Changes in Cottonseed Oil When Used for Frying Vegetable Products Containing Chlorophyll

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The changes that take place in cottonseed oil when used for frying "Tameya" were investigated. The absorption spectra of cottonseed oil (CSO) and cottonseed oil + chlorophyll (CSO + Chl.) at wave length range 500-700 nm showed a sharp peak at 667 nm for CSO + Chl, which is characteristic of chlorophyll. Storing CSO + Chl for one mo. resulted in a shift in the absorption maxima at 667 to 670 nm and the appearance of a band at 610 nm, characteristic of pheophytin. Heating of CSO + Chl at the frying temperature resulted in the disappearance of all maxima. The peroxide value of CSO + Chl increased due to storage for one mo but decreased when CSO + Chl was heated for one hr.

Two types of Tameya were investigated, Tameya (A) with parsley and Tameya (B) without parsley. The results reveal that Tameya (A) when fried in CSO results in an increase in the absorption spectra of the oil at 670 nm and the start of the appearance of a minor peak at 610 nm. Further heating of the oil resulting from frying Tameya (A) shows that pheophytin in the oil disappears with an increase in heating time. Heating glycerol + pheophytin also shows the disappearance of pheophytin peaks. Frying of Tameya A and B in CSO resulted in a decrease in the peroxide value of the oil.

Frying of vegetable oils is known to effect undesirable changes in their chemical characteristics. Eder and Guhr (1) and Moharram and Osman (2) reported increases in linoleic acid and free fatty acids of cottonseed oil. Their work also illustrated hydrolysis of the triglycerides and subsequent loss in neutral oil.

Chlorophyll and pheophytin are present in crude and refined vegetable oils, and the amounts of pheophytin usually is higher. Chlorophyll and pheophytin are reported to act as prooxidants in fats and oils. Pheophytin shows higher prooxidant activity and higher stability in the autoxidation of triglycerides (3,4). Chlorophyll is reported to decompose by hydroperoxides and free fatty acids (5,6).

The aim of the present work is to study the changes that take place in cottonseed oil when used to fry vegetable products containing chlorophyll and pheophytin.

MATERIALS AND METHODS

Food grade cottonseed oil was obtained from the local market. Pure chlorophyll and pheophytin were prepared from fresh leaves of rocket plant (*Eruca sativa*) according to the procedure of Lynn and Schanderl (7). Chlorophyll and pheophytin preparations were dissolved in petroleum ether and the solution mixed with oil to prepare the chlorophyll or pheophytin oil solution, by solvent evaporation.

"Tameya", which is a staple food item in the Egyptian diet, was prepared according to the traditional method.

Five hundred g of dehulled and crushed Faba beans were soaked for 48 hr. The soft cotyledons were mixed with 150 g of ground onion and 50 g green parsley, and spiced with salt, cumin and corriander. The whole mixture was minced, divided into patties (20-25 g each) and deep fried in cottonseed oil at 180 C.

The absorption spectra of the oil samples were recorded between wave length 500 to 700 nm using a Shimadzu UV-Visible Recording Spectrophotometer, model UV 240 Graphtcord. The peroxide value was determined according to AOCS standard procedures (8).

EXPERIMENTAL

Addition of chlorophyll to cottonseed oil. Chlorophyll (0.2 g) was dissolved in 200 g of food grade cottonseed oil. The freshly prepared sample (S_1) was divided into two aliquots. Forty g was stored one mo at room temperature (28 C) and designated (S_2). The second aliquot (150 g) was heated over an open flame to 190 C, similar to the process used in the frying of Tameya. A sample was taken after one hr and designated (S_3). Samples resulting from the two treatments were ana-

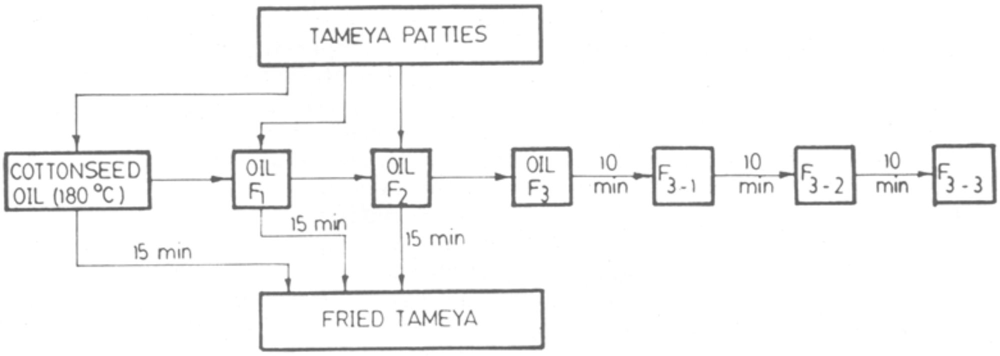

FIG. 1. Treatment on frying Tameya in cottonseed oil.

lyzed for their peroxide value, and their absorption spectra were determined.

