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Stability Studies on Refined Soybean Oil Stored in Various Conditions

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Abstract: The 12 months stability study of freshly produced refined soybean oil revealed that refined soybean oil stored in plastic containers in dark was more hydrolytically and oxidatively stable than that stored in other containers in light condition. There was no significant difference at $P < 0.05$ in free fatty acids and acid value of oil stored under light and dark conditions in tin and glass containers but there was significant difference at $P < 0.05$ in peroxide value of oil stored in light and dark conditions in all the storage containers. Light increased the degree of oxidative rancidity of refined soybean oil, the most in tin containers, followed by glass containers and the least in plastic containers.

Keywords: soybean oil, light and dark conditions, stability study

Introduction

Soybean (*Glycine max*) is native to the North-eastern Asia and was first introduced into the United State in 1765 (Soybean Research Advisory Institute, 1984). Soybean is the world largest oil seed crop, with about 13 million metric tons of oil produced per year (Patterson, 1989). In the growing season of 2002-2003, 30.6 million metric tons of soybean oil was produced worldwide, constituting about half of the worldwide edible vegetable oil production (USDA, 2004). Presently, United States is known to be the largest producer of soybean and soybean oil in the world (ASA,1996;Compton, 1995).

In production of soybean oil, soybeans are cracked, adjusted for moisture content (bean-conditioning), rolled into flakes and extracted with commercial hexane. The oil is then refined and blended for different applications and sometimes hydrogenated. Soybean oil is consumed by humans as well as used in industry for technical purposes e.g. as anti-corrosion agent, anti-static agent, disinfectant, fungicide, pesticide, dust control agent and in making of printing inks (Bernard and Xue, 2004; Fradin and Day, 2002; Erickson *et al.*, 1980).

Due to good organoleptic nature, there has been increasing demand of soybean oil in Nigeria which has invariably led to its scarcity, especially during off-season of the crop (March-September). In most cases, oil merchants buy it when it is relatively cheaper and available (during October-February) and store it indiscriminately in plastic, glass and tin containers without considering the deleterious effect of the containers in the long run on the quality of the oil; the oil is later sold when it becomes expensive (during off-season) in order to make much profit. For economic reasons, some housewives also buy it in large quantities, when it is cheaper and store in various kind of containers, either inside the cupboard (in dark) or on the cooking table (in light) for further domestic and ceremonial uses. In supermarket, the oil is placed on shelves with the illuminated fluorescent light and in local market the oil is placed or sold under the sun (in daylight) without necessarily considering the effects of these conditions on the quality and shelf life of the oil.

Extensive work has been done on extraction (Carlson and Scott, 1991; Scott, 1991; Mounts and Pryde, 1983; Allen *et al.*, 1982), purification and refining (Gunstone and Norris, 1983; Erickson *et al.*, 1980; Bernardini, 1973), physicochemical properties and fatty acid composition of soybean oil (Howard, 1997; Lawson, 1995; Ziller, 1994).

Focus of the present research work was finding the effect of light and dark storage conditions on some quality parameters (free fatty acid, acid value, peroxide value and iodine value) of refined soybean oil stored in different containers (tin, plastic and glass bottles) over a period of twelve months.

Materials and Methods

Refined soybean oil used for this research was obtained from one of the popular vegetable oil companies in the south-western part of Nigeria. Fresh oil was obtained, after production, from the deodoriser at the refinery section of the factory. Two sets of three different containers (tin, greenish glass bottle and whitish transparent plastic bottles) were obtained, washed, cleansed and dried. The containers were of equal capacity (500 ml); each container was filled with 450 ml of

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refined soybean oil leaving 50 ml air space. A set of three different containers, containing oil, was kept in the dark (cupboard) at temperature 26-30 °C and the other set was kept in the light (on laboratory bench) at temperature 27-33 °C for a period of twelve months.

The quality parameters (free fatty acid content, acid value, peroxide value and iodine value) were determined using standard methods (AOCS, 1989). These parameters were monitored monthly for a period of twelve months. All chemicals used in this analysis were of analytical grade.

Statistical Analysis. The results were compared by one-way analysis of variance (one-way ANOVA) to test for significant differences. Means of the group were compared using Duncan Multiple Range Test (DMRT).

