Thermal Stability of *Thevetia peruviana* Juss Seed Oil

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ABSTRACT: *Thevetia peruviana* seed showed characteristic changes in physicochemical properties when heated at 180, 200, and 220°C over a period of 15 h. There is no striking significant difference in the five parameters (iodine value, acid value, peroxide value, saponification value, and polar compounds) studied for the three working temperatures. Thevetia seed oil showed good thermal stability and will be a good frying and cooking oil.

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KEY WORDS: Acid value, iodine value, peroxide value, physicochemical properties, polar compounds, saponification value, thermal stability, Thevetia seed oil.

Thevetia peruviana Juss seed contains about 60% oil with an iodine value (IV) of about 85 and an unsaturated fatty acids content of about 60%. A plant at peak production will supply 300–500 g of oil annually. Thevetia is grown as an ornamental plant. The oil has been shown to be a good alternative to palm oil in poultry diets (1). The utility or commercial potential of the oil, like other unsaturated oils, will depend on its thermal stability. Oils used in cooking, frying, or static heating undergo various chemical and physical changes that contribute to the deterioration of the oil (2–5). To date, there are no reports on either the use of Thevetia seed oil in frying or its response to static thermal treatment. We have carried out this study to evaluate the oxidative changes involved when Thevetia seed oil is heated to frying temperatures.

MATERIALS AND METHODS

Fruits collected from plants growing in the same location were processed to obtain seeds, which were crushed and extracted for the oil with petroleum ether (60–80°C) by Soxhlet extraction. One-liter portions of the oil in beakers properly lagged were heated in air on an electric hot plate. Oil samples were heated at 180, 200, and 220°C for 6 h each day for a total of 15 h. The temperatures kept constant with a variation of less than 2°C in each case. Portions (50 mL) of each oil sample, removed at three-hour intervals, were kept in stoppered bottles and were stored in the dark until the sample was required for analysis. Groundnuts, purchased from a local market, were roasted at 120°C, crushed, and extracted with petroleum ether (60–80°C) by the Soxhlet extraction; the oil, which served as control, was heated at 180°C only. AOAC official methods (6) were used for the determination of acid value (AV; expressed as oleic acid), IV, peroxide value (PV), saponification value (SV), and ultraviolet (UV) absorbance. Polar compounds percentages were determined by the silica gel column chromatographic method of Billek and co-workers (7). Portions (100 mg) of each heated oil sample were reacted with one drop of 2M 2,4-dinitrophenyl hydrazine in 2/mL ethanol, refluxed in steam for 15 min, then worked up to obtain crude products that were chromatographed to eliminate unreacted hydrazine. UV absorption of each product was carried out in CCl_4.

RESULTS AND DISCUSSION

Decreases in the IVs for the oil samples heated at the three temperatures followed the expected general pattern. The variation followed a common trend that is characteristic of unsaturated oils; groundnut oil served as a standard (Fig. 1). For frying temperatures between 170 and 190°C, the oil samples heated to 180°C show a significant decrease ($P < 0.05$) in the IV. The decrease in IV for each heated oil sample is 23, 12, and 10 for heating at 180, 200, and 220°C, respectively. Corresponding increases in PV for the three working temperatures conform with the standard increase for unsaturated oils. Each sample showed a steady increase in PV up to the ninth hour of heating; thereafter there was a decrease. The decrease is insignificant for oil samples heated to 200 and 220°C. The pattern for the change in PV of each oil sample followed a similar trend as reported for soybean oil that was subjected to microwave heating (4). The oil sample heated to 220°C had values that were significantly lower and of a closer range than the other two treatments. Sebedio *et al.* (2,3) and Saidai and Hammond (8) have shown that peroxides form ketols which, at higher temperatures, react to form unsaturated ketones. Furthermore, unheated Thevetia seed oil showed no absorption in the UV spectrum, whereas each heated oil sample absorbed with varying intensities at λ_{max} of 260 and 265 nm. The absorption intensities of the bands are highest for oil

