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A Study on the Effects of Salt and Pepper on Palm Oil used as a Frying Medium

D. A. Okiy

Nigerian Institute for Oilpalm Research, Benin City, Nigeria

&

O. L. Oke

Chemistry Department, University of Ife, Ile-Ife, Nigeria

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ABSTRACT

Chips of yam (Dioscorea rotunda) *were fried in palm oil heated to 150°C prior to frying as follows:* (*a*) *palm oil without ingredients as control,* (*b*) *palm oil with 1% pepper* (Capsicum annum), *and* (*c*) *palm oil with 1% salt. The qualities of the oil in the frying medium and the oil absorbed by the fried yam were investigated for 10 fryings. The amount of carotenes in the oil/ingredient mixtures, both in the frying medium and the yam extract, was less than in the control. The peroxide values of samples in the frying media did not indicate either a pro-oxidant or antioxidant role for the ingredients. In samples of oil absorbed by the yam, the salt gave exceedingly high peroxide values but in the pepper samples, peroxides were not detected in six out of 10 fryings. However, high* p*-anisidine values of samples in the medium and yam extract have put into question the reported role of pepper as an antioxidant. Thus, pepper encouraged the accumulation of secondary rather than primary oxidation products in the oil.*

INTRODUCTION

Palm oil is extracted from the pulpy portion (mesocarp) of the fruit of the oil palm, *Elaeis guineensis* Jacq. The oil has a relatively simple glyceride

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structure comprising trisaturated 7 %, disaturated 38 %, monosaturated 35 %, and triunsaturated 7 % (Jurriens, 1968), giving a fat with a soft texture and a fairly long plastic range. This makes it a satisfactory oil for blending in substantial amounts in margarine and shortening fats for domestic use and also for commercial baking and biscuit manufacture. The absence of lauric glycerides allows palm oil to be used for frying on account of its low foaming properties. Of importance among the non-glyceride components are the carotenoids (0·04–0·12 %), which give crude palm oil its distinctive colour, and tocopherols (0·08 %) which are natural antioxidants.

This report is part of our work on the analytical and nutritional properties of used palm oil, the broad objective of which is to standardise frying palm oil in Nigeria. Standardisation has become necessary because of the increase in the number of people consuming convenience foods with a subsequent increase in the number of retailers of fried foods. Palm oil is mostly used for frying such foods as fish, meat, plantain (*dodo* and *kpekere*, Yoruba), yam (*dundun*, Yoruba) and ground beans (*akara*), amongst others. For economic reasons, the oil is used repeatedly. There has been no attempt in Nigeria to ascertain the quality of such used oils and therefore establish how often such oils could be reused.

In our nutritional studies, we observed that rats on diets of fried palm oil containing salt or pepper had rough hair and suffered from diarrhoea if proteins were omitted in the experimental diets. The mortality rate was also high. It was therefore decided to examine the chemical changes which had taken place in the used palm oil.

Palm oil used for frying or cooking undergoes hydrolysis and oxidation leading to the formation of free fatty acids, peroxides and carbonyl compounds. The oil loses its colour and may either become dark brown or white depending on the type and concentration of oxidation products (Okiy & Oke, 1982).

Chemical and physico-chemical characteristics of the oil are thus affected. Loncin & Jacobsberg (1963) heated palm oil to temperatures of 250 °C and 300 °C and found that polymers and *trans*-isomers were formed. When palm oil was heated intermittently at 200 °C for 15 days, about 4·2 % new chemical species were formed (Guillaumin *et al.*, 1977).

Heating palm oil with food affects the rate of thermal degradation. *Dioscorea rotunda* decreases the rate of destruction of carotene, but accelerates the conversion of peroxides to carbonyl compounds in palm oil (Okiy *et al.*, 1981).

Salt and pepper may be added to the food or oil before frying. Their primary role is to improve the taste of the food and this seems to have overshadowed any effect they may have on the degradation of the oil. Pepper (*Capsicum annum*) is the major spice used in Nigeria. Various spices are reported to exert antioxidant properties. Amongst the spices found to protect oil-in-water emulsions against oxygen absorption was black pepper (Chipault *et al.*, 1955). However, their antioxidant effect on ordinary oils other than emulsions was in doubt. In this study, the pepper was added to the ordinary oil; so also was the salt, though separately. Each sample of the oil was used for frying 10 times.

