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SHORT COMMUNICATION

QUALITY AND FATTY ACIDS OF COCONUT OIL UNDER DIFFERENT CONDITIONS AND DURATION OF STORAGE

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Unrefined coconut oil is susceptible to oxidative and microbial rancidity, leading to objectionable flavour and reduction in shelf-life and resulting in economic loss. To analyse the fatty acid profile and free fatty acids (FFAs) in coconut oil during storage, oil was stored in different containers viz. transparent glass bottles, transparent plastic bottles, opaque bottles and brown glass bottle, and treated with additives viz., NaCl (1%), citric acid (100 ppm) and tamarind (5%). The fatty acid profile and FFA content in oil were estimated in each treatment at monthly interval for five months of storage. The results indicate that during storage, the small and medium chain fatty acids are degraded to form the FFAs. Additives such as citric acid (100 ppm) or common salt- NaCl (1%) prolonged shelf-life with least increase in FFAs. The study recommends that addition of NaCl to oil can be a better practice for storing oil instead of addition of tamarind, a traditional household practice.

***Key words*: Coconut oil, storage conditions, free fatty acids, fatty acid profile**

The main economically important product from coconut is oil. Studies have shown that copra contains an average of 65-69% of oil and used for various purposes, that is, edible (39.4%), toiletry (46.5%) and other industrial (14.1%) uses. Coconut oil is rich in saturated fatty acids, mainly lauric and myristic acids (Naresh Kumar 2011, Naresh Kumar *et al.* 2000). When compared with other leading vegetable oils, coconut oil is low in unsaturated and polyunsaturated fatty acids. The saponification value of the oil is highest (251-263), while iodine value is lowest (8-9.6). Among the vegetable oils, it contains the highest percentage of glycerol. The general fatty acid composition of coconut oil is caproic acid (C6) 0.36%, caprylic acid (C8) 4.5%, capric acid (C10) 3.6%, lauric acid (C12) 48%, myristic acid (C14) 19%, palmitic acid (C16:0) 8.5%, stearic acid (C18:0) 3.2%, oleic acid (C18:1) 6.7% and linoleic acid (C18:2) 1.6% (Naresh Kumar *et al.* 2000, 2004). Variability among the coconut cultivars for fatty acid composition has been reported (Naresh Kumar 2011), and the most suitable cultivars for different uses have been identified (Naresh Kumar *et al.* 2000, 2004, Naresh Kumar 2011).

Studies on changes in coconut oil quality during storage are scarce and none exist on fatty acids. In sunflower oil, oleic acid increased gradually during storage, whereas linoleic and linolenic acids showed decreasing pattern and earthen containers were found to be the best packaging material for the safe storage of oil (Abidi and Singh 1999). Quality of copra was better in coconuts dipped in a solution containing sodium

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hydroxide or sodium bicarbonate. Advantages of chemical treatments were especially noticeable when drying conditions were poor. Effects of treatments on quality of copra and coconut oil have also been determined (Reddy *et al*. 1981). Presence of microorganisms has been reported to increase free fatty acid (FFA) content in coconut oil (Sringam and Netiwar Anon 1990). The storage time and moisture are positive factors in the production of rancidity. The effects of drying-air temperature up to 100°C and position of halved de-husked coconuts with respect to the direction of the air stream have been investigated (Guarte *et al.* 1996) and found that neither drying temperature nor nut position significantly affected the quality or fatty acid composition of coconut oil. Later studies also found that the copra drying temperatures did not influence the fatty acid composition up to 110°C except for some long chain fatty acids, in very low concentrations (Naresh Kumar 2005). The results suggested that a drying temperature of 90°C is the optimum for production of high quality copra and coconut oil in the shortest drying time. Since no information is available on variation in fatty acid composition in coconut oil and changes in oil quality during storage, the present experiment was planned to address the above mentioned gaps.

