Minufiya J. Agric. Res. Vol.35 No. 3:911-926 (2010) "http://agri.menofia.edu.eg/megla.html"

PHYSICO-CHEMICAL PROPERTIES AND EVALUATION OF *JATROPHA CURCAS* SEEDS

E.H. Mansour, E.H. Rahma and Shirin M. Hamoda
Dep. of Food Science and Technology, Faculty of Agriculture, Minufiya University
(Received: Mar. 2 , 2010)

ABSTRACT: ***The physico-chemical properties, chemical composition, oil constants, minerals content and antinutrients present in Jatropha curcas seeds were determined. Jatropha fruits contain 3 seeds inside a brown outer husk. The seed it self consists of a white kernel with outer black coat (shell). The average weight of fruit and seed were 2.59 and 0.62 gm, respectively. The percentages of seed, husk, kernel and shell were 72.01, 27.99, 65.24 and 34.76%, respectively. The seed kernel was rich in protein (26.15%) and lipid (51.16%). The contents of starch, total soluble sugars and free reducing sugars were 9.97%, 10.24% and 4.52%, respectively. Jatropha seed oil is liquid at room temperature, soluble in organic solvents. Physical properties such as viscosity, specific gravity, colour and refractive index of Jatropha oil were 52.60 (cSt), 0.879 (gm/cm^3), 4.0 yellow and 1.4735, respectively. The acid, saponification and iodine values of Jatropha seed oil were 5.58 mg KOH/gm oil, 192 mg KOH/gm oil, and 102.29 mg I_2/gm oil, respectively. The major fatty acids found in the oil sample were oleic (44.11%), linoleic (33.19%), palmitic (13.42%) and stearic (6.85%) acids. The flour levels of essential amino acids, except lysine, were higher than that of the FAO/WHO reference protein for a five year old children. Trypsin inhibitor (24.37 TIA/mg protein), phytic acid (7.87 mg/ g flour), tannins (0.03 mg/g flour) and hemagglutinin (118 HU/g flour). Jatropha seed flours are rich in P (2041), K (1044.80), Mg (1033.58), Ca (514) and Na (101.76 mg/100gm flour).***

Key word: ***Jatropha curcas, physical properties, Composition, Fatty acids, Oil properties, Amino acids, Antinutritional factor, Minerals.***

INTRODUCTION

Jatropha curcas **is a drought-resistant shrub or tree belonging to the family Euphorbiaceae.** ***Jatropha curcas*** **is also referred to as physic nut, purging nut, pinoncillo, habb-el-meluk, black vomit nut, American purging nut, barbados purging nut, big purge nut. It can easily be propagated by cutting or seeding and it grows rapidly. The plant grows readily in swamp or shade and quick growing and survives in poor stony soils and considered to have originated in central and South America but presently grows in most of the tropics. (Heller, 1996).**

In the tropics, ***Jatropha curcas*** **is traditionally used for medicines and as hedges (Jones and Miller, 1992). It use as green manure to rise grown on loamy acid soil was reported (Scherchan *et al.,* 1989). In addition, the plant is**

cultivated mainly to produce oil. A seed yield of about 5 tons per year from a one hectare plantation has been achieved (Makkar and Becker, 1997); such yield can produce 2 tons of oil and 1 ton of protein-rich seed flour. The seeds of *Jatropha curcas* are a good source of oil, which can be used also in medicines, soap, and cosmetics manufacture in various tropical countries. (Makkar *et al*., 1998).

The defatted flour has been found to contain a high amount of protein, which ranged between 50% and 62%. Except for lysine all other essential amino acids in *Jatropha curcas* flour protein have been reported to be in higher concentrations than those of the FAO/WHO reference pattern suggested for pre-school children (Makkar *et al*., 1998). In addition to the more common toxic varieties, a non-toxic variety of *Jatropha curcas* seeds, that contained negligible amounts of phorbolesters, but similar levels of trypsin inhibitors, lectin activity and phytic acid compared to the toxic variety, has been reported (Makkar and Becker, 1999). The non-toxic seed kernels are consumed by local people after roasting. The hydrothermally processed defatted flour of the non-toxic variety did not show any toxicity to rats (Makkar and Becker, 1999), but the toxic variety show poisoning in humans after accidental consumption of seeds have been recorded. The oil is toxic but can serve as fuel for diesel engines, indicating its potential as a renewable energy source. The seed flour left after extraction of oil is presently used as a fertilizer and is not suitable for animal feed as it is toxic to fish, monogastrics and ruminants. The main toxic agent has been identified to be phorbol esters. The oil extracted from the seeds can be used as a substitute for diesel after transesterification. Biodiesel has currently high demand in the United States and Europe and being promoted in a big way in countries such as India. The residual protein-rich seed cake, remaining after extraction of the oil, could form a protein-rich ingredient in feeds for poultry, pigs, cattle and even fish if it could be detoxified.