Frying Tameya in cottonseed oil. Figure 1 represents the treatments carried on to investigate changes that take place in cottonseed oil when used to fry Tameya.

In the first experiment eight Tameya patties (ca. 25 g each) prepared from ground Faba beans with parsley were fried in fresh food cottonseed oil for ca. 15 min at 180 C. The fried Tameya was removed and the oil (F_1) was used similarly for frying second, then third, sets of Tameya patties to get F_2 and F_3 oils. After the third frying the resulting oil was heated for 30 min and 20-g aliquots taken every 10 min.

The second experiment was similar to the first with the exception that Tameya was fried without parsley.

RESULTS AND DISCUSSION

Very little is known about the fate of the green chlorophyll pigments or pheophytin present in foods during the process of frying these foods in oil. In this study, the effect of the green pigments present in Tameya, that might dissolve in the oil during frying, on the absorption spectra and peroxide value of the frying oil was investigated.

Figure 2 shows the absorption spectra of cottonseed oil with dissolved chlorophyll or pheophytin. The spectra reveal two major maxima at 667 and 670 nm, respectively, for the two pigments. Pheophytin also shows maxima at 610, 548 and 506.

Chlorophyll and cottonseed oil. Food grade cottonseed oil does not show a characteristic absorption band at the wave length range 500-700 nm. Chlorophyll dissolved in food grade cottonseed oil gives sharp absorption maximum at 667 nm (Fig. 3a). Storage of the oil with dissolved chlorophyll at room temperature for a month resulted in major changes in the absorption spectra with the appearance of a band at 610 nm and a shift in the 667 nm band to 670 nm. These two bands are characteristic for pheophytin (Fig. 3b).

TABLE 1

Peroxide Value of Oils Resulting from Different Treatments

Treatment		Peroxide value	% Change in peroxide value
Cottonseed oil (CSO)		2.78	
Cottonseed oil + chlorophyll		2.98	7.2
Cottonseed oil (stored 1 mo)		7.44	168.0
Cottonseed oil + chlorophyll (stored 1 mo)		8.40	202.0
Cottonseed oil (heated 1 hr)		1.79	-36.0
Cottonseed oil + chlorophyll (heated 1 hr)		0.82	-70.0
CSO + tameya + parsley	F_1	3.04	9.4
	F_2	2.46	-11.5
	F_3	2.38	-14.4
CSO + tameya	F_1	2.80	0.7
	F_2	2.84	2.2
	F_3	2.10	-24.5

