SEED MOISTURE **JATROPHA**

EFFECT OF SEED MOISTURE ON OIL CONTENT AND PROPERTIES OF *Jatropha curcas* L.

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ABSTRACT

Moisture content is a key determinant of seed physiological quality. Determination of appropriate lowest safe moisture content for *Jatropha curcas* seeds was carried out in order to recover maximum oil with good physico-chemical properties. Simultaneously the effect of moisture reduction on seed viability was also tested. From this study it was deduced that seeds need to be dried to 6% or 5% moisture content to obtain maximum oil percentage. However oil properties were found to be desirable in seeds dried to 6% than that of 5% moisture content. Seed viability was not significantly influenced by reduction in moisture content which shows that drying jatropha seeds to 6% moisture content would favour improved oil recovery of better quality without affecting seed viability.

KEY WORDS: Jatropha oil, Biofuel, Viability, Drying, Curcas seed.

Introduction

Seed drying is the most critical operation after harvesting a seed crop. The purpose of drying is to reduce the moisture content of seeds to a safe level. Delays in drying, incomplete drying or ineffective drying would reduce the seed quality and result in losses regardless of the storage facility used. For prolonged storage the seed moisture content must be as low as possible, however not below the critical moisture level below which the seed would lose its viability. At harvest time the seed contains considerable amount of moisture and higher the moisture content greater is the respiration rate that results in deterioration of the seed. High moisture promotes the development of molds and insect infestation that are harmful to the seed and also lowers germination rate. Therefore, drying of seed is critical to prevent fungal and insect infestation and quality deterioration of the seed (Dadalani *et al.*, 2003).

Seed moisture content is generally stated on a wet weight basis. Tolerance of desiccation in seeds is a multifactorial trait in which the synthesis of protective substances and the control of degradative processes that are induced during dehydration are equally critical. The most documented degradative reaction linked with desiccation sensitivity in seeds is the accumulation of peroxidative damage following drying (Leprince *et al.*, 2000[a]). Free fatty acids accumulate in plant membranes after exposure of plants to environmental stress, such as freezing and desiccation. Fatty acid accumulation has been linked to various biophysical changes and to the occurrence of lipid peroxidation, but the relationships appear complex and inconsistent (Barclay and McKersie, 1994). In desiccation-tolerant seeds, several metabolic parameters indicate that mitochondria experience decreasing oxygen availability when tissues are dried below 0.6 g/g (g water/g dry weight. The cause for this desiccation-induced hypoxia is thought to be an impeded diffusion of oxygen as a result of the exponential increase in viscosity during water loss (Leprince and Hoekstra, 1998). Drying induces disturbances in metabolism associated with the desiccation sensitivity of the tissue well before the loss of membrane integrity (Leprince *et al.*, 2000[b]).

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Table 1

Effect of seed moisture on oil content and physical characteristics of Jatropha oil

Seed moisture Content %	Viscosity at 30°C	Specific gravity	Refractive Index (nD)	Oil %
9 (9.209)	9.322[c]	0.8775[a]	1.466[c]	20.59[b]
8 (8.116)	10.285[b]	0.9095[b]	1.466[c]	21.28[b]
7 (7.283)	8.893[a]	0.8965[b]	1.465[b]	21.26[b]
6 (6.245)	9.714[c]	0.8580[a]	1.463[a]	23.98[a]
5 (4.979)	9.607[c]	0.8565[a]	1.465[b]	26.18[a]
	S.e.d. = 0.148 C.D. = 0.316	S.e.d. = 0.0157 C.D. = 0.0334	S.e.d. = 0.0002 C.D. = 0.0006	S.e.d. = 1.217 C.D. = 2.593

Values followed by the same alphabet do not vary significantly at 5% level of confidence.

Hence drying can influence the quality of oil and other metabolic activities in a seed.

The oil yielding plant, *Jatropha curcas* L. a member of Euphorbiaceae, has been found to be one of the most promising species in India for attaining self-sufficiency in energy (Wani and Sreedevi, 2006). Seeds being one of the successful mode of propagation for *Jatropha curcas,* in addition to being a source of non-edible oil, it demands adequate care for quality improvement. Among the various seed parameters, seed moisture content has been considered the most important factor controlling physiological reaction in seeds, which in turn influences seed viability and oil properties. It is generally considered that seed moisture contents in excess of 12–14% invite fungal invasion thereby promoting seed decay. It is therefore necessary to reduce seed moisture content to the Lowest Safe Moisture Content (LSMC). The present paper aims at identifying the Lowest Safe Moisture Content of *J. curcas* in relation to seed viability and oil properties.