MATERIALS AND METHODS

Sample preparation

Special grade palm oil with a free fatty acid content of 3 % was taken from the mill at the Nigerian Institute for Oil Palm Research (NIFOR), Benin City. Yam chips were fried in palm oil, heated to 150 °C prior to frying as follows: (a) without ingredients, (b) with 1 % pepper (*Capsicum annum*), and (c) with 1 % salt. No antioxidants were added to the oil. The yam (*Dioscorea rotunda*) was cut into slices of about 10 cm × 2 cm and weighed. About 1 litre of palm oil was placed in an aluminium pot and heated to 150 °C. The slices were then placed in the oil and occasionally agitated to prevent local overheating.

After the frying, the slices were placed in a wire gauze to allow unabsorbed oil to drain off. The slices were pounded in a porcelain mortar, placed in a Soxhlet extractor and the absorbed oil was extracted with petroleum spirit, 60–80 °C.

Quality evaluation

The following quality characteristics were determined. The method used for peroxide value was adapted from Cocks & van Rede (1966) and modified according to Mehlenbacher (1960). The *p*-anisidine value was determined by the method of Tsoukalas & Grosch (1977), while the oxidation value = 2 × peroxide value + *p*-anisidine value (Johansson, 1975). Carotene was determined according to the method of Brubacher (1968).

RESULTS

Peroxide value

Figures 1 and 2 give the peroxide values (PV) of palm oil in the frying medium and in the oil absorbed by the fried yam, respectively. In Fig. 1, salt or pepper slightly depressed the peroxide values up to the eighth frying after which considerable amounts of peroxides accumulated. The peroxide value of the oil without any ingredient (oil alone) passed through a maximum at the seventh frying and then declined. Figure 2 represents the PV of the oil absorbed by the fried food. In it, apart from the salt sample, peroxides were rarely absorbed by the yam. Of 10 fried samples, peroxides were not detected in seven in the oil alone and six in the pepper

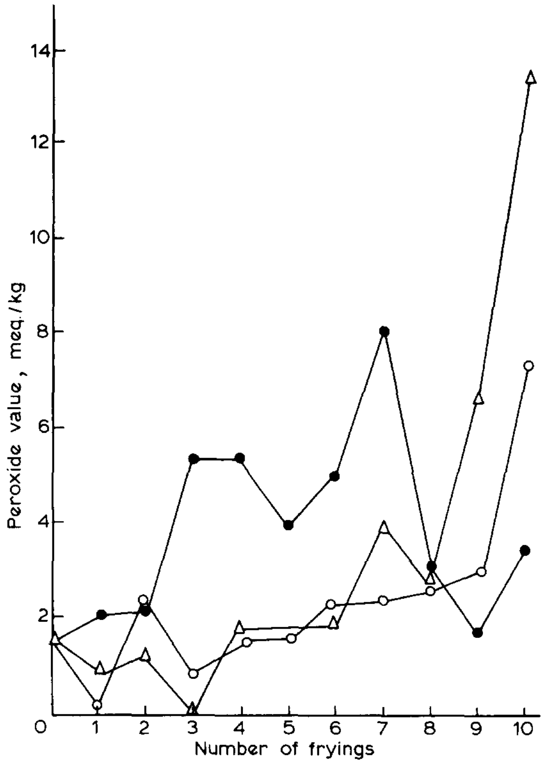

Fig. 1. Peroxide value of palm oil in the frying medium. ●, oil alone; ○, oil + 1% pepper; △, oil + 1% salt.

