Fundamentals of Renewable Energy and Applications

Sahay and Shyam, J Fundam Renewable Energy Appl 2014, 4:2
http://dx.doi.org/10.4172/2090-4541.1000136

Research Article Open Access

Storage Conditions to Improve the Shelf Life of *Jatropha curcas* Seeds in Terms of Quality of Oil

Sudha Sahay[1]* and M Shyam[2]

[1]*Loyola Centre for Research and Development, Xavier's College Campus, Navrangpura, Ahmedabad – 380 009, Gujarat, India*
[2]*Sardar Patel Renewable Energy Research Institute (SPRERI), Post Box 2, Vallabh Vidhyanagar – 388 120, Gujarat, India*

Abstract

Problem statement: It is known that the chemical composition of oil varies according to the climate and locality. *Jatropha* seeds are the main feed stock available for biodiesel production. Since, *Jatropha* oil is hydroscopic - absorbs water. Also, it is high in acid, has high tendency to degrade quickly, particularly if not handled properly through the supply chain. In the presence of high moisture content, the poly chains of fatty acid (oil) gets oxidized and free fatty acid radicals are generated that deteriorates the oil quality in terms of increased viscosity, reduced trans-esterification; reduced energy efficiency and high corrosion to the IC engines.

Approach: Seeds need to be kept in proper storage conditions, not only to maintain moisture but also to prevent undue degradation and contamination / spoilage due to pest and microbial attack. Exposure to air and moisture must be minimized because that attracts microbes to attack seeds. Our efforts are in the direction to increase shelf life/stability of *Jatropha curcas* seeds in terms of seed contamination / infection caused by insects and pests as well as the quality of oil recovered.

Result: Among all storage parameters the seeds kept at cold temperature i.e. –20 °C showed the significant decrease in FFA percentage in comparison to fresh seed oil and at 10 °C.

Conclusion: Although cold storage proved to be effective to maintain or minimize the oil FFA content, the method was relatively expensive.

Keywords: *Jatropha curcas*; Storage conditions; Alternate fuel; Oil extraction

Introduction

Jatropha oil can be used as alternative fuel and for making biodiesel which overcome energy crisis problem. Various methods have been applied for the *jatropha* oil extraction such as solvent extraction [1], enzymatic extraction [2], mechanical extraction by screw press [3] etc. Studies have been done on the physico-chemical properties of *Jatropha* oil including the fatty acids and TAGs composition of *Jatropha* oil [4]. *Jatropha* seeds and seed oil quality may get deteriorated on storage due to bacteria, moles, enzymatic degradation, oxidation and hydrolysis [5,6]. Therefore, it is important to understand the effect of storage conditions on quality of oil in order to optimize the economically viable storage conditions for storage of oil/seeds. It has been observed that lesser the FFA in raw oil (>1%) the better is the bio-diesel recovery [3]. Higher FFA oil can also be used but the bio-diesel recovery will depend upon oil type and amount of sodium hydroxide used.

An experiment was taken up to determine the optimum storage parameters such as surrounding temperature, seed moisture, types and structure of storage containers and their impact on the *Jatropha* oil quality in terms of FFA content was studied.

Materials and Methods

Seed material

Local *Jatropha curcas* seeds were purchased from Dahod, Gujarat. Damaged seeds were discarded and seeds in good condition were cleaned and dried under the sun for about three days.

Seed Sampling: 50 kg cleaned and dried *Jatropha* seeds were filled in plastic barrels, M S barrels, plastic bags, and jute bags. One set of storage barrels and bags were kept at an ambient temperatures and one set of storage seeds in plastic bags were kept at cold temperatures viz. 10°C and - 20°C. Seeds stored at ambient temperature were tested at every three months interval, whereas, seeds stored at cold temperatures were tested at every five months interval Table 1 to examine the effect of storage time on oil yield from Jatropha seeds and FFA content of *Jatropha* oil. Each time one batch of seeds was procured and oil was extracted.