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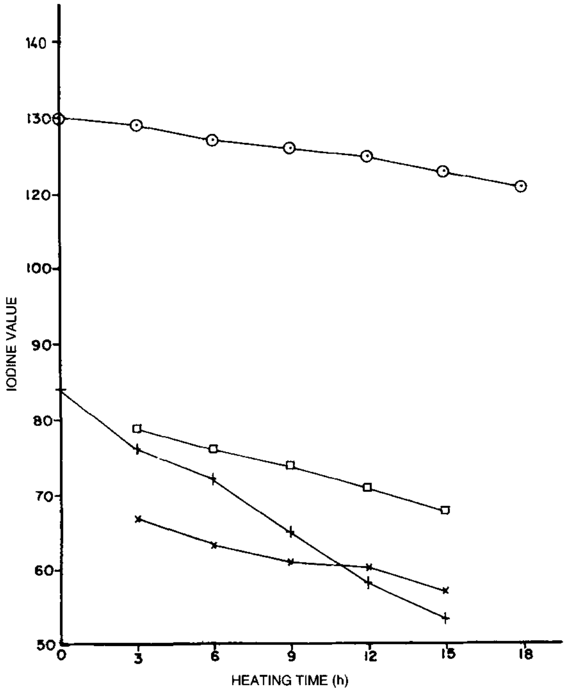

FIG. 1. Effect of heating time on iodine value of the oils. Groundnut oil at 180°C (○); Thevetia seed oil at 180°C (+), at 200°C (*), and at 220°C (□).

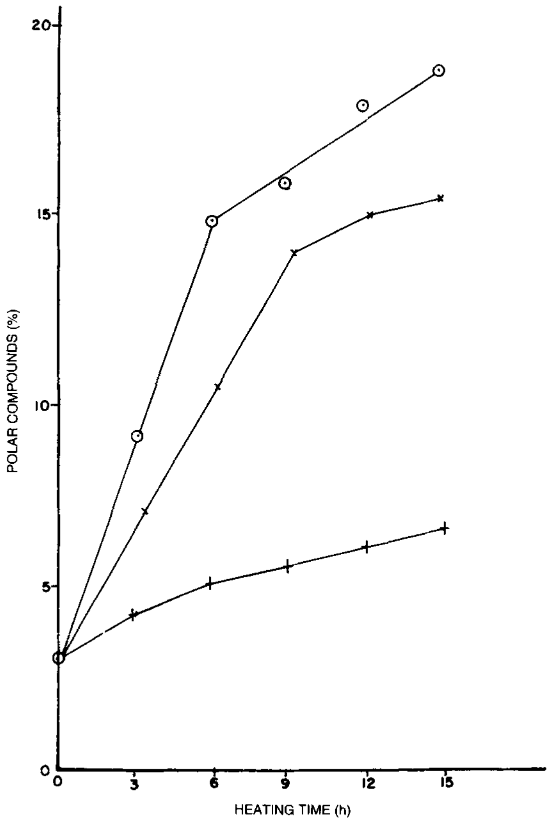

FIG. 2. Effect of heating time on polar compound of Thevetia seed oil at 180°C (○), at 200°C (*), and at 220°C (+).