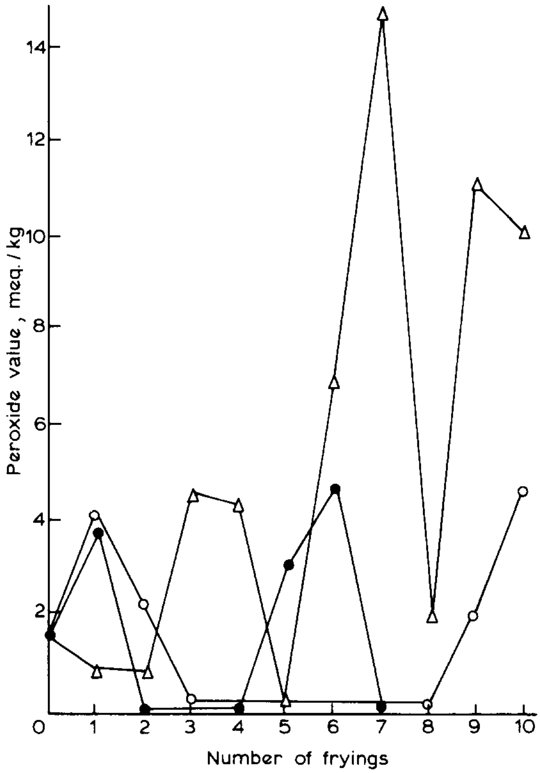

Fig. 2. Peroxide value of palm oil absorbed by yam during frying. ●, oil alone; ○, oil + 1% pepper; △, oil + 1% salt.

samples. When peroxides were detected, the value was only slightly above 4 meq/kg. However, in the salt sample, the peroxide values were high after the fifth frying, reaching a maximum of about 15 meq/kg at the seventh frying.

p-anisidine value

Figure 3 indicates the *p*-anisidine value of palm oil in the frying medium while Fig. 4 shows the *p*-anisidine value of palm oil extracted from the fried yam. These results contrast sharply with those of the peroxides in Figs 1 and 2, particularly with the oil alone or pepper samples.

The *p*-anisidine value of the oil absorbed for the pepper sample was

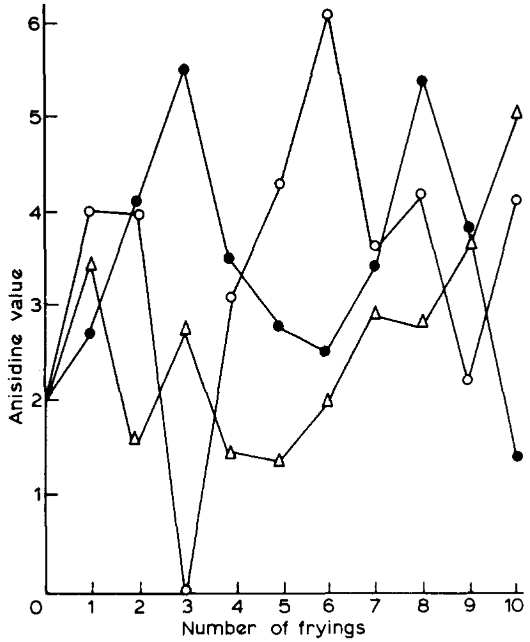

Fig. 3. Anisidine value of palm oil in the frying medium. ●, oil alone; ○, oil + 1 % pepper; △, oil + 1 % salt.

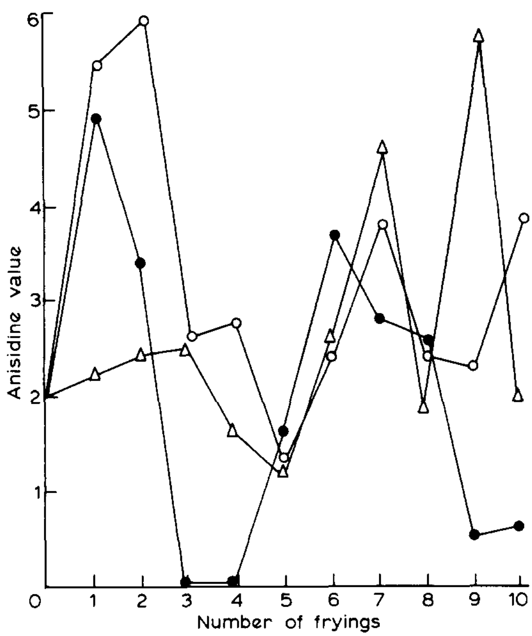

Fig. 4. Anisidine value of palm oil extracted from fried yam. ●, oil alone; ○, oil + 1 % pepper; △, oil + 1 % salt.

very high at the first and second fryings (Fig. 4). On the other hand, the *p*-anisidine value of the salt sample showed progression in the extent of deterioration of the oil with increasing number of fryings.

Oxidation value

The oxidation values of palm oil in the frying medium and palm oil extracted from fried yam are presented in Figs 5 and 6, respectively. Salt slightly depressed the oxidation value in the medium up to the eighth frying but salt or pepper increased the oxidation value in the oil absorbed by the fried yam. In the absorbed oil, oxidation products accumulated early in pepper samples but much later in salt samples. Only the salt sample showed an induction period.