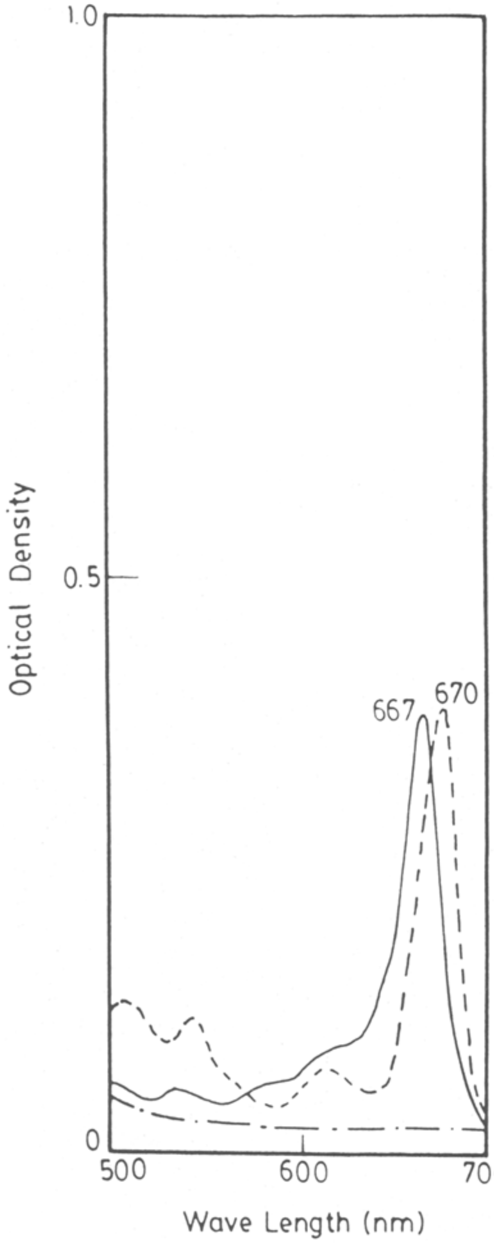

FIG. 2. Absorption spectra of cottonseed oil containing chlorophyll and pheophytin. (—) Chlorophyll in oil, (---) Pheophytin in oil, (-·-) Food grade cottonseed oil.

Heating of the oil with dissolved chlorophyll at the frying temperature resulted in total disappearance of wave length maxima, probably due to decomposition of chlorophyll and the general decrease in the absorption spectra (Fig. 3c).

Peroxide values given in Table 1 reveal that storage of cottonseed oil for one month resulted in a 168% increase in the peroxide value. Storage of cottonseed oil containing chlorophyll resulted in 202% increase which indicates that this increase in the peroxide value coincided with a change in the pigment to pheophytin. Heating of cottonseed oil with or without chlorophyll resulted in a decrease in the peroxide value. This can be explained on the basis that at high

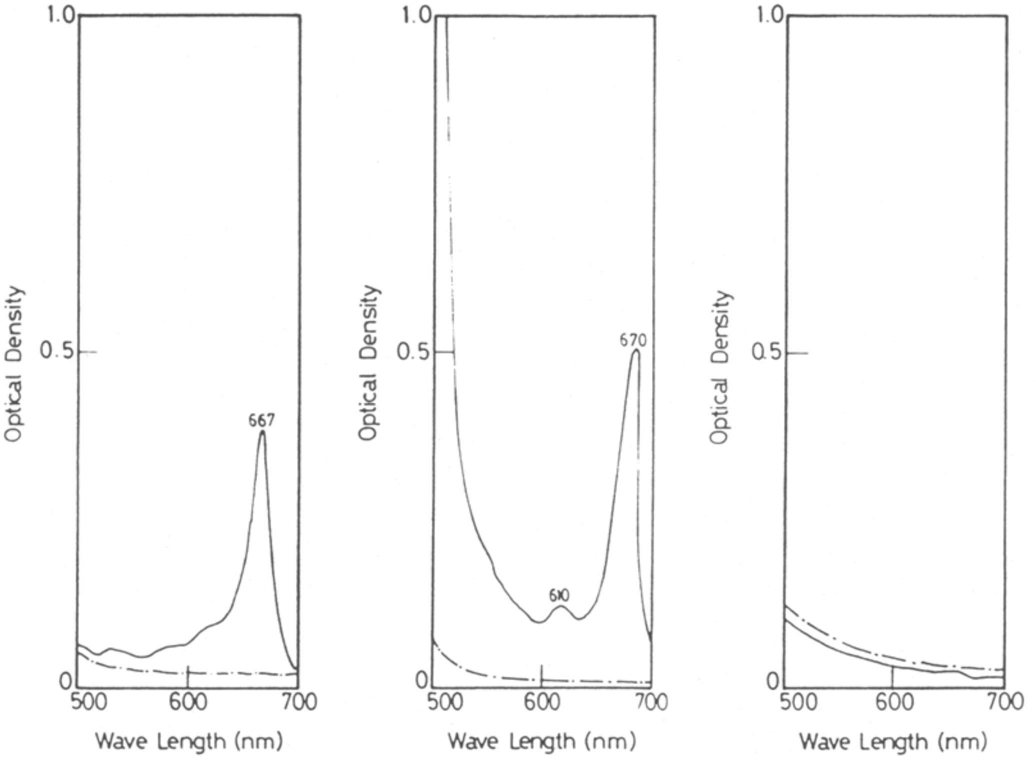

Fig. 3 - 1

Fig. 3 - 2
One month storage

Fig. 3-3
One hour heating

FIG. 3. Changes in the absorption spectra of cottonseed oil containing chlorophyll (–·–·–) Food grade cottonseed oil, (——) Oil + chlorophyll.