Oil extraction

Jatropha oil was expelled using 6 bolt baby oil expeller of 50 kg/hr capacity. Electric motor (7.5 kW) powered to the expeller through a belt drive. *Jatropha* seeds were fed manually in the feeder. The blades of feeder gave constant feeding to the expeller shaft through the hopper. The expeller shaft is surrounded by metallic plates such that the solid waste comes from the left end of the expeller and oil comes out from the bottom. Oil which comes out contained a large amount of impurities which was allowed to settle for 24 hrs.

Testing of oil

Acid value (% FFA) of the seed oil was determined as per standard procedure. Approximately 20 g oil was taken into 100 ml glass beaker

***Corresponding author:** Sudha Sahay, Loyola Centre for Research and Development, Xavier's College Campus, Navrangpura, Ahmedabad – 380 009, Gujarat, Tel: +91 11 26591258; E-mail: sudhasahay@rediffmail.com

Received September 10, 2013; **Accepted** September 08, 2014; **Published** September 15, 2014

Citation: Sahay S, Shyam M (2014) Storage Conditions to Improve the Shelf Life of *Jatropha curcas* Seeds in Terms of Quality of Oil. J Fundam Renewable Energy Appl 4: 136. doi: 10.4172/2090-4541.1000136

and 50 ml of 95 % alcohol was added to it and the solution was neutralized with 0.1 N alkali solution using phenophthalein indicator. The content were heated to boiling point and shaken thoroughly, in order to dissolve the free acids as completely as possible. The solution was then cooled and titrated against 0.1N alcoholic caustic potash solution with constant shaking (using phenophthalein as indicator) until the pink color persist after vigorous shaking. End point is supposed to be reached when the pink color persist for 30 seconds.

Calculations

From each oil sample, there were triplicates sets of oil samples were taken for FFA content analysis. Average FFA percentage value was the representative of actual acid value of that respective oil sample. Acid value of seed oil was determined according to AOAC Official Method Cd 3a- 63. Percentage Free Fatty Acids (FFAs) were calculated using oleic acid as a factor.

Statistical analysis

All the data obtained were subjected to Analysis of Variance (ANOVA) and where significant differences were observed, means were separated by the range test (HSD) for different storage parameters.

Result

Oil extracted from the fresh *Jatropha* seeds showed the presence of 1.14% of FFA. Table 2 shows the effect of type of containers, temperatures, and storage time on the FFA content of the *Jatropha* seeds. Oil FFA estimation in the seeds stored in different containers and at ambient temperature, did not show a definite pattern. Up till nine months when seeds were stored at ambient and cold temperatures in different storage containers, there were moro-less similar FFA content in each oil sample. However, on 16 months storage, the maximum FFA were observed in the oil extracted from seeds in jute bags (6.62%) and least in plastic bags (1.46%). FFA content had marginally increased in plastic and MS barrels Figure 1. At cold temperatures where the seeds were kept in the plastic bags, the FFA content did not show a significant variation at 10°C with increase in time, whereas from 5 months to 16 months the FFA content of the oil from seeds kept at –20°C showed a significant decrease in FFA percentage in comparison to the fresh seed oil Figure 2. Our results also showed that the percentage of FFA present in oil was not directly related to the amount of oil recovered at different time period of seed storage. Extracted oil at different time period was stored in the plastic canes kept at ambient temperature. It was observed that older the oil higher the FFA content. FFA content in the stored

S. No.	Months	Storage Period	Seed samples for oil extraction
1	29 Dec-09	0-Fresh	At the time of purchase
2	Mar-10	3-months old	Ambient storage: plastic barrel; MS barrel; plastic bag; jute bag
3	May-10	5-months old	Cold storage: 10°C; - 20°C
4	Jun-10	6-months old	Ambient storage: plastic barrel; MS barrel; plastic bag; jute bag
5	Sep-10	9-months old	Ambient storage: plastic barrel; MS barrel; plastic bag; jute bag
6	Oct-10	10-months old	Cold storage: 10°C; - 20°C
7	Dec-10	12-months old	Ambient storage: plastic barrel; MS barrel; plastic bag; jute bag
8	Apr-11	16-months old	Ambient storage: plastic barrel; MS barrel; plastic bag; jute bag; cold storage: 10°C; - 20°C

Table 1: Period of oil extraction from different *Jatropha* seed samples.

