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Effect of storage conditions on *Moringa oleifera* Lam. seed oil: Biodiesel feedstock quality

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ABSTRACT

Moringa seed oil is known as Ben oil. Recently research by several authors illustrated the potential use of Ben oil for biodiesel production. Oil quality is directly related to the physiological condition of the seeds from which it is extracted. Oil extracted from damaged and deteriorated seed can compromise fuel quality. The aim of the study was to investigate the effect of various storage conditions and—duration on *Moringa oleifera* seed oil quantity and quality as a potential source of biodiesel. Firstly, oil was extracted from fresh seeds and stored in dark bottles at room temperature. Secondly, Seeds were stored following a factorial $2 \times 4 \times 3$ experiment with two types of containers (paper and aluminium bags), four temperatures (−19, 4, 20 and 30° C) and three storage periods (6, 12 and 24 months). From the experimental results, it was observed that the oil content of moringa seed did not change significantly ($p < 0.05$) after 12 months of storage but decrease significantly in seed stored at 4 °C in paper bags and those at 20° and 30 °C in aluminium bags at 24 months. The free fatty acid increased significantly ($p < 0.05$) after 12 months at all storage conditions and continued to increase above the recommended value (2%) for biodiesel parent oil at 24 months, except for that of seed stored at −19 °C in aluminium bags. The density of moringa seed oil remained unchanged throughout storage. The viscosity of oil extracted from seed stored in paper bags at −19 °C and that of the oil stored in dark bottle at room temperature decreased significantly at 24 months. Based on these results, moringa seed can be stored at any of the applied conditions for six months, but if they are stored beyond this period, the use of low temperature such as −19 °C and 4 °C and sealed containers are recommended. It is not advisable to store the extracted oil for more than 6 months.

1. Introduction

Moringa seed oil is known as Ben oil. It is considered as a great natural cosmetic emollient based on its tactile property and nearly total absence of colour and odour (Ayerza, 2011). Moringa seed oil can also be used as cooking oil and industrially as a fine machine lubricant (Rahman et al., 2009). Recently, research by several authors illustrated the potential use of ben oil for biodiesel production (Rashid et al., 2008). Moringa oil is said to be highly resistant to oxidation rancification (Tsaknins et al., 1999). Preserving properties of seeds and maintaining the quality of extractable compounds are among the major challenges that have been faced by food industries for many years and recently by biodiesel industries.

Environmental factors such as temperature, light, as well as sowing date and irrigation regime can affect the composition of vegetable oils and therefore their physical and chemical characteristics. The quality of crude oil is also influenced by the storage conditions of seeds before industrial extraction (Martini and Anon, 2005). Storage is done to preserve harvesting quality, but not to improve it (Sisman and Delibas, 2004). The storage problem is exacerbated by storage conditions such as exposure to air, light, temperature and moisture. Oil quality is directly related to the physiological condition of the seeds from which it is extracted (Terigar et al., 2010). Oil extracted from damaged and deteriorated seed can develop volatile acids, high acidity and low stability.

A reduction in oil content of damaged seed was reported by Sathya et al. (2006) who identified hydrolysis and oxidation to be the reasons for the decrease in oil quantity and quality in stored seed. Hydrolysis occurs because of moisture as triglycerides are decomposed and fatty acids are released. Many vegetable oils possess a significant amount of fatty acids with double or triple bonds, rendering oxidative stability a concern, especially when storing oil over an extended period of time (Knothe, 2007).

Several studies have highlighted the effect of environmental conditions on stored vegetable oils. Many authors (Sisman and

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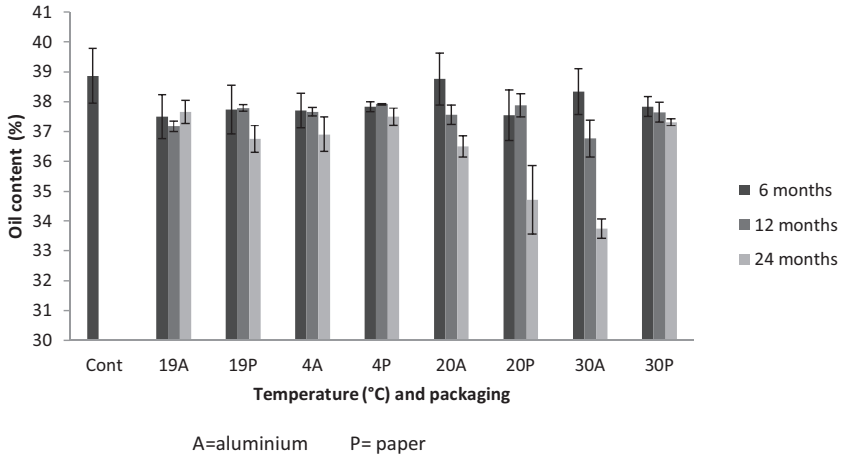

Fig. 1. Oil content of moringa seed stored in aluminium and paper bags at −19°, 4°, 20° and 30° C for 6, 12 and 24 months.