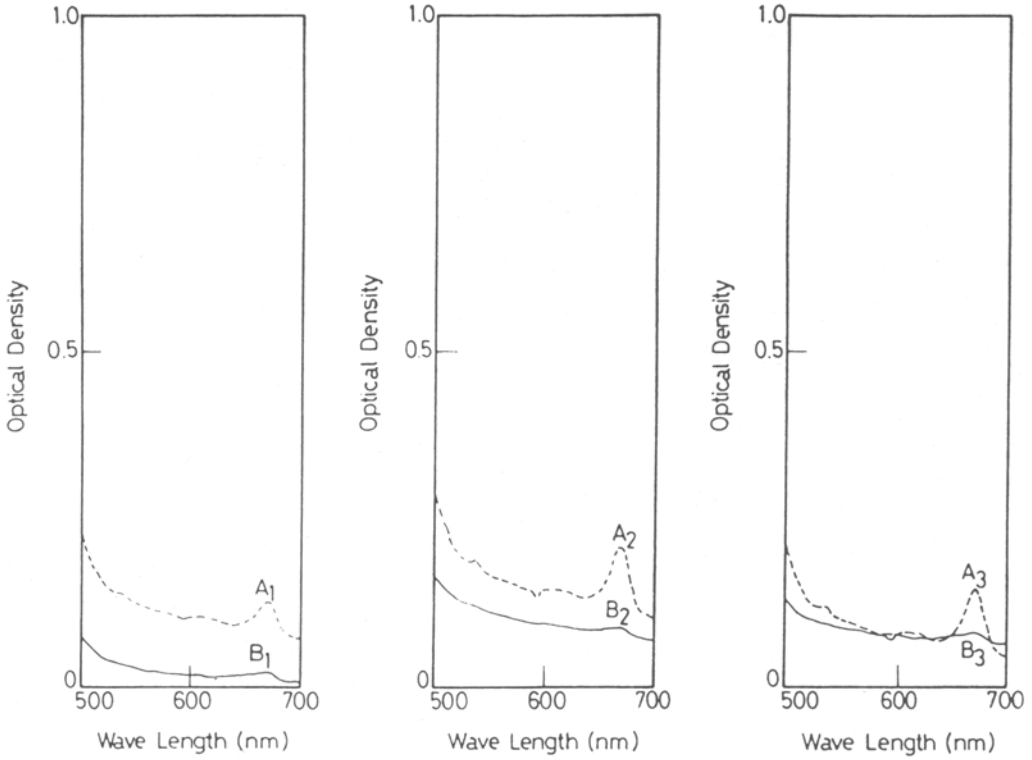

Fig. 4 - 1
First frying

Fig.4 - 2
Second frying

Fig.4 - 3
Third frying

FIG. 4. Changes in absorption spectra of cottonseed oil when used for frying of Tameya. A = Oil + Tameya + Parsley, B = Oil + Tameya.

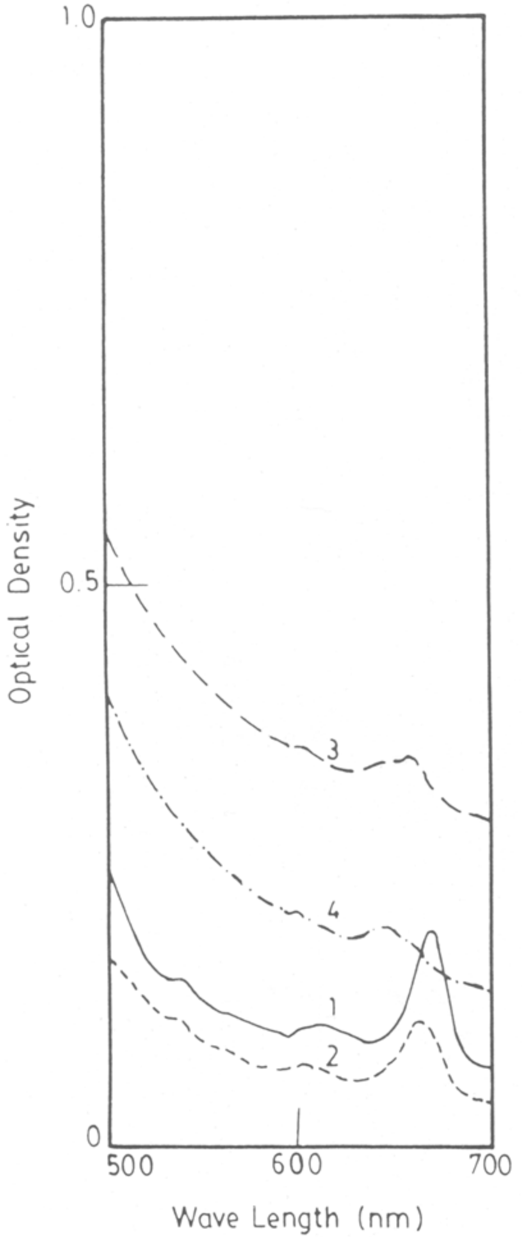

FIG. 5. Changes in the absorption spectra of cottonseed oil which has been used in frying tameya by prolonged heating. (1) Oil resulting after frying Tameya. (2, 3, 4) Oil (1) when heated for 10, 20, 30 additional minutes, respectively.

