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Chemical composition and nutritional value of jatropha (*Jatropha curcas* L.) leaves

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Abstract

Jatropha *jatropha curcas* L. is considered an important biofuel plant which has limitedly distributed in subtropical arid region because it's very sensitive to decreased temperature. Hence, therefore, the proximate composition of mineral content, vitamins, amino acids and some nutritional components of jatropha leaves were estimated. The results indicated that leaves had lesser concentration of chemicals where were 1.99 % N, 0.14 % P, 1.08% K, 2.95% total carbohydrates, 12.46% protein, 2.47 $mg.g^{-1}$ total chlorophyll, 0.40 $mg.g^{-1}$ carotenoids, amino acids (0.0159 $mg.g^{-1}$ aspargine, 0.0306 $mg.g^{-1}$ proline, 0.0127 $mg.g^{-1}$ cystine and 0.0205 $mg.g^{-1}$ histidine), vitamins (0.064 $mg.g^{-1}$ B_1 , 0.121 $mg.g^{-1}$ B_2 , 0.058 $mg.g^{-1}$ pantothenic acid , 0.049 $mg.g^{-1}$ niacin , 0.229 $mg.g^{-1}$ Inositol , 0.75 $mg.g^{-1}$ α-tocopherol , 0.18 $mg.g^{-1}$ γ-tocopherol and 0.30 $mg.g^{-1}$ K_1), 1.29 $mg.g^{-1}$ phenolic acid, 0.540 $mg.g^{-1}$ flavonoids, $mg.g^{-1}$ 0.870 tannins and 13.53 antioxidant activity. These low values may be results from the high sensitivity of plant to arid environments, which in turn may led to some amino acids could not be detected. Therefore, it's recommended to improve input growth factors that correlated with biochemical and physiological traits like fertilizers, plant growth regulators, soil properties and some techniques that used pre-sowing to prime seeds considered an effective strategy for succeeding cultivation of jatropha in arid regions as in west Iraq.

Key words: Jatropha, leaves, chemical composition, nutritional value.

Introduction

Jatropha curcas, physic nut or purging nut is a drought resistant shrub or tree belonging to the family Euphorbiaceae, which is cultivated in central and south America, southeast Asia, India and Africa (Schmook and Seralta-Peraza, 1997; Gubitz *et al*., 1999; Martınez-Herrera *et al*., 2006).

Jatropha curcas L. potentially can became one of the world's key energy crops. The seeds can produce crude vegetable oil that can be refined into high quality biodiesel. Low numbers of female flowers, limited branching and inadequate pollination are the major factors that limit seed production and thus oil yield of *J. curcas*. Therefore it's is still an undomesticated plant in which many basic agronomic properties are not yet thoroughly understood (Achten *et al*., 2008).

Jatropha curcas oil contains about 14% free fatty acid (FFA) which is beyond the limit of 1% level which can be efficiently converted into biodiesel by trans-esterification using an alkaline catalyst (Tiwari *et al*., 2007). The fatty acids that were reported in a previous study of *J. curcas* oil are palmitic acid (11.3%), stearic acid (17%), arachidic acid (4.7%), oleic acid (12.8%), and linoleic acid (47.3%) (Adebowale and Adedire, 2006). All parts of *J. curcas* can be used for a wide range of purposes, the tree itself has been used for erosion control, fire wood, hedge plant and for plant protection, also the bark is rich in tannin and yields a dark blue dye (Gubitz *et al*., 1999; Openshaw, 2000; Augustus *et al*., 2002). Investigations on the phytochemical screening of *J.curcas* stem bark and leaf extracts revealed the presence of saponins,

steroids, tannins, glycosides, alkaloids and flavonoids (Uche and Aprioku, 2008; Igbinosa *et al*., 2009; Namuli *et al*., 2011; Gupta *et al*., 2003). These compounds are known to be biologically active and therefore aid the antimicrobial activities of *J. curcas*. These secondary metabolites exert antimicrobial activity through different mechanisms. Tannins have been found to form irreversible complexes with proline rich protein (Shimada, 2006) resulting in the inhibition of cell protein synthesis. Parekh and Chanda (2007) reported that tannins are known to react with proteins to provide the typical tanning effect which is important for the treatment of inflamed or ulcerated tissues. Herbs that have tannins as their main components are astringent in nature and are used for treating intestinal disorders such as diarrhea and dysentery (Dharmananda, 2003). These observations therefore support the use of *J. curcas* in herbal cure remedies. Different extracts of *J. curcas* leaves were bio-assayed and analyzed. The main allelopathic substance was determined by gas chromatography-mass spectrometry (GC-MS) data as azelaic acid which possesses allelopathic potential (Ma *et al*., 2011). Abugre and Quashie-Sam (2010) suggested that the inhibitory effect due to the presence of allelochemicals as phenolic compounds that could inhibit the growth of the crops.