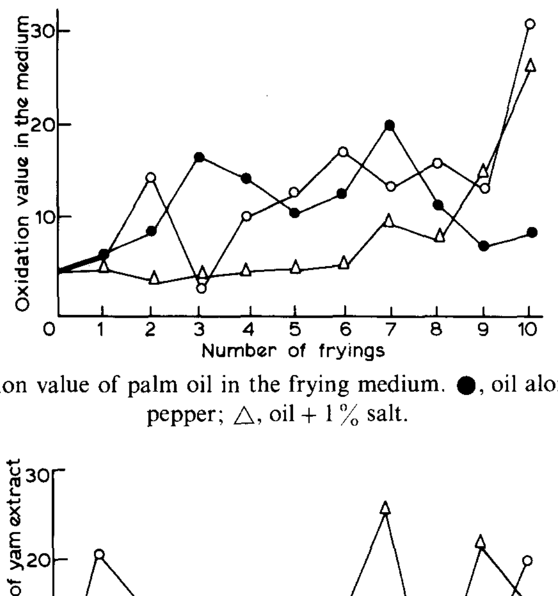

Fig. 5. Oxidation value of palm oil in the frying medium. ●, oil alone; ○, oil + 1% pepper; △, oil + 1% salt.

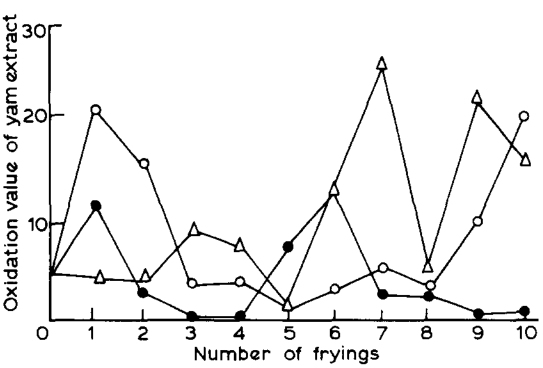

Fig. 6. Oxidation value of palm oil extracted from fried yam. ●, oil alone; ○, oil + 1% pepper; △, oil + 1% salt.

Carotene

Figure 7 shows the loss of carotene in the frying medium and Fig. 8 the carotenoid absorption by the fried yam. In the medium, the loss of carotene in an oil/salt or oil/pepper mixture was more rapid than in a sample of oil alone. The carotene content of the fresh palm oil was 915 ppm. Fifty per cent of the carotenes were destroyed after only two

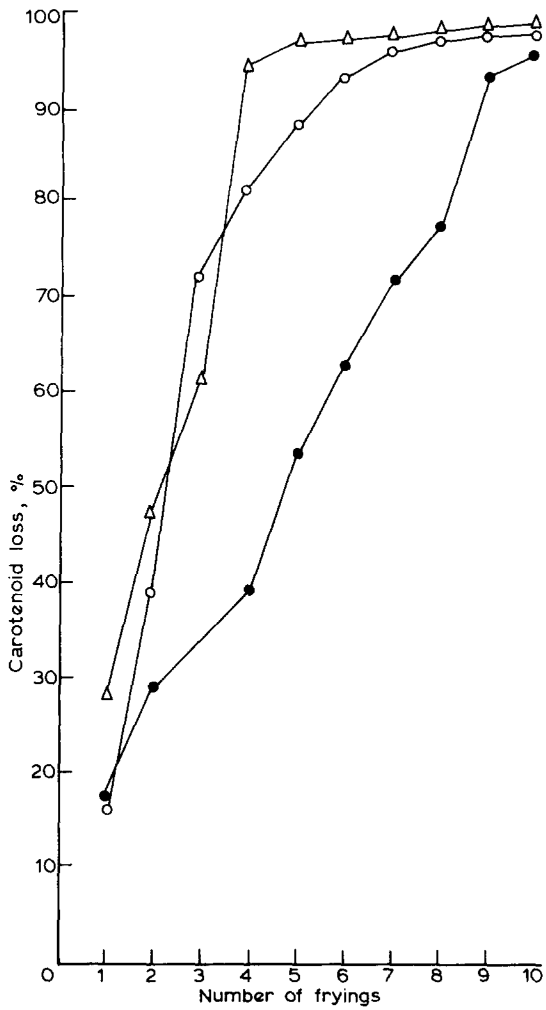

Fig. 7. Carotenoid loss in palm oil during frying with yam. ●, oil alone; ○, oil + 1 % pepper; △, oil + 1 % salt.

