale multiplication using conventional breeding approaches or tissue culture based techniques. This is likely to improve food security in various tropical countries by providing edible oil, and roasted nuts and seed cake which potentially could be good sources of protein supplementation for both humans and animals.

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