The aim of this research is to determine the chemical composition and physical characteristics of *Jatropha curcas* seeds and some characteristics of *Jatropha curcas* oil and also some antinutritional components i,e trypsin inhibitor activity, tannin, phytic acid, and hemagglutinin contents of *Jatropha curcas* seed flour.

MATERIALS AND METHODS

1. Materials

***Jatropha curcas* seeds were obtained from Aswan farm, Egypt, during the summer season of 2005. The seeds were hand sorted to remove wrinkled, moldy seeds and foreign materials then stored in polyethylene bags in the refrigerator (~5°C) until used.**

2. Methods

2.1. Physical properties of seeds

2.1.1. Weight of fruits:

The dry fruits were weighed, counted and the husk was separated from the seeds. The weights of seeds, and husks were recorded (50 times) and the average was recorded.

2.1.2. Weight of seeds:

Ten handfuls of seeds were randomly taken from the *Jatropha curcas*. The weight of each handful and the number of seeds in it were used to calculate the average weight of seed in each handful. The shells carefully removed and the weights of kernels and shells were recorded.

2.2. Proximate chemical composition:

The contents of moisture, crud fat, ash, total protein (N × 6.25), and crude fiber were determined according to AOAC (1995) in seeds, shell, Kernel and flour. Carbohydrate was determined by difference.

2.3. Physical properties of Jatropha oil:

2.3.1. Specific gravity:

The specific gravity was determined by finding the ratio of the density of oil to that of water using a relative density bottle at room temperature (Pearson, 1981).

2.3.2. Refractive index:

Refractive index was determined as described by Pearson (1981) at 28 °C using Abbe refractometer.

2.3.3. Viscosity:

The viscosity of oil sample was measured as Cm pois using viscometer ICI Co Research equipment-London at 50 °C.

2.3.4. Colour:

The colour of oil sample was determined by a Lovibond tintometer using a 5.25 inch cell. The yellow filter was fixed at 35 and the intensity of red was measured according to the AOCS (1973).

2.4. Chemical characterization of Jatropha oil:

The values of acid, Saponification and iodine were determined according to AOCS (1973).

2.5. Fatty acid composition:

2.5.1. Identification and determination of fatty acids by gas liquid chromatograph (GLC):

The method described by Farag *et al*. (1981) was applied for determination of fatty acids by GLC. The methyl esters of fatty acids obtained from oil and

standard materials were analyzed with a Pye Unicam Series 304 gas chromatograph equipped with dual flame ionization detector and dual channel recorder. The separation of fatty acid methyl esters was conducted using a coiled glass column (1.5 m × 4 mm) packed with Diatomite (100-120 mesh) and coated with 10% polyethylene glycol adipate (PEGA). The column oven temperature was programmed at 8°C/min from 70°C to190°C, then isothermally at 190°C for 25 min with nitrogen flow rate at 30 ml/min.

2. 6. Amino acids

Amino acids were determined by using atomic amino acid analyzer according to the method described by Moore and Stein (1963). Hydrolysis was performed in the presence of 6 M HCl at 110°C for 24 hr. Sulfur containing amino acids were determined after performing acid oxidation.

2.7. Antinutritional factors:

2.7.1. Tannins (as tannic acid):

Total tannins were determined colorimitricaly as described in Makkar and Goodchild (1996).

2.7.2. Phytic acid:

Phytic acid was determined according to the method of Wheeler and Ferrel (1971).

2.7.3. Determination of trypsin inhibitor activity:

Trypsin inhibitor activity was determined according to the method of Kakade *et al*., (1969). The results were recoded is trypsin unit inhibited (TUI) per gram protein or flour.

2.7.4. Determination of hemagglutinin activity:

The hemagglutinin activity in *Jatropha curcas* flours was estimated according to the method of Liener and Hill (1953).

2. 8. Minerals content:

Different minerals and some heavy metals in Jatropha flour were determined according to AOAC (1995).