In order to determine the changes in oil quality during storage, coconut oil was stored in different containers with three treatments for 5 months. Earlier studies indicated that citric acid (500 ppm), tamarind (2%) and common salt (1%) were effective in prolonging the shelf-life of coconut oil (Chempakam *et al.* 2000). Thus, in this experiment those effective treatments were considered. The details of the storage conditions and treatment of oil in this experimental setup were T1 – stored in transparent glass bottle (control), T2 – treated with 1% NaCl stored in transparent glass bottle, T3 – treated with citric acid (100 ppm) stored in transparent glass bottle, T4 – treated with tamarind (5%) stored in transparent glass bottle, T5 – stored in plastic transparent bottle, T6 – stored in plastic opaque bottle, T7 – stored in brown glass bottle. All treatments were maintained and samples were analysed in three replications. The oil quality parameters such as fatty acid profile and FFA contents were estimated in samples from each treatment at monthly interval. The FFA values are expressed on NaOH equivalent basis multiplied by a factor 10.

Oil samples from different storage conditions were methyl esterified following the method of Padua-Resurrection and Benzon (1979) for determining the fatty acid profile. Methyl esterified sample (1ìl) was injected into the Gas Chromatograph (GC-2010, Shimadju, Japan), fitted with auto injector and capillary column (BPX-70). Elutants were detected on flame ionization detector (FID). The run conditions were maintained as reported earlier (Naresh Kumar 2007). Chromatograms were compared to record the variation in the fatty acid profile. Fatty acid profile was analysed during first, second and third month of storage. Biochemical changes in oil during storage were determined through the estimation of FFA value of each sample following the procedure described by Cox and Pearson (1962). FFA value was estimated at monthly interval up to 5 months of storage period. All the above data were statistically analysed using SPSS (V.10) software following completely randomized design. The standard error of means was calculated and means were compared at p=0.05 using the critical difference.

The quality of oil depends not only on the quality of copra, but also on storage conditions of milling copra and extracted oil too. Unrefined coconut oil is vulnerable to oxidative and microbial rancidity. This is accelerated by the presence of initial moisture and the action of air, light and lipid splitting enzymes. Rancidity leads to objectionable flavour due to the accumulation of decomposition products of oxidation reaction. Rancidity can be due to oxidation (oxidative rancidity) or due to enzymatic activity (enzymatic rancidity) or due to exposure to moisture (hydrolytic rancidity).

Results from storage experiments indicated that oil stored without any treatment accumulated high FFA than under various treatments (Fig. 1a). Coconut oil treated with either citric acid or common salt showed longer shelf-life which was reflected in the lower FFA value. Oil stored in brown glass bottles and plastic opaque containers maintained quality for longer periods as indicated by less FFA value than the oil stored in other containers. FFA values increased during storage period and this increase was more in control, whereas it is less in oil treated with 1% NaCl or 100 ppm citric acid.

The percentage increase in FFA over initial values were calculated and shown in Fig. 1b. In control,