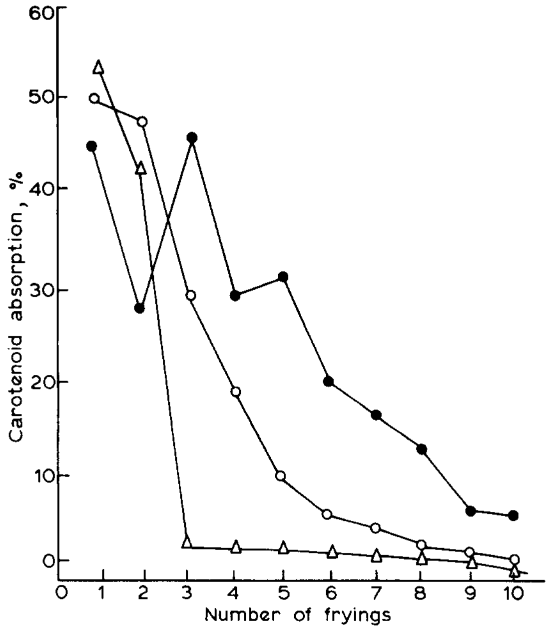

Fig. 8. Carotenoid absorption by yam during frying in palm oil. ●, oil alone; ○, oil + 1 % pepper; △, oil + 1 % salt.

fryings when salt or pepper was added, whereas frying without these ingredients prolonged the 50 % destruction time to about the fifth frying. Carotene was also extracted from the fried yam (Fig. 8). At the first and second fryings, the amount of carotene extracted from the yam fried in palm oil with added ingredients was more than that in oil alone. Thereafter, the carotene extracted from the yam was less in the oil/ingredient mixtures than in oil alone. However, on the basis of carotene available in the media, there was greater absorption of carotene into the yam fried in oil/ingredient mixture than in oil alone.

DISCUSSION

The primary products of oxidation are the peroxides. Therefore, it is usual to determine the concentration of peroxides to monitor the deterioration of oxidized palm oil. However, from Figs 1 and 2, it seems that peroxides are sensitive to pepper which prevents an accumulation either in the medium or the fried food. This might lead to the conclusion that pepper is an antioxidant. Since peroxides are vulnerable, they do not reveal the complete oxidative history of the oil. The result in Fig. 2 is of interest because of uncertainty about the safety of peroxides.

An alternative approach to the determination of the extent of deterioration of a thermally oxidized oil is to measure the carbonyl compounds formed by the degradation of the peroxides. The most reliable and widely used of the analytical methods is the *p*-anisidine value. It is obvious from Figs 3 and 4 that pepper encouraged the accumulation of carbonyl compounds in the medium and the food. Carbonyls, being important flavour compounds, would affect the odour and taste of the fried yam and probably the shelf life too.

It is noteworthy that pepper destroys palm oil more than salt which has a potential pro-oxidant Na^+ radical. This suggests that heat destroys the antioxidant property of pepper. This study also shows that the peroxide value is a poor index to monitor deterioration of thermally oxidized palm oil. Of the three samples, salt had the least influence on oxidation products of the oil in the frying medium but appeared to have enchanced the absorption of peroxides into the fried yam. In order to monitor the deterioration of a thermally oxidized oil, it seems inappropriate to take samples from the oil in the frying medium. Our suggestion is that oil should be extracted from a sample of the fried food for this purpose. Pepper and salt behaved differently in the accumulation of carbonyl compounds, in that pepper enhanced the accumulation of carbonyl compounds in the fried yam much earlier than the salt. Thus the useful life of frying palm oil is shorter when pepper rather than salt is the ingredient. The effect of salt becomes pronounced only after the seventh frying. However, the rate of carotenoid destruction is fastest in oil with salt and subsequently there is less carotene absorbed into the fried yam in those samples.

CONCLUSION

In most fryings, salt or pepper and sometimes both are added either to the oil or food before frying commences. Our findings suggest that salt does not harm the oil if the period of reuse of the oil is short. However, pepper does much harm to the oil from the onset of frying and this is more obvious in extracts from the fried food than in the frying medium.

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