The flour was wet digested using concentrated sulfuric acid and perochloric. The minerals were determined in the clear solution using Atomic Absorption Spectrophotometer (SOLAAR – UNICAM 989).

2.9. Statisticial analysis:

All data represent means of triplicate determinations and are expressed as mean ± standard deviation. A one way analysis of variance (SAS, 1988) was carried out significance differences were determined at ($P \leq 0.05$).

RESULTS AND DISCUSSION

1. Physical characteristics

The physical characteristics of Jatropha seeds are shown in Table (1). In fact Jatropha fruits contain 3 seeds inside a brown outer husk. The seed it self consists of a white kernel with outer black coat (shell). These fractions are show in Fig. (1). Therefore, it is necessary to determine the properties of each fraction compared to the others. Particularly the weight, its percentage in the total seed (whole kernel + shell) and the different ratios between these different fractions. This will give a clear idea about the most valuable fraction of Jatropha seed.

The average weight of kernel, shell and husk was 0.4, 0.22 and 0.69 gm respectively. The percentages of these fractions are 65.24, 34.76 and 27.99% for kernel, shell and husk, respectively. Our findings are in a good agreement with that of Makkar *et al*.(1998).

Table (1): Some physical characteristics of *Jatropha curcas* seeds.

Jatropha fractions	Value
Fruit weight (gm)	2.59 ± 0.27
Seed%	72.01 ± 1.23
Husk%	27.99 ± 1.16
Seed weight (gm)	0.62 ± 0.03
Kernel%	65.24 ± 1.10
Shell%	34.76 ± 1.10

Mean ± standard division

2. Chemical Composition

The chemical composition of seed, kernel and shell of *Jatropha curcas* are shown in Table (2). Chemical composition was significantly (p≤0.05) different in seed, kernel and shell. *Jatropha curcas* kernel contained the highest (p≤0.05) level of lipid (51.16 %) then in seed (35.23%) and in shell (0.96%) and protein in kernel (26.15%), then in seed (23.12%) and in shell (2.34%). While, Jatropha kernel had the lowest (p≤0.05) content of moisture (6.02%) , then in seed (6.22%) and in shell (7.01%) , ash (3.83%) , then in seed (5.18%) and in shell (5.91%), crude fiber (2.67%) then in seed (12.89%) and in shell (81.22%). finally, the highest (p≤0.05) content of carbohydrates was found in seed (17.36%), then in kernel (10.17%) and in shell (2.56%) . Of course these changes are due to the removal of the outer coat (shell) which mainly consists of crude fiber and total ash. This trend was also clear in the chemical compositions of shell. It showed a marked increase in total crude fiber but total carbohydrates decreased.

Fig 1

Table (2): Proximate chemical composition of *Jatropha curcas* seeds, kernels, and shells.

Components (%)	*Jatropha curcas* fractions			
	Seeds	Kernels	She	LSD
Moisture	6.22 ± 0.02^{b}	6.02 ± 0.02^{c}	7.01 ± 0.04^{a}	0.05451
Total proteins	23.12 ± 0.02^{b}	26.15 ± 0.03^{a}	2.34 ± 0.04^{c}	0.1794
Total lipids	35.23 ± 0.02^{b}	51.16 ± 0.06^{a}	0.96 ± 0.02^{c}	0.0793
Total ash	5.18 ± 0.06^{b}	3.83 ± 0.04^{c}	5.91 ± 0.02^{a}	0.0901
Crude fibers	12.89 ± 0.07^{b}	2.67 ± 0.03^{c}	81.22 ± 0.04^{a}	0.10317
Total carbohydrates	17.36 ± 0.04^{a}	10.17 ± 0.05^{b}	2.56 ± 0.04^{c}	0.08395

Each value in the table ± Standard deviation of three replicates.
Means in the same row with different letters are significantly different (p≤ 0.05).
Total carbohydrates were determined by difference.

From the results in Table (2) it is very clear that the kernel of Jatropha seeds is the most valuable fraction to be used in the field of food and nutrition compared to whole seed which comes in the second stage. Meanwhile shells could be used as feed or other non-food uses.

The differences found in the chemical composition of these fractions were significant (p≤0.05) from the statistical point of view. Generally, these data agree well with that obtained by (Banerjee, 1989; Aderibigbe *et al*., 1997; Liberalino *et al*., 1998; Makkar *et al*., 1998 and Martinez – Herrera *et al.,* 2006).