Delibas, 2004; Sisman, 2005 and Martini and Anon, 2005) have reported that an increase in temperature and humidity causes oil degradation and an increase free fatty acids in sunflower oil. This was later confirmed by Tasan et al. (2011) and Abdelmonem and Ahmed Ishag (2012) who observed significant changes in physical and chemical characteristics of sunflower oil, both in stored oil and in fresh oil extracted from stored seeds, irrespective of the extraction method. Similar observations have been reported by Gupta and Rao (2008) with stored *Jatropha* seed oil and by Vujasinovic et al. (2010) with pumpkin seed oil.

Globally, biodiesel quality is being standardized to obtain an end product of good quality, to ensure better criteria of storage, and to successfully commercialize (Atabani et al., 2012; Kandil et al., 2013; Othman and Ngassapa, 2010). Since biodiesel is produced from feedstocks of various origins and qualities, it is important to standardize fuel quality to guarantee an engine performance without hitches. Currently, the properties and qualities of biodiesel must conform to the international biodiesel standard specification. The main specifications are American Standards for Testing Materials (ASTM 6751-3) or the European Union Standard for biodiesel fuel (EN 14214) (Atadashi et al., 2010). Other standards are available globally such as in Germany (DIN 51606) and South Africa (SANS 1935) (Wilson et al., 2005).

The effect of storage conditions on moringa seed oil is not known. The aim of this study is therefore to investigate the effect of various storage conditions and—duration on *Moringa oleifera* seed oil quantity and quality as a potential source of biodiesel.

2. Material and methods

Seeds from pods harvested in an orchard of the Hatfield Experimental Farm of the University of Pretoria (25°45S, 28°16E) from June to October 2012 were used. The experimental design was as follows:

2.1. Experimental procedure

The effect of storage conditions and storage period was assessed by a two-fold experiment:

a Oil was extracted from freshly harvested seeds and samples of 55 ml were stored in triplicates at ambient room temperature (15–25 °C) in dark (to prevent light) glass bottles. Oil quality was assessed at the end of each of three storage periods, 6, 12 and 24 months. This treatment will be referred as "stored oil" in the rest of the paper.

b Seeds were stored following a factorial 2 × 4 × 3 experiment with two types of storage containers (open paper bags (P) and sealed aluminium bags (A), four temperatures (−19, 4, 20 and 30 °C) and three storage periods (six (6), 12 and 24 months). Each treatment was stored in triplicate, with each replicate consisting of about

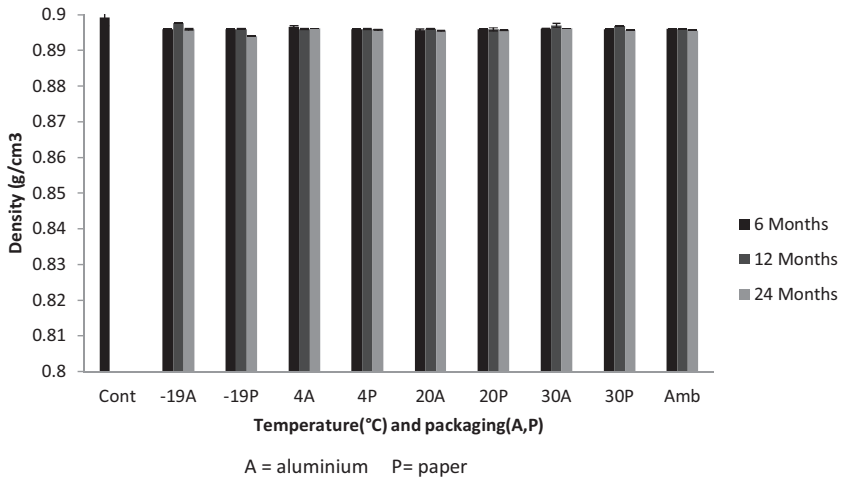

Fig. 2. Density of moringa seed oil stored in aluminium and paper bags at −19°, 4°, 20° and 30° C for 6, 12 and 24 months.