S. No	Storage Parameter	Storage Period				
	Ambient Temp.	Fresh Seeds	3 Months	6 Months	9 Months	16 Months
		Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
1	Plastic Bag	1.14 ± 0.26	0.99 ± 0.04	1.89 ± 0.26	1.55 ± 0.10	1.47 ± 0.07
2	M S Barrel	1.14 ± 0.26	1.32 ± 0.01	1.01 ± 0.05	1.56 ± 0.01	2.08 ± 0.23
3	Plastic Barrel	1.14 ± 0.26	1.44 ± 0.24	1.10 ± 0.22	2.09 ± 0.05	3.13 ± 0.32
4	Jute Bag	1.14 ± 0.26	0.82 ± 0.02	0.66 ± 0.50	1.32 ± 0.12	6.62 ± 0.39
	Cold Temp.		5 Months	10 Months		16 Months
5	Plastic Bag (10°C)	1.14 ± 0.26	1.41 ± 0.07	1.41 ± 0.11		1.36 ± 0.12
6	Plastic Bag (- 20°C)	1.14 ± 0.26	1.56 ± 0.05	1.29 ± 0.24		0.58 ± 0.19

Table 2: Percent FFA in oil extracted from Jatropha seeds kept under different storage parameters.

S. No	Storage Parameter	Oil Storage Period			
		7 Months Old	10 Months Old	13 Months Old	16 Months Old
		Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
1	RT1	1.33 ± 0.11	1.80 ± 0.12	2.71 ± 0.08	3.09 ± 0.32
2	RT2	1.44 ± 0.01	1.84 ± 0.04	2.25 ± 0.05	3.09 ± 0.32
3	RT3	1.52 ± 0.06	1.87 ± 0.28	2.62 ± 0.03	3.09 ± 0.32
4	RT4	1.64 ± 0.02	2.22 ± 0.23	2.93 ± 0.05	3.09 ± 0.32
		7 Months Old		12 Months Old	16 Months Old
5	RT5	2.15 ± 0.09		2.75 ± 0.35	3.09 ± 0.32
6	RT6	1.23 ± 0.15		3.84 ± 0.12	3.09 ± 0.32

Table 3: Percent FFA in Jatropha oil stored at different time period.

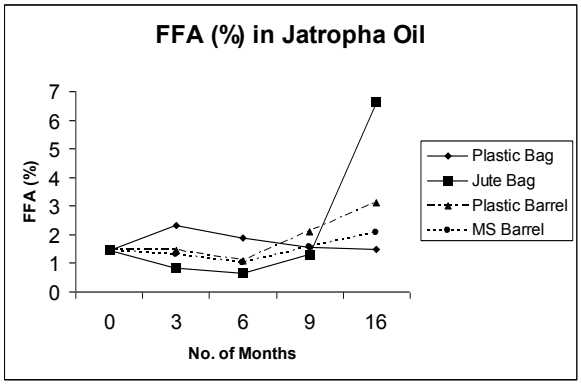

Figure 1: Effect of storage time of *Jatropha* raw oil FFA content where seed stored at ambient temperature in different types of containers.

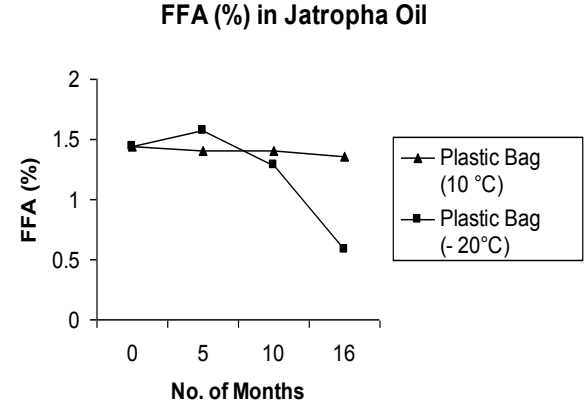

Figure 2: Effect of storage time of Jatropha raw oil FFA content where seed stored at cold temperature in different types of containers.