3. Carbohydrate fractions of Jatropha seed flours

The major carbohydrate fractions i,e total soluble sugars, free reducing sugars and starch of *Jatropha curcas* seed flour are presented in Table (3). The content of total soluble sugars, free reducing sugars and starch of *Jatropha curcas* seed flours were 9.97%, 10.24% and 4.52%, respectively. Our findings are in a good agreement with those of Martínez – Herrera *et al*., (2006).

From data and results in Tables (2, 3) we can say that the produced *Jatropha curcas* seed flour in this study is quite high in protein, total ash and low in lipids and starch which represent a good material to be used in different food industries. Also, there are another advantages it has a good white colour without any off flavour which fits to many food products.

Table (3): Carbohydrate fractions of *Jatropha curcas* flours (on dry weight basis).

Jatropha fractions	Value
Total soluble sugars%	10.24 ± 0.07
Free reducing sugars%	4.52 ± 0.026
Starch%	9.97 ± 0.04

Is the mean of three replicates ± SD.

4. Characteristic of Jatropha seeds oil:

4.1. Physical and chemical properties of Jatropha seeds oil:

Physical properties (viscosity, specific gravity, colour and refractive index) and chemical properties (acid value, saponification and iodine values) of Jatropha seed oil are show in Tables (4 and 5). The viscosity, specific gravity, colour and refractive index of Jatropha oil were 52.60 (cSt), 0.920 (gm/Cm^3), 4.0 yellow and 1.4735, respectively.

The refractive index of Jatropha seed oil is 1.4735 which is quite close to that of sunflower oil (1.4693), cotton oil (1.4675) and corn oil (1.4681). This means that the Jatropha seed oil could be used as a cooking oil if it is free from any toxic substances or any other health harming factors.

The colour of Jatropha seed oil is yellow which resumples most of vegetable oils. Our findings regarding to other seeds oil physical properties are similar to that reported by Diligent Tanzania Ltd. As reported in the feet note of Table (4).

The acid value of Jatropha seed oil is 5.58 mg KOH/gm oil which is very high indicating that lipase enzyme in the kernel is highly active therefore, it is very important to inactivate the enzyme by any heat treatment (dry or moist) after harvesting the seeds are keeping it under cold temperature (~5°C) during storage before oil extraction.

The Saponification value is very high reporting a value of 192 mg KOH/gm oil and that means short chain fatty acids are predominant in Jatropha seed oil composition.

The iodine value was also high about 102.29 mg I_2/gm oil indicating a high percentage of unsaturation in this oil. This is quite true since it contains 79.25% total unsaturated fatty acids compared to 20.75% of saturated fats. The chemical properties of Jatropha seed oil reported by Diligent Tanzania ltd which was included in Table (5) for comparison indicate that the oil chemical properties of Jatropha seed cultivated in Egypt is quite similar to that of Tanzania.

Table (4): Some physical characteristics of Jatropha seeds oil.

Properties	Value
Colour	4.0 yellow (Golden yellow)
Viscosity at 30^0C (cSt)	52.60 ± 0.001
Specific gravity (gm/cm^3)	0.920 ± 0.00
Refractive index (20°C)	1.4735 ± 0.0
Flash Point [1]	240 ºC
State [1]	Liquid at room temperature
Solubility [1]	Organic solvent – insoluble in water
Appearance [1]	Similar to castor oil
Odour [1]	Similar to castor oil

[1] From. Diligent Tanzania Ltd.
Material Safety Data Sheet III Physical Data.

Table (5): Some chemical characteristics of *Jatropha curcas* seed oil.

Properties	Value	
	Jatropha seed oil	Diligent reference[1]
Acid value (mg KOH/ g)	5.58 ± 0.09	1.24 - 4.24
Saponification value(mg KOH/ g)	192 ± 4	169.9 - 197
Iodine value (mg I_2 / g)	102.29 ± 1.06	97.1 – 111.6

[1] From. Diligent Tanzania Ltd.
Material Safety Data Sheet III Physical Data.

4.2. Fatty acid composition

The fatty acid composition of the oil in *Jatropha curcas* seeds is recorded in table (6) also the data of free fatty acids reported by Diligent company included. Both data are very similar. The fatty acids found in the oil sample were oleic, linoleic, linolenic, palmitic, myristic and stearic. The major fatty acids in the oil sample were oleic and linoleic acid .The results showed that the oil is composed mainly of unsaturated fatty acids (79.254%). The results obtained are very similar to those reported by (Banerji *et al*., 1985; Heller, 1996 and Martínez-Herrera *et al.,* 2006).