Results and Discussion

Mean value of free fatty acid (FFA), acid value (AV), peroxide value (PV) and iodine value (IV) of refined soybean oil stored in tin, greenish glass bottle and whitish transparent plastic bottle in light and dark conditions for a period of twelve months are given in Table 1. It was found that free fatty acid content and acid value of refined soybean oil were linearly correlated in the storage conditions. However, there was no significant difference at $P < 0.05$ in FFA values and AV of the oil stored in light and dark conditions in tin and glass containers but the reverse trend was observed in plastic containers. Overall assessment of storage conditions revealed that refined soybean oil stored in plastic containers had the least value of FFA and AV while oil stored in tin containers had the highest values of FFA and AV. According to Ihekoronye and Ngoddy (1985) the FFA value and AV of any lipid are measure of hydrolytic rancidity; the higher the values of FFA and AVs of lipid, the higher the degree of hydrolytic rancidity. Therefore, hydrolytic rancidity of refined soybean oil decreases in the order of storage containers: tin > glass > plastic.

The PV of refined soybean oil stored in light (27-33 °C) and dark (26-30 °C) conditions in all the storage containers are significantly different at $P < 0.05$. The IV of the oil was not significantly different in the storage conditions except for tin containers in light and plastic containers in dark. The PV and IV showed that the two parameters are inversely correlated and both are measure of primary products of lipid oxidation (Amir *et al.,* 2005; Rossel, 1994). The storage condition that had the highest PV gave the least IV and *vice versa.* The oxidative rancidity of refined soybean oil stored in dark (26-30 °C) was remarkably lower than that stored in light (27-33 °C) due to lower mean PV and higher mean IV. In both light and dark conditions, refined soybean oil in plastic containers was the most oxidatively stable while that in tin containers was the least oxidatively stable. The oxidative rancidity of the oil increased in the storage conditions in the order: plastic dark < glass dark < tin dark < plastic light < glass light < tin light.

It may be seen that both the FFA value and AV followed the same trend during the storage. During the first four months of storage, the FFA value and AV of the oil in all the storage conditions were constant indicating the induction period, while during the last five months of storage, there was sudden increase in FFA value and AV of oil in all the storage conditions. The sudden increase was well pronounced in tin containers followed by glass bottles and the least in plastic containers. Thus, the hydrolytic rancidity of refined soybean oil decreased in order of storage condition: plastic light < plastic dark < glass dark < glass light < tin light < tin dark.

Figures 3 and 4 present PV and IV, respectively, of the stored refined soybean oil. The plot in Fig. 3 resembles the PV plot reported by Zalejska - Fiolka (2001) for effect of garlic extract

Table 1. Mean values of some quality parameters of refined soybean oil stored in various conditions for twelve months

	Storage conditions (Mean value ± standard deviation)			
	Free fatty acid (% oleic acid)	Acid value (mg KOH/g oil)	Peroxide value (meq/kg oil)	Iodine value (Wijs)
Tin light	0.34 ± 0.91^{d}	0.67 ± 0.37^{d}	161.40 ± 142.02^{f}	136.24 ± 5.69^{a}
Tin dark	0.35 ± 0.22^{d}	0.68 ± 0.42^{d}	72.41 ± 50.89^{d}	139.80 ± 2.05^{b}
Glass light	0.30 ± 0.16^{c}	0.59 ± 0.30^{c}	92.20 ± 75.61^{e}	138.98 ± 3.07^{b}
Glass dark	0.30 ± 0.15^{c}	0.59 ± 0.31^{c}	43.67 ± 26.00^{b}	140.97 ± 1.05^{b}
Plastic light	0.24 ± 0.11^{a}	0.47 ± 0.22^{a}	53.52 ± 25.03^{c}	140.56 ± 1.47^{b}
Plastic dark	0.26 ± 0.13^{b}	0.51 ± 0.24^{b}	37.20 ± 20.56^{a}	141.13 ± 1.06^{c}

Within each column, mean values followed by the same superscript are not significantly different at $P<0.05$ level (DMRT).

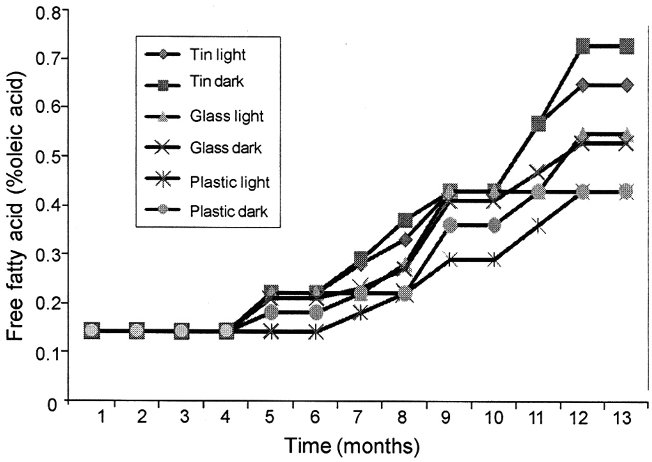

Fig. 1. Free fatty acid of refined soybean oil stored in various containers in light and dark conditions.

