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INVESTIGACION

Flavour changes due to effect of different packaging materials on storing of cottonseed oil, hydrogenated oil and margarine

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RESUMEN

Cambios en el flavor debidos al efecto de diferentes materiales de envases en almacenamiento de aceite de semilla de algodón, aceite hidrogenado y margarina.

Aceite de semilla de algodón decolorado, aceite de palma parcialmente hidrogenado y margarina fueron envasados en latas metálicas y botellas de plástico blancas y almacenados durante siete meses a temperatura ambiente en estantes. Se relacionó la evaluación de la estabilidad de los aceites con la deterioración del flavor. La deterioración del flavor producida en aceite de semilla de algodón decolorado, aceite de palma parcialmente hidrogenado y margarina fue observada debido al aumento en la cantidad de aldehídos y cetonas que juegan un importante papel en la deterioración de los aceites. A partir de los resultados obtenidos se encontró que las latas metálicas ofrecieron una adecuada y mejor protección frente a la deterioración que los envases de plásticos para aceite de semilla de algodón y aceite de palma parcialmente hidrogenado. Por otra parte, los recipientes de plástico fueron mejores para el almacenamiento de margarina y esto es debido a la presencia de agua y sales en ella en una proporción del 16% y 2% respectivamente.

PALABRAS-CLAVE: Aceite de semilla de algodón – Aceite hidrogenado – Almacenamiento – Envase – Flavor – Margarina.

SUMMARY

Flavour changes due to effect of different packaging materials on storing of cottonseed oil, hydrogenated oil and margarine.

Bleached cottonseed oil, partially hydrogenated palm oil and margarine were packed in metal cans and white plastic bottles and stored for seven months at room temperature on side bench. Assessment of the stability of the oils towards flavour deterioration was reported. The deterioration of flavour developed from bleached cottonseed oil, partially hydrogenated palm oil and margarine was observed due to increase amount of aldehydes and ketones which play an important role in deterioration of the oils. From the results we found metal can offered suitable and better protection against deterioration than plastic package for cottonseed oil, partially hydrogenated palm oil. While plastic container was better for storing margarine and this is due to the presence of water and salt in margarine where they compose about 16% and 2% respectively.

KEY-WORDS: Cottonseed oil – Flavour – Hydrogenated oil – Margarine – Package – Storage.

1. INTRODUCTION

Exposure to diffuse daylight or artificial light is well known to cause a marked acceleration in the deterioration of unsaturated oil. This deterioration is probably sensitized by chromophoric impurities of oils, especially residual natural dyes and pigments, which absorbed strongly in visible or near ultraviolet light (1-3) and cause significant deterioration of oil quality in the presence of air (4-9).

Volatile oxidation products responsible for flavour alteration were studied by many authors (10-13) who found that fatty substances underwent autoxidation to produce small quantities of low molecular weight aldehydes, ketones and acids which have very objective odour and taste. This piece of work was done to study the effect of packing materials on storing of lipids.

2. MATERIALS AND METHODS

Bleached cottonseed oil, partially hydrogenated palm oil and margarine were stored in metal cans and white plastic bottles with air in the headspace and served at room temperature during the whole periode of investigation.

Suitable amount of aroma –concentration was prepared according to the method proposed by Sattar Co-workers (14).

The method of preparation of aroma concentrated was carried out by heating the samples on silicon oil

bath at 190° C but for margarine at 135° C in 500 ml round bottom flask under reduced pressure (about 30 mm Hg) for two hours. The aroma was collected in traps cooled to –20° C using crushed ice-salt acetone mixture. The collected distillated was thrice extracted with peroxide-free ether/and the combined extracts were dried over anhydrous sodium sulphate. The extract was filtered and ether was then removed by distillation at 40° C to obtain the aroma concentrate.

Flavour of cottonseed oil, partially hydrogenated palm oil and margarine was detected at zero time (control), four and seven months storing by using gas liquid chromatography, the analysis was run using varian 3700 gas chromatograph, equipped with flame ionization detector under the following conditions:

- Column package 10% diethylene glycol succinate (DEGS) on chromosorb W (80-100 mesh).
- Column length 6 feet with internal diameter 1/4 inch.
- Column temperature: for flavour 70-190° C with programming rate 4° C/min.
- Injection temperature 220° C.
- Detector temperature 300° C.
- Carrier gas (He) flow rate 30 ml/min.
- Hydrogen flow rate 30 ml/min.
- Air flow rate 300 ml/min. (15,16)

3. RESULTS AND DISCUSSION

Volatile components of control sample (zero time storing), were found to be composed of butanoic acid, 2-hexanol, methyl valerate, hexanoic acid, methyl hexanoate, heptanal and 3-ethyl hexanone (Table I).