From the previous results about the oil properties of Jatropha seed oil it is a healthy oil due to the presence of the unsaturated fatty acids i,e. oleic, linoleic (44.1, 33.19%) which protect the body from the heart diseases and

reduce the blood cholesterol and triglycerides. Also it is susptible to oxidation and rancidity therefore; it requires a good handling and storage to keep and protect its nutritional quality and avoid its oxidation.

Table (6): Fatty acid composition of *Jatropha curcas* seed oil.

Fatty acid	%
Oleic acid (18:1)	44.110
Linoleic acid (18:2)	33.193
Linolenic acid (18:3)	0.5270
Palmitoleic acid (16:1)	1.3424
Total non-saturated fatty acid	79.254
Myristic acid (14:0)	0.352
Palmitic acid (16:0)	13.537
Stearic acid (18:0)	6.857
Total saturated fatty acid	20.74

5. Amino acid composition

The amino acid composition of the Jatropha flour is presented in Table (7). Also the patterns of soybean and reference profile of the FAO/WHO (1990) were included for comparison. The results of amino acid profiles of Jatropha seed flour revealed the following:

1- The contents of essential amino acid of leucine, isoleucine, therionine and valine except lysine either comparable or higher than that of soybean flour. Most of essential amino acid contents of the different Jatropha seed flours were higher than the suggested reference pattern of FAO/WHO (1990) for preschool children (2-5 years old). These findings may focus the interest of using Jatropha seed flour as a good source for essential amino acids in different food products.

2- The lower concentration was observed only for sulpher containing amino acids cystine and methionine in addition to tyrosine. The contents of these acids were slightly lower than that present either in soybean protein (Vasconcelos *et al*, 1997) or the reference pattern of FAO/WHO (1990).

3- The major non- essential amino acid was glutamic followed by arginine and aspartic with value of 15.80, 11.85, and 8.16, respectively. Histidine, serine and glycine were found in higher concentration than that in soybean. Due to the higher contents of arginine and glutamic acid found in Jatropha seed flours from the nutrition point of views it give a good

potential for its utilization in food products as a source of protein and amino acid. Our findings are in a good agreement with those of Martínez – Herrera *et al*., (2006).

Table (7): Amino acid profile of *Jatropha curcas* flour as compared to soybean and FAO/WHO[1] (1990) patterns.

Amino acid (gm/100 gm protein	*Jatropha curcas*	Soybean	FAO/WHO[1]
Essential Amino acid			
Leucine	**6.54**	**7.61**	**6.6**
Isoleucine	**4.65**	**3.98**	**2.8**
Lysine	**5.41**	**6.84**	**5.8**
Methionine	**0.33**	**1.39**	**2.5**
Cystine	**0.44**	**1.64**	
Tyrosine	**2.59**	**4.94**	**6.3**
Phenylalanine	**4.60**	**5.76**	
Tryptophan	**ND**	**0.88**	**1.1**
Threonine	**3.35**	**3.85**	**3.4**
Valine	**5.51**	**4.72**	**3.5**
Total essential Amino acids	**33.42**	**41.61**	
Non- essential Amino acid			
Aspartic acid	**8.16**	**11.9**	
Histidine	**5.32**	**3.03**	
Proline	**0.71**	**5.10**	
Serine	**4.79**	**4.15**	
Glutamic acid	**15.80**	**18.6**	
Glycine	**4.16**	**3.93**	
Alanine	**4.13**	**4.19**	
Arginine	**11.85**	**7.47**	
Total non- essential Amino acids	**54.92**	**58.37**	

FAO/WHO[1] (1990) reference pattern suggested for pre-school children (2-5 years old).
ND: not determined.

6. Antinutritional factors

The results in Table (8) represented the trypsin inhibitor, tannins, phytic acid and Hemagglutinin of Jatropha flour. The contents of trypsin inhibitor, tannins, phytic acid and Hemagglutinin in Jatropha flour were 24.37 TIA /mg flour, 0.03 mg/gm flour, 7.87 mg/gm flour and 118 HU/gm flour, respectively. Trypsin inhibitor and hemagglutinin are heat–labile and can be partially or completely denatured when exposed to elevated temperature. However, phytic acid could be reduced through termination.

Table (8): Antinutritional factors of *Jatropha curcas* flour.