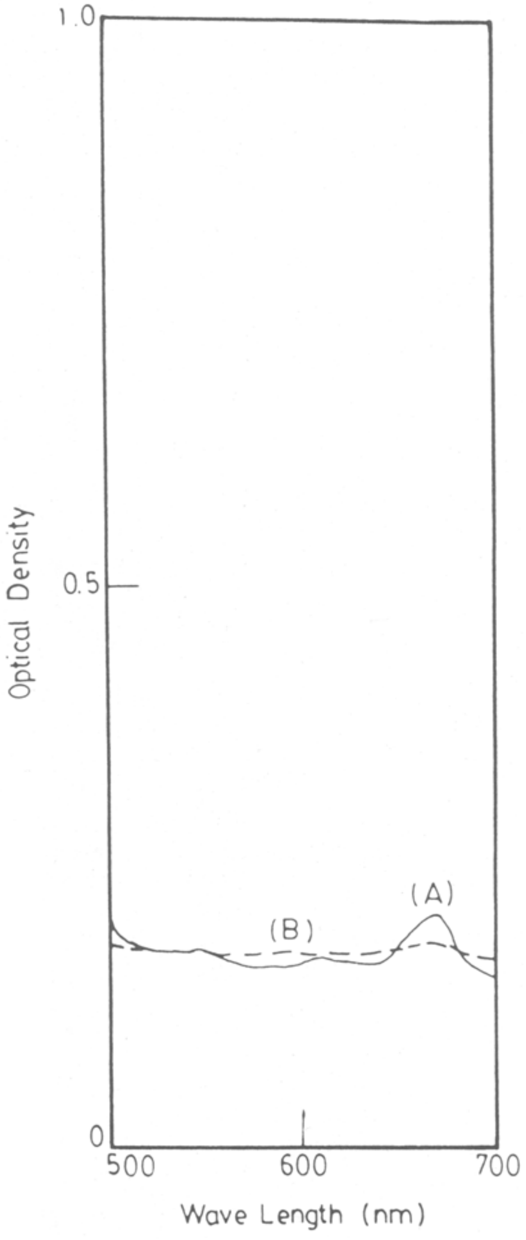

FIG. 6. Absorption spectra of pheophytin in glycerol. (A) Glycerol + pheophytin, (B) Glycerol + pheophytin after heating.

temperatures, the rate of decomposition of the peroxides is higher than the rate of their formation (2,9).

Frying Tameya in cottonsed oil. Figure 4 represents absorption spectra curves for cottonseed oil after being used for frying Tameya constituting parsley (curve A) or without parsley (curve B).

The curves reveal that chlorophyll in the parsley results in an increase in the absorption spectra of the oil at 670 nm. The three successive fryings result in an increase in the absorption at 670 nm and the start of appearance of a minor peak at 610 nm. These two wave lengths indicate that chlorophyll which dissolved from the parsley in the oil changed during frying to the more stable pheophytin.

Table 1 shows that at the first two fryings of Tameya without parsley the peroxide value of the oil slightly increased, while after the third frying the peroxide value of the oil was 24.5% less than the original. Oil resulting from the first frying of Tameya with parsley shows a 9% increase in the peroxide value, while oil resulting from the third frying shows a 14.4% decrease compared to the original oil. These results are in agreement with the findings of Lea (9).

Figure 5 includes four curves that represent the change in the absorption spectra of cottonseed oil that was used for frying three sets of Tameya patties containing parsley, when subjected to further heating periods. The results reveal that pheophytin which is characterized by the two wave lengths 670 and 610 nm gradually decreases by heating the oil, which indicates degradation of the constituting pigments.

Figure 6, which represents pheophytin dissolved in glycerol (curve A) with maximum at 670 nm loses its maximum absorption after heating (curve B). This also indicates that pheophytin decomposes by heating to oxidative products which have no color, and that no reaction takes place between the oil and pheophytin during heating.

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[Received October 1, 1986; accepted May 18, 1987]