The phenolic acids such as kaempferol, coumarin, catechin, and quercetin acids were found in jatropha leaves (Rejila and Vijayakumar, 2011; Rejila *et al*., 2012) and alkaloids, saponins, steroids and tannins (kinpelu *et al*., 2009). Results of Igbinosa *et al*. (2011) indicated that *J. curcas* is a potential source of natural antioxidants that could be a good agent as pharmaceutical plant which its products in related with the polyphenolic contents and antioxidant potential of the aqueous extracts (The total phenol, flavonoids, flavonols and proanthocyanidin contents). Pompelli *et al*. (2010) revealed that the activities of antioxidant enzymes as superoxide dismutase, catalase, ascorbate peroxidase and glutamine synthetase in leaves were the highest in water-stressed environment. Thus, this mechanism makes jatropha could counteract the oxidative impact and survive in the arid environment. Li *et al*. (2003) reviewed the biological activities of tannins and observed that tannins could be used in cancer prevention due to its anticancer activity. The presence of tannins in *J. curcas* supports the traditional medicinal use of this plant in the treatment of different ailments. Each parts of plant have been used for rearing of silkworm, in dyeing, medicines, and as an anti-inflammatory substance. Pesticidal and mollusc control properties, as attractant bees, soap production, fuel, lubricant, fertilizer or in biogas production, green manure and in biogas production. Lastly, the roots contain yellow oil with strong antihelminthic properties (Sirisomboon *et al*., 2007; Basha *et al*., 2009; Karaj and Muller, 2010). Jatropha is adaptable crop to complete well in marginal soils in semi arid tropics which is suitable to be grown in non-arable lands, as it is demanded to replace ptro-diesel (Francis *et al*., 2005), to reduce soil degradation and desertification. Recently, the jatropha was introduced in Iraq as a promising raw material to produce biofuel, enhance socio-economy of tribes and to farm the regions had desert climate. Therefore, this study was conducted out to assess chemical and nutritional components of jatropha leaves in west desert of Iraq (Alanbar province).

Materials and Methods

Plant materials: Jatropha species *Jatropha curcas* L. leaves were collected from the field of center of desert studies CDS, University of Alanbar, Iraq at October, 2011. The sample was cleaned manually to remove all foreign materials such as dust, dirt and infested leaves. The cleaned sample were blended to powder form with a high-speed blender (Braun KMM 30 mill), type 3045, CombiMax (Germany).

Chemical analysis: All chemical analysis used in this study were performed at the laboratories of department of vegetable crops and medicinal plants, university of life sciences, Lublin, Poland.

For determination macroelements (nitrogen, phosphor and potassium) were estimated according to the method described by (Apolonia *et al*., 1991). Total carbohydrates by Luff–Schoorl method modified by (Fortuna *et al*., 2003), whereas the percentage of protein was calculated using a conversion factor of 6.25. Photosynthetic pigments (chlorophyll a, chlorophyll b and carotenoids) were determined as the method described by (Moran, 1982). Vitamins, phenolic acid, flavonoids and tannins were determined according to the method described by (Strzelecka *et al*., 1987). Antioxidant activity (DPPH inhibition)

following the method described by (Yen and Chen, 1995), whereas the amino acids were calculated in accordance with a formula given by (Schneider, 1989).

Statistical analysis: Data were analyzed by using the General Linear Model Procedure of SAS (2001). Means were compared by the Duncan's Multiple Range test at 5% probability (Steel and Torrie, 1960). All data represented as means of triplicate ± standard deviation.

Results and Discussion

Chemical composition and Minerals content: The proximate biochemical composition of leaves of *Jatropha curcas* from desert climatic region in Iraq are shown in Table (1), data showed that leaves contain 2.95 total carbohydrates and 12.46 protein, these results provided that the leaves of jatropha composed essentially from protein. This low level of carbohydrates may be due to desert climatic environments that jatropha was grown or because of being the samples taken in October the month which winter is begun i.e. the temperature is decreased lead to chlorophyll broke down. Thus, the leaves were inactivated.

It is evident from the data in Table (1) that minerals content under investigation (N, P and K) were less. Results indicate that the highest mean level of macro elements in the leaves was nitrogen which recorded 1.99%, followed by potassium of 1.08%. While phosphorus was the least one of 0.14. This may be due to the transporting of the minerals from source (leaves) to sink (parts as flowers). On the contrary of N, P and K uptake via plant of such three nutrients were gradually decreased by stressed environment. Leaves uptake of each of nitrogen, phosphorus and potassium were decreased due to the use of their products. Potassium is an essential nutrient and has an important role in the synthesis of amino acids and proteins.