Antinutritional factors	Value
Trypsin inhibitor (TUI/mg protein)	24.37
Tannins (Tannic acid) mg/gm flour	0.03
Phytic acid (mg/gm flour)	7.87
Hemagglutinin activity (HU/gm flour)	118

7. Minerals

The contents of macro elements (Na, K, Ca, Mg and P) and micro minerals (Fe, Mn, Zn and Cu) and some heavy metals i,e Pb and Cad of Jatropha flour are included and shown in Tables (9). The results proved that:

a) Macro minerals (Na, K, Ca, Mg and P) contents were 101.05, 1044.80, 514, 1033.53 and 2045 mg/100gm flour, respectively.

b) Micro minerals (Fe, Zn, Mn, Cu, Pb and Cad.) contents of Jatropha flour were 10.46, 10.33, 6.583, 1.33, 0.0 and 0.0 (mg/100 gm flour), respectively. This may add an advantage to Jatropha seed flour to be used as a good source for micro elements to improve the nutrition status of children (Peace and Aladesanmi, 2008).

Also it is very interesting point to declare that the flours of Jatropha seed were completely free from the toxic heavy metals such as Pb and Cad. this finding increases its potential uses in different food products as a safe and good source for mineral nutrients.

Table (9): Some minerals contents of *Jatropha curcas* flour (mg/100gm flour).

Jatropha curcas flour	*Macro minerals*				
	Na	K	Ca	Mg	P
	101.05	1044.80	514	1033.53	2045
	Micro minerals				
	Fe	Mn	Zn	Cu	Pb	Cad.
	10.46	0.783	10.33	1.33	0.0	0.0

REFERENCE

Aderibigbe, A. O., C.O. Johnson, H. P. Makkar, K. Becker and N. Foidl (1997). Chemical composition and effect of heat on organic matter and nitrogen degradability and some antinutritional components of *Jatropha* meal. Animal feed Science Technology, 67: 223- 243.

AOAC (1995). Official Methods of Analysis of the Association of Official Analytical Chemists, 16th ed. Washington, USA.

AOCS (1973). Official and Tentative Methods of the American Oil Chemist,s Society, Vol.1 (3rd ed.) AOCS, Champaign, IL. USA.

Banerjee, A.K. (1989). Shrubs in tropical forest ecosystems, examples from India. World Bank Technical Paper Number 103.

Banerji, R., A. R. Chowdhury, G. Misra, G. Sudarsanam, S. C. Verma and G. S. Srivastava (1985). Jatropha seed oils for energy. Biomass, 8: 277.

FAO/WHO (1990). Protein quality evaluation. In *Report of a joint FAO/WHO experts consultation* (p. 23). Rome, Italy: Food and Agriculture Organization of the United Nations.

Farag, R. S., A. M. Youssef, F. A. Khalil and R. A. Taha (1981). The lipids of various fungi grown on an artificial medium. J. Am. Oil Chem. Soc., 58: 765.

Heller, J. (1996). Physic nut (*Jatropha curcas L*.). Promoting the conservation and use of underutilized and neglected crops. I. Gatersleben: Institute of Plant Genetics and Crop Plant Research/Rome: International Plant Genetic Resources Institute.

Jones, N. and J.H. Miller (1992). *Jatropha curcas* – amultipurpose species for problematic sites. Land – Resource – Series. No .1. pp.40.

Kakade, M.L., N. Simons and I.E. Liener (1969). An evaluation of natural vs synthetic substrates for measuring the antitryptic activity of soybean samples. Cereal Chem. 46: 518- 528.

Liberalino, A.A., E.A. Bambirra, T. Moraes-Santos and C.E. Viera (1988). *Jatropha curcas L*. seeds. Chemical analysis and toxicity . Arq. Biol. Technol. 31: 539- 550.

Liener, I.E. and E.G. Hill (1953). The effect of heat treatment on the nutritive value and hemagglutinating activity of soybean oil meal. J. Nutr. 49: 609.

Makkar, A. O. and A.V. Goodchild (1996). Quantification of tannins . A Laboratory Manual, Int. Centre Agric. Res. Dry Areas, Allepo, Syria, pp. 25.

Makkar, H. P., A. O. Aderibigbe and K. Becker (1998). Comparative evaluation of non-toxic and toxic varieties of *Jatropha curcas* for chemical composition, digestibility, protein degradability and toxic factors. Food Chemistry, 62: 207 - 215.