Material and Methods

Seed collection and processing

Black pulpy fruits of *Jatropha curcas* were collected from 20 trees from Attapady (11° 14' N; 76° 48' E), Kerala during July 2007. The fruits were manually processed to extract the seeds. The fresh seeds were bulked and used for the study.

Determination of seed moisture content (MC)

The processed seeds were tested for moisture content on fresh weight basis by oven dry method (ISTA, 1999). The seed moisture content was estimated inclusive of seed coat. Four samples from the same seed lot were drawn and dried to different target moisture contents (8, 7, 6 and 5%). The target weight for drying the seeds was determined using the formula given by DFSC (1999). The seeds were subjected to shade drying at ambient conditions (30±1°C; RH 65%) to attain the targeted weight. The actual moisture contents of the seeds were also determined as per standard procedures recommended by ISTA.

Germination test

Germination study was conducted on sand medium in the nursery (ISTA, 1993). The test was carried out with 4 replications of 25 seeds each. The final count of germination test was taken after 40 days of sowing.

Oil content estimation

The seeds were ground using mortar and pestle and 20 g of coarse seed powder was taken for oil extraction. Commonly used semi-continuous method in Soxhlet apparatus was applied, using Petroleum ether (boiling point: 40-60 °C) as solvent for extraction of oils. In this present study, whole seeds were used for oil extraction. Petroleum ether in the flask was evaporated, the extracted oil was allowed to cool, weighed and expressed as

Table 2

Effect of seed moisture content on chemical characteristics of Jatropha oil

Seed moisture Content %	Acid value mg of KOH	Sap. value mg of KOH	Iodine no. g. of iodine	Perox milliEq/Kg
9 (9.209)	4.49[a]	164.09[b]	118.30[b]	1.8[a]
8 (8.116)	4.49[a]	168.30[b]	145.30[a]	1.4[a]
7 (7.283)	3.37[a]	171.11[a]	149.36[a]	2.6[b]
6 (6.245)	2.81[a]	158.48[c]	140.86[a]	2.0[a]
5 (4.979)	5.61[b]	168.30[b]	147.20[a]	2.2[b]
	S.e.d. = 0.893 C.D. = 1.903	S.e.d. = 3.9 C.D. = 8.31	S.e.d. = 3.85 C.D. = 8.21	S.e.d. = 0.292 C.D. = 0.623

Values followed by the same alphabet do not vary significantly at 5% level of confidence.

percentage The percentage of oil in the sample was calculated as follows.

$$\text{Oil content (\%)} = [(B-A)/C] \times 100$$

A = weight of clean dry flask (g)
B = weight of flask with fat (g)
C = weight of sample (g)

Characterization of oil

Specific gravity of oil was determined at 30 °C using specific gravity bottle. The viscosity (at 30°C) of oil samples was measured using Engler Viscometer and expressed in Degree Engler. The oil samples were subjected to chemical characterization for Acid value (Cox and Pearson, 1962), an important indicator of vegetable oil quality (Kardash and Tur'yan, 2005). Acid value is expressed as the amount of Potassium hydroxide (in milligrams) necessary to neutralize free fatty acids contained in 1 g of oil. Saponification number (Horowitz, 1975) expressed in milligrams of Potassium hydroxide absorbed per gram of oil, is a measure of fatty acid chain length in oils. Iodine value (Horowitz, 1975) expressed in grams of Iodine absorbed per 100 grams of oil, indicates the degree of unsaturation and Peroxide value (Cox and Pearson, 1962) expressed in milli Eq / Kg of oil is an index of fatty acid oxidation.

Statistical analysis

The experiments were carried out in Completely Randomized Design with four replications each. ANOVA was used to test the effect of moisture reduction on oil parameters and seed viability. Means that exhibited significant differences were compared by Duncan's Multiple Range test (α = 0.05) (Panse and Sukhatme, 1995).