Pigments content: From the given data in Table (1) it can be concluded that desert climate environments produced the lowest value in the content of photosynthetic pigments i.e. chlorophyll a 1.58, b 0.89, a + b 2.47 and cartenoids 0.40 $mg.g^{-1}$. The chlorophyll concentration is considered very little due to the decreasing of nitrogen in leaves of jatropha (Table 1). These desert-cultivated plants showed lower chlorophyll a, chlorophyll b, total chlorophyll, carotenoid and protein content in leaf as compared with other trials indicating lower physiological performance in absence of irrigated conditions. The decreasing of chlorophyll, amino acid and proteins in leaves are used as signals of senescence in green leaves tissues (Pompelli *et al*., 2010). Carotenoids controlled energy excess dissipation and scavenging of singlet oxygen. Hence, however, these biochemicals had not antioxidant activity due to its decreased levels. To improve vital traits like biomass and yield, it had to be necessary to use proper soil and crop managements.

Amino acids composition: These results demonstrated that the amino acid compositions may be affected by desert and fall season conditions. The data in Table (2) indicated that only four acids were found in leaves of jatropha. Levels of aspargine, proline and sulphur amino acids were lower of 0.0159, 0.0306, 0.0127 and 0.0205 $mg.g^{-1}$, respectively. The levels of essential amino acids, in the jatropha leaves were lesser than some other plants (Makkar *et al*., 1998). From the given data in Table (2) it can be concluded that climatic factors affected in proline content. This may be due to the proline methodism which is a typical mechanism of biochemical adaptation subjected to stress condition. The catabolism of proline involves its conversion to glutamic acids via Pyrroline-scarboxylate reduction and subsequent metabolism of glutamate by Kreb cycles reaction that release CO_2 as the end product. Results on proline content had a similar trend as that in the photosynthetic pigments Which was decreased the average content of leaves. Also, the results showed that vitamins contents were differed in harmony with other nutritional components which α-tocopherol had the highest value of 0.79 $mg.g^{-1}$ followed by inositol of 0.229 $mg.g^{-1}$. Vit. B_1 had the lowest one of 0.064 $mg.g^{-1}$. Vitamins B_2, pantothenic acid, niacin, γ-tocopherol and K_1 had values of 0.121, 0.058, 0.049, 0.18 and 0.30 $mg.g^{-1}$. Free amino acid is considered the best indicator of arid environment as firmly decreased under desert conditions (Pompelli *et al*., 2010).

Phenols and DPPH assay: The data are presented in Table (3), phytochemical analysis of the extract revealed the presence of phenolic acid, tannins and flavonoids. The results indicate that these compounds were very little which were 1.29, 0.870 and 0.540 $mg.g^{-1}$, for each compound, respectively.

Table (1): Minerals, macronutrients and pigments of jatropha leaves (Means±SD).

Minerals and macronutrients (%)		Pigments ($mg.g^{-1}$)	
N	1.99±0.07	Chlorophyll a	1.58±0.25
P	0.14±0.02	Chlorophyll b	0.89±0.18
K	1.08±0.07	Total chlorophyll	2.47±0.42
Total carbohydrates	2.95±0.2	Carotenoids	0.40±0.06
Protein	12.46±0.45		

Table (2): Vitamins and amino acid of jatropha leaves (Means±SD).

Vitamins ($mg.g^{-1}$)		Amino acid ($mg.g^{-1}$)	
B_1	0.064±0.008	Aspargine	0.0159±0.0015
B_2	0.121±0.014		
Pantothenic acid	0.058±0.012	Proline	0.0306±0.0009
Niacin	0.049±0.006		
Inositol	0.229±0.027	Cystine	0.0127±0.0004
α-tocopherol	0.75±0.09		
γ-tocopherol	0.18±0.03	Histidine	0.0205±0.0006
K_1	0.30±0.02		

Table (3): Phenols of jatropha leaves (Means±SD).

Phenols ($mg.g^{-1}$)	
Phenolic acid	1.29±0.053
Flavonoids	0.540±0.011
Tannins	0.870±0.16
DPPH assay	13.53±0.22

This reduction may be due to enzymatic activity of polyphenol oxidase. Tannins are complicated polyphenolics found in the large number of plants genera that have antinutritional influence by constituting complexes compounds. Thus, precipitating dietary proteins and digestive enzymes. Flavonoids are well known for their ability to inhibit pain perception (Okwu and Josiah, 2006). Flavonoids as anti-oxidants also have anti-inflammatory properties due to their inhibitory effects on enzymes involved in the production of the chemical mediator of inflammation (Oweyele *et al*., 2005). jatropha leaves extracts were assayed for antioxidant activity by the DPPH assays. The results showed that leaves had value of 13.53. Plant phenolics combine one of the major groups of compounds acting as primary antioxidant or free radical terminators. Synergism of poly-phenolic compounds in the plant extract may contribute to its antioxidant activity. The high antioxidant activity of the extracts could be attributed to the presence of phenolic compounds. In spite of the mechanism of actions of these compounds are unclear, the obtained data could be due to the phenolic compounds had the ability to absorb and neutralize free radicals, quench active oxygen species and decompose superoxide and hydroxyl radicals as well as the flavonoids effects on membrane permeability, and by inhibition of membrane-bound enzymes such as the ATPase and phospholipase A2 (Igbinosa *et al*., 2011). Thus, these compounds decreased the injurious impact of the free radicals.

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