Makkar, H. P., K. Becker and B. Schmook (1998a). Edible provenanaces of *Jatropha curcas* from Quintana Roo state of Mexico and effect of roasting on antinutrient and toxic factors in seeds. Plant Foods for Human Nutrition, 52: 31- 36.

Makkar, H. P. and K. Becker (1999). Nutritional studies on rats and fish (*Carp cyprinus carpio*) fed diets containing unheated and heated *Jatropha curcas* meal of a non-toxic provenanace . Plant Foods for Human Nutrition, 53: 183 – 192.

Martínez- Herrera, J., P. Siddhuraju, G. Francis, G. Davila-Ortiz and K. Becker (2006). Chemical composition, toxic/antimetabolic constituents, and effects of different treatments on their levels, in four provenances of *Jatropha curcas L*. from Mexico. J. Food Chem. 96: 80-89.

Moore, S and W. H. Stein (1963). Chromatographic determination of amino acids by the use of automatic recording equipment. In: Colowick, SP, Kaplan NO. (eds). Methods in enzymology Vol. 6. New York: Academic Press, P860.

Peace, O.E. and A.O. Aladesanmi (2008). Effect of fermentation on some chemical and nutritive properties of Berlandier Nettle Spurge (*Jatropha cathartica*) and physical nut (*Jatropha curcas*) seeds. Pakistan Journal of Nutrition 7: 292- 296.

Pearson, D. (1981). Chemical Analysis of Foods. 7th Edn., J. and A. Churchill, London.

SAS (1988). SAS Users Guide: Basics Version 5th edn. Cary. NC: SAS Institute.

Scherchan, D.P., Y.B. Thapa, R.J. Khadka and T.P. Tiwari (1989). Effect of green manure on rice production. Pakhribas Agricultural Centre Occasional Paper. 2: 12.

Vasconcelos, I.M., E.A. Siebra, A.A.B. Maia, R.A. Moreira, A. F. Neto, G.J.A. Campelo and J.T.A. Oliveira (1997). Composition, toxic and antinutritional factors of newly developed cultivars of Brazilian soybean (Glycine max). Journal of Sciences and Food Agriculture, 75: 419.

Wheeler, E.I. and R.E. Ferrel (1971). A method for phytic acid determination in wheat and wheat fractions. Cereal Chem. 48: 312.

الخواص الطبيعية - الكيماوية وتقييم بذور الجاتروفا كركاس

عصام الدين حافظ منصور ، السيد حلمى عبد السلام رحمة ،

شيرين محمود طه حمودة

قسم علوم وتكنولوجيا الأغذية – كلية الزراعة – جامعة المنوفية

الملخص العربي

تم دراسة الخواص الطبيعية– التركيب الكيميائى لبذور و زيت الجاتروفا. أيضا تقدير محتوى الدقيق من الأحماض الأمينية ومضادات التغذية المختلفة والمعادن . ولقد أوضحت النتائج المتحصل عليها ما يلي :

١– متوسط وزن الثمرة الجاتروفا ٢.٥٩ جرام ، وكانت نسبة وزن البذور ٧٢.٠١% ونسبة وزن الغلاف الخارجي للثمرة ٢٧.٩٩ %. وبذلك تمثل البذور المكون الأكبر بالنسبة لمكونات الثمرة.

٢– متوسط وزن البذرة ٠.٦٢جرام ، وكانت نسبة وزن اللب ٦٥.٢٤ % ونسبة وزن القشرة الخارجية للبذرة ٣٤.٧٦ %. وبذلك يمثل اللب المكون الأكبر بالنسبة لمكونات البذرة.

٣– كانت القشرة الخارجية عالية في محتواها من الألياف (٨٢.٩٣%) ونسب منخفضة من البروتين والكربوهيدرات ٤.٨٦% ، ٥.٢٨% علي التوالي.

٤– تحتوى البذور علي الزيت ، البروتين ، الكربوهيدرات ، الألياف ، الرماد بنسب ٣٥.٢٣%، ٢٣.١٢% ، و ٢٢.٥٨% ، ١٣.٨٩% ، ٥.١٨%. مكونات البذرة الداخلية الزيت بنسبة ٥٢.١٧% ثم البروتين والكربوهيدرات والرماد الكلي والألياف بنسب ٢٦.٧٦ % ، ١٣.٣٧% ، ٤.٤٣%، ٣.٢٧% علي التوالي.