Results and Discussion

The values obtained for oil percentage and its physical properties have been presented in *Table-1*. Ranking of the treatments was based on oil percentage. The oil content was found to be significant with values as high as 23.98% and 26.18% respectively, in 6% and 5% MC seeds when compared to other treatments. Between the two, the quality characteristics of oil were relatively low in 5% MC seeds than that of seeds with 6% MC. The oil physical properties, Specific gravity (0.8580) and Refractive Index (1.463) which are the important desirable characteristics of a fuel oil were found to be low and promising in 6% MC seeds. The viscosity of the fuel affects the pumping characteristics and the atomisation of the fuel during injection (droplet spectrum, geometry of the injection stream). As a result of the more difficult flowing, pumping and atomising behaviour, high viscosity may lead to cold-start problems. An increase in viscosity may be an indicator of excessive oxidation or polymerisation of the oil (Thuneke and Kern, 2002).

The chemical characterization of oil under different treatments has been furnished in *Table-2*. Favourable status of chemical properties namely, low Acid value (2.81) and low Peroxide value (2.0) as evidents from the results assign 6% MC seeds

Table 3

Effect of seed moisture content on viability of *Jatropha curcas*

Seed moisture Content %	Germination %
9 (9.209)	85[a]
8 (8.116)	95[a]
7 (7.283)	95[a]
6 (6.245)	83[a]
5 (4.979)	80[a]
S.e.d.	6.83
C.D.	14.56

Values followed by the same alphabet do not vary significantly at 5% level of confidence.

superior to all other treatments. However, better ranking with respect to high Saponification value (171.11) and low Iodine value (118.30) were recorded for 7% and 9% MC treatments respectively. The acid value is an indicator of the content of free fatty acids in plant oil. High acid value in the fuel leads to corrosion, abrasion and deposits in the engine. Furthermore the free fatty acids may react with the alkaline components of the lubricating oil and affect its lubricity. Peroxide value can be a useful early indicator of oxidative deterioration and a decrease in the effectiveness of the oil's own antioxidants. During storage, peroxides are generated by oxygen access. A rise of viscosity and gummy deposits can be the consequence. Furthermore there are indications that plant oils damaged by oxidation may lead to thickening of the oil and therefore to engine damage. The iodine value is an indicator of the amount of fatty acids with double bonds in the oil. A low iodine value indicates a high degree of saturation of the oil. This value gives information about the possible creation of deposits at the injector nozzles and in the combustion chamber, about the storage stability of the oil and its tendency to polymerise, and about the possibility of adverse effects on the oil (Thuneke and Kern, 2002).

The effect of moisture reduction on seed viability is given in *Table-3.* No significant variation in viability was noticed with moisture reduction indicative of active desiccation tolerance in *J. curcas* seeds. However in *Shorea robusta* (Sal) rapid loss of viability was recorded with the reduction in moisture content below the lowest safe moisture content (37%) (Chaitanya and Naithani, 1994). The lowest safe moisture content (LSMC) for *Azadirachta indica* A. Juss (Neem) seeds was found to be 10.9% and a rapid loss of viability was experienced when the seeds were dried below the LSMC (Varghese and Naithani, 2001). In *Helianthus annuus* L. (Sunflower) seeds it has been studied that desiccation does not reduce seed viability and that desiccation to seed moisture between 26 and 33% may increase oil content by 1% while treatment between 55 and 65% may reduce oil content by 3%. Reduction in seed moisture increases the contents of oil (Radic, 2006). Similar results were found in the present study. Hence taking into consideration, the highest oil content and better status for maximum number of desirable oil properties, **6% moisture content treatment is found to be the best and could be recommended as the Lowest Safe Moisture Content** to which jatropha seeds need to be dried.

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The Big Three

The three varieties of melons account for most of the melons eaten, and each is loved for its distinctive flavour.

Watermelon	Cantaloupe	Honeydew
Fresh, wet, mildly sweet	Rich, intensely sweet like honey	Mild, fragrant, slightly sweet
Calories : 30	Calories : 34	Calories : 36
Vitamin C : 8 mg	Vitamin C : 37 mg	Vitamin C : 18 mg
Fiber : 0.4 g	Fiber : 0.9 g	Fiber : 0.8 g