Table I

Percentage of Volatile Components of Cottonseed Oil

Peak no.	tR	Control	Metal can		White plastic package		Component
			4th month	7th month	4th month	7th month	
1	0.5	–	–	–	–	–	Ethanol
2	1.0	–	–	–	–	–	Methyl ketone
3	1.5	–	–	–	–	–	Ethyl ketone
4	2.0	0.99	Trace	20.23	13.21	13.13	Propanal
5	2.5	–	–	–	–	–	Butanal
6	2.75	–	Trace	3.52	14.10	7.41	Pentanal
7	3.25	7.09	–	5.30	–	3.15	Butanoic acid
8	3.75	–	3.1	–	–	–	1-Hexanol
9	4.5	12.41	34.1	39.22	5.53	18.20	2-Hexanol
10	5.5	–	–	–	–	–	Unidentified
11	6.0	–	–	–	–	–	Hexanal
12	6.5	2.13	–	–	–	–	Unidentified
13	7.0	12.25	–	2.51	–	1.50	Methyl valerate
14	7.5	17.14	–	–	–	–	Hexanoic acid
15	8.0	17.42	–	8.00	–	4.21	Methyl hexanoate
16	9.0	6.03	–	5.21	–	3.0	Heptanal
17	9.5	–	–	–	–	–	Heptanol
18	10.0	–	–	–	–	–	Unidentified
19	10.5	3.25	–	1.50	–	–	Octanal
20	11.25	–	–	–	–	–	1-Octanol
21	11.75	–	–	–	–	–	Methyl heptanoate
22	12.5	–	–	–	–	–	Methyl octanoate
23	13.0	–	–	–	–	–	Unidentified
24	13.75	–	–	–	–	–	Unidentified
25	14.5	0.75	3.4	2.61	2.32	1.4	Nonanal
26	15.5	–	–	–	–	–	Unidentified
27	16.0	–	–	6.6	–	3.33	Decanal
28	18.0	1.38	–	0.9	–	–	1-Octene-3-ol
29	18.5	0.35	7.2	0.3	–	–	Hendecanal
30	19.0	–	–	–	–	–	Unidentified
31	19.5	0.53	–	–	8.1	3.10	Octanol
32	20.0	–	–	–	–	–	Unidentified
33	20.5	3.33	–	0.9	–	–	Dodecanal

Table I Continue

Percentage of Volatile Components of Cottonseed Oil

Peak no.	tR	Control	Metal can		White plastic package		Component
			4th month	7th month	4th month	7th month	
34	22.0	0.28	–	–	–	–	Decanoic acid
35	23.0	0.89	4.1	0.8	5.2	5.27	Nonenal
36	24.5	0.71	–	–	1.3	–	2,5-Hexadione
37	25.1	0.39	4.6	2.4	10.6	7.30	2,4-Nonadienal
38	25.5	7.37	3.1	–	–	–	3-Ethyl hexanone
39	29.0	2.24	3.9	–	10.2	7.5	3-Ethyl heptanone
40	30.5	3.07	–	–	1.5	–	3-Ethyl octanone
41	31.5	–	–	–	5.12	6.2	3-Ethyl nonanone
42	33.0	–	9.20	–	4.31	2.30	2,4-Decadienal
43	35.5	–	27.30	–	15.20	9.00	Undecanol
44	37.5	–	–	–	3.31	4.00	Unidentified

These volatile components constituted more than 79% of the total volatile components of bleached cottonseed oil at zero time storing.

In metal can backage 2-hexanol increased after four and seven months, on the other side butanoic acid, methyl valerate, hexanoic acid, methyl hexanoate and heptanal completely disappeared after storing for four months for metal can and plastic containers propanal, pentanal, 2-hexanol, 2-4, nonadienal and undecanol formed about 66.0% and 58.0% after storage for four months in metal can and plastic container respectively, while they composed 65.6% and 55.0% after storage for seven months in both packages, respectively.