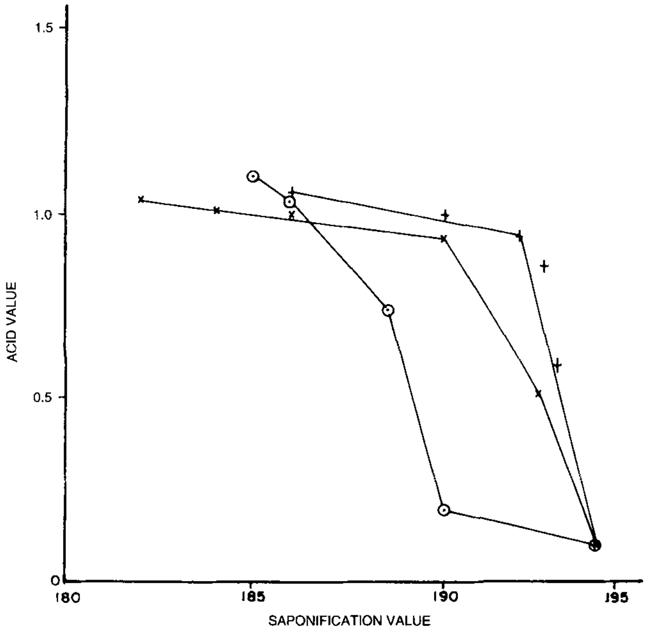

FIG. 3. Correlation between acid value and saponification value of Thevetia seed oil at 180°C (○), at 200°C (*), and at 220°C (+).

samples heated to 220°C and lowest for the oil samples heated to 180°C. The absorption band at 265 nm is common to all heated oil samples; Przybylski and Hongen (9) associated this band with unsaturation and carbonyl. The hydrazones obtained in each heated oil sample had UV absorption bands at 265 and 350 nm. The latter band is assigned to the phenylhydrazine moiety, and this confirms the formation of carbonyl functions in each heated oil sample. Additional information in support of formation of carbonyl and possibly unsaturation functionalities, particularly in the oil sample heated to 220°C, is obtained from the polar compounds (Fig. 2) and their UV absorption. The compounds showed adsorption at 340 and 260 nm. There is an increase in the amount of polar compounds as temperature and heating time were increased. This agrees with performance of sunflower oil, with polar compounds ranging from 6.2 ± 0.3 to 18.7 ± 0.8%. Figure 3 presents a good correlation between SV and AV for each oil sample heated at the three temperatures. In general, there is a decrease in SV (Fig. 4) for each oil sample and a corresponding increase in AV (Fig. 5). This is particularly true for the oil heated up to the ninth hour. The gradient of AV increase is generally lower than the sixth hour at 200 and 220°C and the ninth hour at 180°C of heating of Thevetia seed oil. Sunflower oil and soybean oil, when heated with or without added free fatty acids, have been reported to show linear increases in their AV. Samchez *et al.* (5) suggested that thermoxidative, rather than hydrolytic processes, occurred in the oil that resulted in a continuous production of free fatty acids. Heated Thevetia seed oil has shown a similar linear increase in AV. When this is related to the good correlation between the pairs of IV and PV (Fig. 6) of SV and AV (Fig. 3), it can be concluded that thermoxidative processes occurred in our oil during its thermal treatment. Whatever the process, Theve-

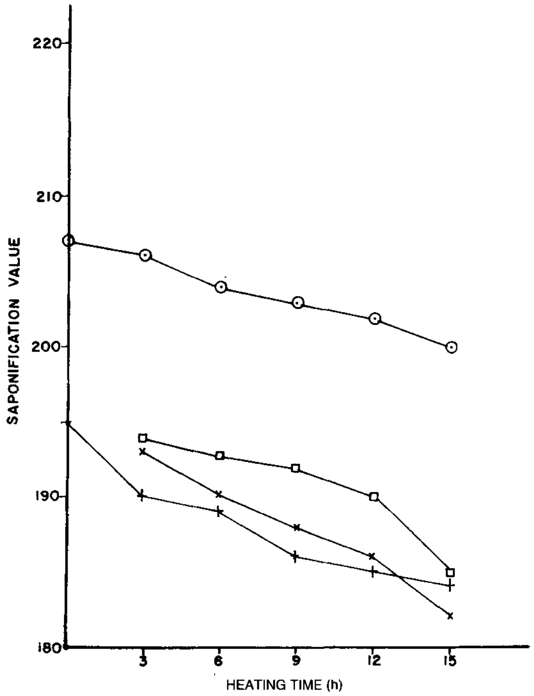

FIG. 4. Effect of heating time on saponification value of groundnut oil at 180°C (⊙), and of Thevetia seed oil at 180°C (+), at 200°C (*), and at 220°C (□).