oil was not related to the original seed storage conditions. Statistical analysis of the mean value was performed using ANOVA. P values for the plastic bags, jute bags, plastic barrels, M S barrels, 10°C, and -20°C was 0.002, <0.0001, <0.0001, <0.0001 , 0.32 and 0.006 respectively. In stored oil the P values for the plastic bags, jute bags, ,Plastic barrels, M S barrels, 10°C, and -20°C was 0.0001, <0.0001, , <0.0001, 0.0003, , 0.052 and 0.0006. HSD test among the treatment group was highly significant at the designated level for <0.01 and <0.05.

Oil samples were stored in plastic cane at ambient temperature. RT 1, RT 2, RT 3, RT 4, RT 5 and RT 6 are the stored oil samples of seeds that were kept in jute bag, plastic bag, MS barrel and plastic barrel at ambient temperature and at 10°C and - 20°C in plastic bags respectively.

Conclusion

At ambient temperature, the level of FFA in the stored seeds did not vary much when they were stored in plastic bags, jute bags and plastic barrels. In Indian conditions upto nine - ten months, we can keep the seeds in any type of container at ambient temperature and maintain the FFA percentage of its oil. It showed increase in FFA content after nine months in steeds stored in MS barrels.

(i) In jute bags, the FFA content was increased after 16 months due to the oxidation reaction, since pore in the jute bags allowed aeration. Also oil of the seeds in plastic bags had less FFA than plastic barrels due to the difference in thickness of container wall.

(ii) In Jatropha seeds stored at cold temperatures level of free fatty acids or acid values in the raw oil remained almost same in the initial period but after one year of storage it reduced significantly at – 20°C.

(iii) Although cold storage proved to be effective to maintain or reduce the oil FFA content, the method was relatively expensive.

Future Scope of Work

Further work can be done in the area of storage stability since no work has been done so far in this area. Storage stability of both *Jatropha* oil and bio-diesel in containers of copper, steel, plastic etc. need could be studied.

Acknowledgement

The authors acknowledge the financial support received from the Indian Council of Agricultural Research, New Delhi and thank the Director, SPRERI for allowing use of various facilities required for conducting the research.

References

1. Sayyar S, Abidin ZZ, Yunus R, Muhammad A (2009) Extraction of oil from *Jatropha* seeds – Optimization and kinetics. Am J Appl Sci 6: 1390-1395.
2. Shah S, Sharma A, Gupta MN (2004) Extraction of oil from *jatropha curcas* L seed kernels by enzyme assisted three phase partitioning. Ind Crop Prod 20: 273-279.
3. Gupta RC, Rao DG (2008) Effect of Storage time on yield and free fatty acid (FFA) content of Raw Jatropha oil. XXXII National Systems Conference, NSC 2008, December 17-19, India 440-443
4. Akbar E, Yaakob Z, Kamarudin SK, Ismail M, Salimon J (2009) Characteristics and composition of *Jatropha curcas* oil seed from Malasia and its potential as biodiesel feedstock. Eur J Sci Res 29: 396-403.
5. Sangha MK, Gupta PK, Thapar VK, Verma SR (2004) Storage studies on plant oils and their methyl esters. J Sci Res Dev 6: 1-15.
6. Diwani GE, Rafie SE, Hawash S (2009) Protection of biodiesel and oil from degradation by natural antioxidants of Egyptian J*atropha*. Int J Environ Sci Tech 6: 369-378.

Citation: Sahay S, Shyam M (2014) Storage Conditions to Improve the Shelf Life of *Jatropha curcas* Seeds in Terms of Quality of Oil. J Fundam Renewable Energy Appl 4: 136. doi: 10.4172/2090-4541.1000136