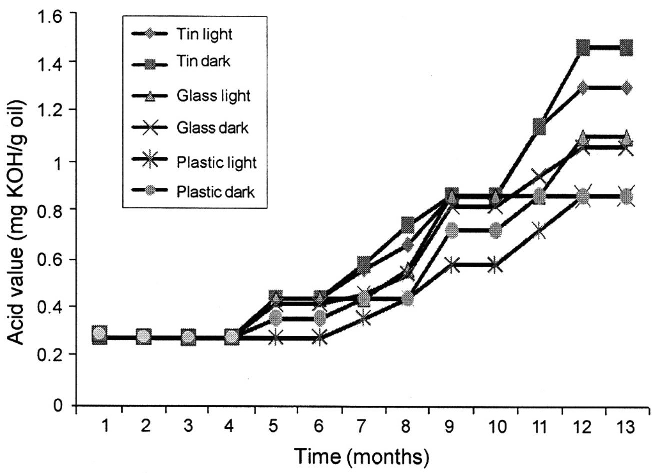

Fig. 2. Acid value of refined soybean oil stored in various containers in light and dark conditions.

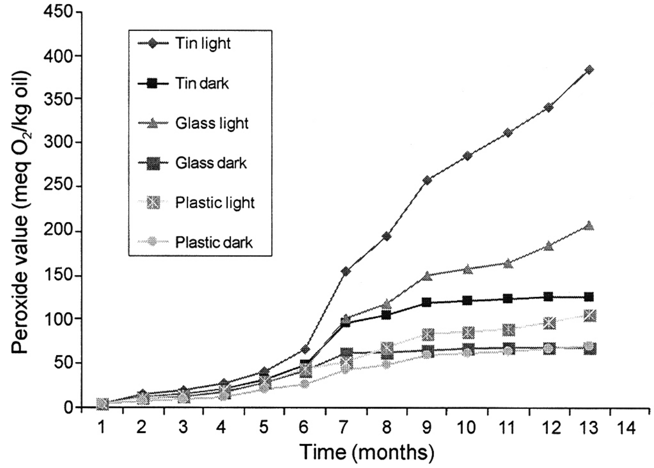

Fig. 3. Peroxide value of refined soybean oil stored in various containers in light and dark conditions.

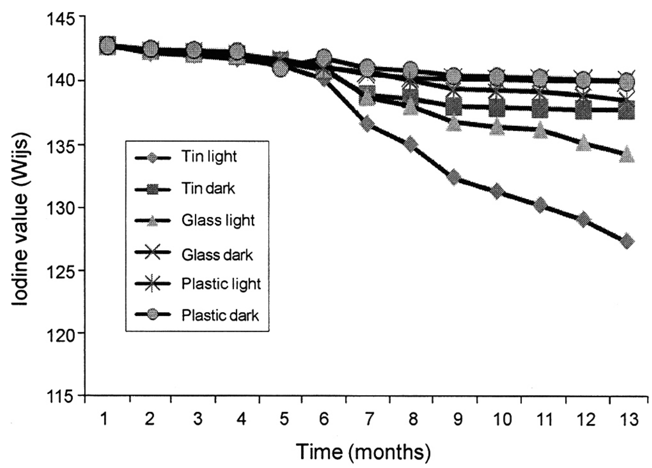

Fig. 4. Iodine value of refined soybean oil stored in various containers in light and dark conditions.

on the olive and peanut oil at 30°C and 60°C and the plot of PV of stored pistachio nut at different temperatures as illustrated by Maskan and Karatas (1998). It was observed that as the PV of the oil samples increased, the IV decreased in all the storage conditions. This may be attributed to the reduction in the number of unsaturated double bonds in the hydrocarbon chain structure of the oil with the increase in oxidation thereby limiting the double bond sites for iodine reaction (iodination). In all the storage containers, the PV was remarkably less in dark than in light, although the reverse trend was observed in IV. Since both the PV and the IV are measure of oxidative stability of lipids (Amir *et al.,* 2005; Rossel, 1994), the overall assessment reveals that oxidative rancidity of refined soybean oil increases in the order of storage conditions: plastic dark < glass dark < tin dark < plastic light < glass light < tin light.

Conclusion

Light and dark conditions affect the free fatty acid value, peroxide value and iodine value of refined soybean oil in varying degrees. The nature of storage containers seriously affect the quality parameters of the oil. Refined soybean oil is much more stable in dark condition and in plastic containers. Refined soybean oil is prone to oxidative rancidity than hydrolytic rancidity in all the storage containers and conditions. However, there remains room for further investigations of the effect of different shades (colours) of containers (tin, glass and plastic) on the quality parameters of crude and refined vegetable oils.

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