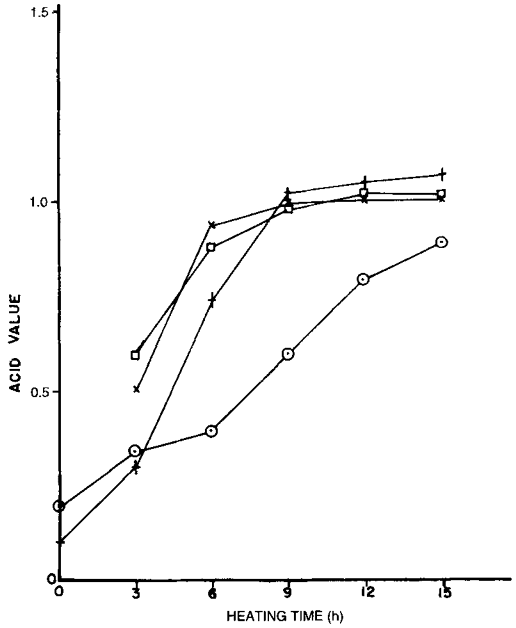

FIG. 5. Effect of heating time on acid value of oils. Groundnut oil at 180°C (⊙); Thevetia seed oil at 180°C (+), at 200°C (*), and at 220°C (□).

tia seed oil is stable to thermal treatment because the concentration of total polar compounds (2–18%, Fig. 2) is low compared with the total polar compounds in heated refined olein (0.6–4%). It has been widely accepted that the total amount of polar materials is the most reliable parameter for measuring fat deterioration during frying (10). Furthermore, sunflower oil, soybean oil, and low-erucic acid rapeseed oil kept

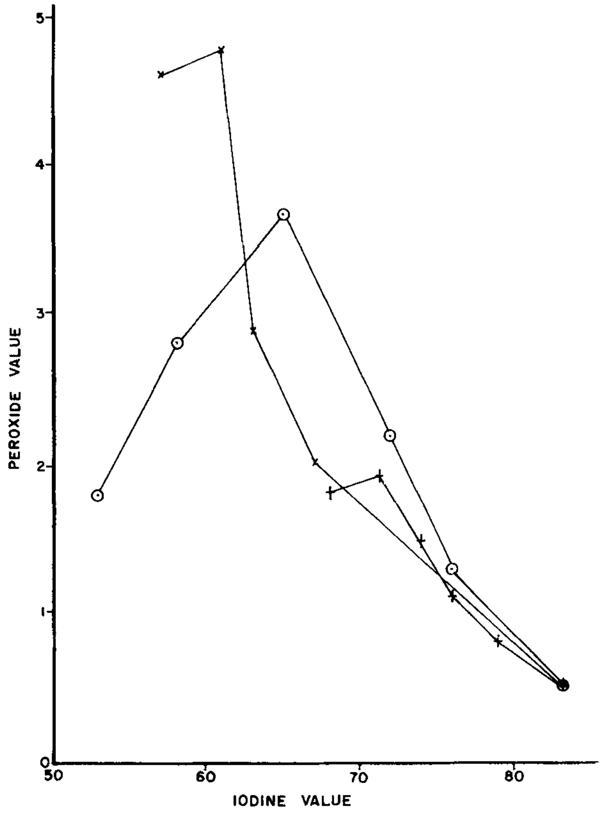

FIG. 6. Correlation between peroxide value and iodine value of Thevetia seed oil at 180°C (⊙), at 200°C (*), and at 220°C (+).

at 60°C showed variations close in magnitude to what we report here for Thevetia seed oil heated at 180°C.

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