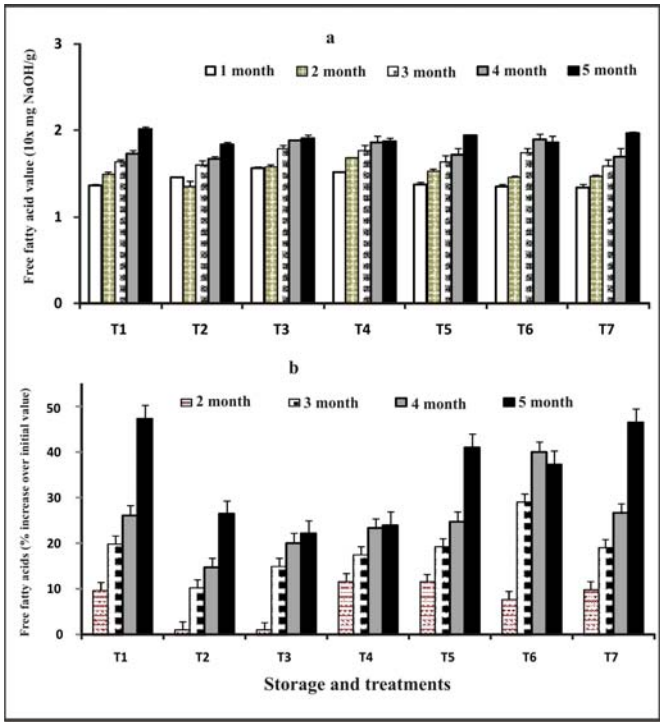

Fig. 1. (a) Variation in free fatty acid value (in 10 x mg NaOH/ g equivalents) and (b) percentage variation in free fatty acid values from initial values in coconut oil with different treatments during five months of storage. T1– stored in transparent glass bottle (control), T2– treated with 1% NaCl and stored in transparent glass bottle, T3– treated with citric acid (100 ppm) and stored in transparent glass bottle, T4– treated with tamarind (5%) and stored in transparent glass bottle, T5– stored in plastic transparent bottle, T6 – stored in plastic opaque bottle, T7– stored in brown glass bottle

percentage increase of FFA ranged from 9.7% to 47.3% during the storage period over initial FFA value. Thus during the 5^{th} month of storage, the FFA value was more than that of the initial period. However, in oil treated with 1% NaCl (T2), the FFA value increased by 1.1% after 2 months and by 26.5% by the end of 5^{th} month of storage over initial values. When compared with other treatments, variation in FFA value was less in oil treated with 100 ppm citric acid with change in FFA value over initial period varied from 1% to 22.2% during storage period of 5 months. In T4 (5% tamarind), FFA value changed by 11.6% to 24% over initial values during storage period. Increase in FFA over initial value was more in control followed by oil kept in either brown glass bottle, plastic transparent bottle or plastic opaque bottle, and oil treated either with 5% tamarind, 1% NaCl or 100 ppm citric acid.

Data on changes in fatty acid profile during storage of coconut oil indicated that among the coconut oil samples with different treatments, there was no significant variation in the percentage of small and medium chain fatty acids (SMCFAs) (Fig. 2). The SMCFAs were more in oil stored in brown glass bottles, but decreased slightly by the end of 3 months of storage. In most of the treatments, the percentage of SMCFAs decreased marginally during storage. The percentage of long chain saturated fatty acids and that too of long chain unsaturated fatty acids varied slightly during the storage period, however, the changes were not significant. The results indicate that during storage, the SMCFAs were degraded to form the FFAs. However, the degradation was very less compared to reported changes in fatty acid profile during storage in safflower oil (Abidi and Singh 1999). One reason may be that in coconut oil percentage of linoleic and linolenic acids, both of which are unsaturated long chain fatty acids, is very less (about 1.5% and 0.2%, respectively) as compared to that of safflower oil. Presence of high percentage of saturated fatty acids seems to render stability to coconut oil.

Coconut oil treated with 100 ppm citric acid contained less FFAs than other treatments. This may be attributed to the inhibiting effect of citric acid on the oxidation reactions. Degradation in the oil quality might be due to the loss of natural antioxidants in the oil during storage (Manalac *et al.* 1967). The presence of natural antioxidants like vitamin C and â- carotene in oil prevent the rancidity in oil. Loss of neutral oil was also reported (Petrauskaite *et al.* 2000) during the chemical treatments and mechanical treatments of oil. Stability of coconut oil increased when they were treated with BHA, BHT and citrate (Fritsch 1971). Similar observations were recorded in the current study as well. The study also indicate that addition of NaCl to oil can be a better practice for storing oil instead of addition of tamarind, a traditional practice. It was observed that the among the containers, oil stored in brown glass bottle and plastic non-transparent bottles had less change in FFA value and retained its quality for 5 months. Storage in brown glass containers prevents oxidation of lipids by rays of