٥– الخواص الطبيعية مثل اللزوجة والكثافة النوعية واللون ومعامل الإنكسار لزيت بذور الجاتروفا كانت ٥٢.٦ (cSt) ،٠.٨٧٩ جم/سم^{٣} ، ٤ أصفر ، ١.٤٧٣٥ علي التوالي.

٦– الخواص الكيميائية مثل (رقم الحامض ، رقم التصبن ، الرقم اليودى) لزيت بذور الجاتروفا كانت ٥.٥٨ ملجم بوتاساكاوية/جم زيت ، ١٩٢ ملجم بوتاساكاوية/جم زيت ، ١٠٢.٢٩ ملجم يود/جم زيت علي التوالي.

٧- أحتوى الزيت علي حمضي الأوليك واللينوليك بنسب ٤٤.١١% ، ٣٣.١٩% علي التوالي. بالإضافة إلي كل من البالمتيك والمارستيك والاستيارك بنسب ١٣.٥٣ ، ٠.٣٥٢، ٦.٨٥ % علي الترتيب وكانت نسبة الأحماض الدهنية غير المشبعة ٧٩.٢٥%.

٨- لا يصلح زيت الجاتروفا للاستخدام الآدمي لاحتوائه علي المادة السامة الـ phorbol ester ، ويستخدم كزيت ديزل ويدخل أيضاً في صناعة الصابون.

٩- محتوى الدقيق من الأحماض الأمينية الأساسية هو ٣٣.٤٢ جم/١٠٠جم بروتين ، أما غير الأساسية فكانت ٥٤.٩٢ جم/١٠٠جم بروتين ومحتوى الأحماض الأساسية مناسب تغذوياً.

١٠- محتوى دقيق الجاتروفا من مثبط انزيم التربسين (٢٤.٣٧ وحدة تربسين مثبطة/جم بروتين) ، التانين (٠.٠٣ ملجم/جم دقيق)، حامض الفيتيك (٧.٨٧ ملجم/جم دقيق)، تجلط كرات الدم الحمراء (١١٨ وحدة/ جم دقيق).

١١- يعتبر دقيق الجاتروفا غني في الفسفور(٢٠٤١) والبوتاسيوم (١٠٤٤.٨٠) والمنجنيز (١٠٣٣.٥٨ ملجم/١٠٠ جم عينة). وكذلك الكالسيوم(٥١٤) والصوديوم(١٠١.٧٦) متواجدان بمستوى كبير من الوجهة التغذوية.

١٢- العناصر المعدنية الصغرى مثل الحديد ، والزنك ، والنحاس ، والمنجنيز تتواجد بتركيزات بسيطة في دقيق بذور الجاتروفا . يعتبر الحديد (١٠.٤٦ ملجم/١٠٠ جم عينة) أكبرهم تركيزاً يليه الزنك (١٠.٣٣ ملجم/١٠٠ جم عينة) والنحاس (١.٣٣ ملجم/١٠٠ جم عينة) والمنجنيز (٠.٧٨٣ ملجم/١٠٠ جم عينة). مما يضيف ميزة لدقيق الجاتروفا كمصدر جيد للعناصر الصغرى في أغذية الأطفال. كما أنه خالي تماماً من المعادن الثقيلة السامة مثل الرصاص والكاديوم .

Table (7): Amino acid profile of *Jatropha curcas* flour as compared to soybean and FAO/WHO[1] (1990) patterns.

Amino acid (gm/100 gm protein	*Jatropha curcas*	Soybean	FAO/WHO[1]
Essential Amino acid			
Leucine	6.54	7.61	6.6
Isoleucine	4.65	3.98	2.8
Lysine	5.41	6.84	5.8
Methionine	0.33	1.39	2.5
Cystine	0.44	1.64	
Tyrosine	2.59	4.94	6.3
Phenylalanine	4.60	5.76	
Tryptophan	ND	0.88	1.1
Threonine	3.35	3.85	3.4
Valine	5.51	4.72	3.5
Total essential Amino acids	33.42	41.61	
Non- essential Amino acid			
Aspartic acid	8.16	11.9	
Histidine	5.32	3.03	
Proline	0.71	5.10	
Serine	4.79	4.15	
Glutamic acid	15.80	18.6	
Glycine	4.16	3.93	
Alanine	4.13	4.19	
Arginine	11.85	7.47	
Total non- essential Amino acids	54.92	58.37	

FAO/WHO[1] (1990) reference pattern suggested for pre-school children (2-5 years old).
ND: not determined.