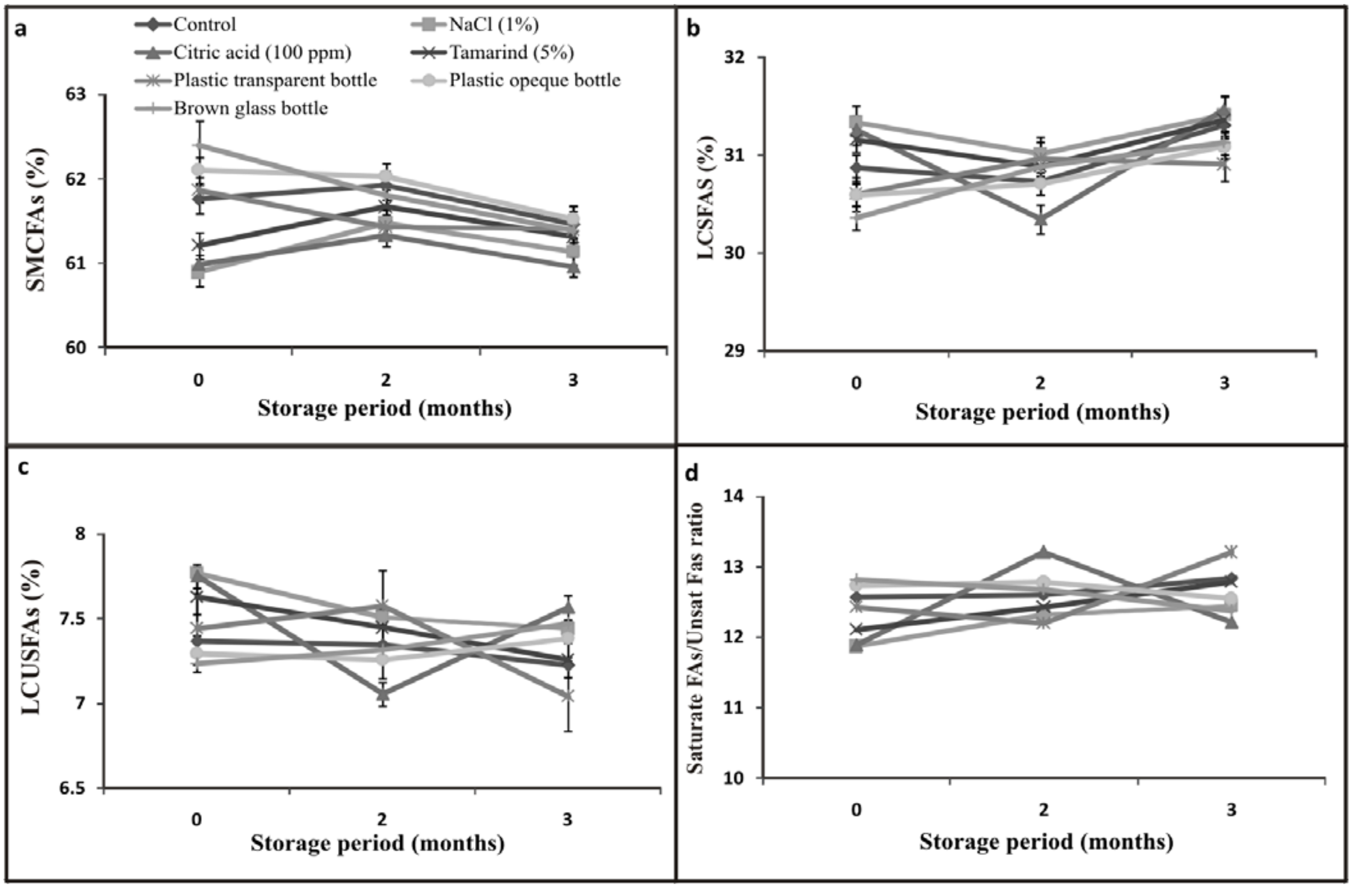

Fig. 2. Variation of (a) small and medium chain fatty acids (SMCFAs), (b) long chain saturated fatty acids (LCSFAs), (c) long chain unsaturated fatty acids (LCUSFAs) and (d) saturated/unsaturated fatty acid ratio of coconut oil under different treatments and duration of storage

light. Sunflower oil stored in brown glass bottle has less FFA value than the other containers (Nasirullah and Nagaraja 2006), while storage conditions and packaging materials influenced fatty acid composition of safflower oil (Abidi and Singh 1999). The findings of this study suggest that storage in brown glass bottles and plastic opaque bottles provides longer shelf-life of coconut oil. However, treatment of oil with citric acid (100 ppm) or with common salt- NaCl (1%) may prolong further shelf-life with less increase in FFAs.

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