The deterioration of flavour developed from hydrogenated oil is reported in (Table II). A remarkable oxidation was observed due to increase amount of hexanal. Ketones played an important role in the flavour of partially hydrogenated palm oil. Alcohols and ester were also identified in the aroma of partially hydrogenated palm oil.

The changes in the flavour developed from margarine stored in metal can and white plastic package for four and seven months compared with control sample were reported in (Table III).

A remarkable oxidation was observed due to increase of aldehydes and some ketones. Short chain fatty acids were probably produced by chain breaking through autoxidation and they play a major role in the odour of margarine. Alcohols generally played a minor role in the aroma of margarine.

Table II

Percentage of Volatile Components of Partially Hydrogenated Palm Oil

Peak no.	tR	Control	Metal can		White plastic package		Component
			4th month	7th month	4th month	7th month	
1	0.5	–	–	–	–	–	Ethanol
2	1.0	–	–	–	–	–	Methyl ketone
3	1.5	–	–	–	–	–	Ethyl ketone
4	2.0	–	–	–	–	–	Propanal
5	2.5	–	–	–	–	–	Butanal
6	2.75	–	–	–	–	–	Pentanal
7	3.25	–	–	–	–	–	Butanoic acid
8	3.75	–	–	–	–	–	1-Hexanol
9	4.50	20.59	28.32	30.13	16.41	17.61	2-Hexanol
10	5.5	–	–	7.5	–	–	Unidentified
11	6.0	3.59	–	–	–	4.30	Hexanal
12	6.5	–	–	–	–	–	Unidentified
13	7.0	–	–	–	–	–	Methyl valerate
14	7.5	–	–	–	–	–	Hexanoic acid

Table II (Continue)

Percentage of Volatile Components of Partially Hydrogenated Palm Oil

Peak no.	tR	Control	Metal can		White plastic package		Component
			4th month	7th month	4th month	7th month	
15	8.0	–	–	–	–	–	Methyl hexanoate
16	9.0	–	–	–	–	–	Heptanal
17	9.5	–	–	–	–	–	Heptanol
18	10.0	–	–	–	–	–	Unidentified
19	10.5	–	–	–	–	–	Octanal
20	11.25	–	–	–	–	–	1-Octanol
21	11.75	–	–	–	–	–	Methyl heptanoate
22	12.5	17.10	9.24	4.7	19.00	10.52	Methyl octanoate
23	13.0	–	–	–	–	–	Unidentified
24	13.75	2.82	–	1.90	3.52	4.00	Unidentified
25	14.5	–	–	–	–	–	Nonanal
26	15.5	2.25	Trace	1.34	2.97	3.21	Unidentified
27	16.0	–	–	–	–	–	Decanal
28	18.0	–	–	–	–	–	1-Octene-3-ol
29	18.5	–	–	–	–	–	Hendecanal
30	19.0	–	–	–	–	–	Unidentified
31	19.5	–	–	–	–	–	Octanol
32	20.0	–	–	–	–	–	Unidentified
33	20.5	–	–	–	–	–	Dodecanal
34	22.0	1.56	Trace	1.5	2.0	2.2	Decanoic acid
35	23.0	15.58	20.2	19.53	17.9	18.1	Nonenal
36	24.5	5.10	5.1	5.1	7.3	8.0	2,5-Hexadione
37	25.1	25.45	21.2	21.3	21.4	21.21	2,4-Nonadienal
38	25.5	3.89	5.31	4.66	5.36	6.12	3-Ethyl hexanoate
39	29.0	2.07	3.20	2.30	4.14	4.73	3-Ethyl heptanone
40	30.5	–	–	–	–	–	3-Ethyl octanone
41	31.5	–	–	–	–	–	3-Ethyl nonanone
42	33.0	–	–	–	–	–	2,4-dodecadienal
43	35.5	–	–	–	–	–	Undecanol
44	37.5	–	–	–	–	–	Unidentified

Table III

Percentage of Volatile of Margarine

Peak no.	tR	Control	Metal can		White plastic package		Component
			4th month	7th month	4th month	7th month	
1	0.5	–	–	–	–	–	Ethanol
2	1.0	0.11	2.2	3.2	2.1	3.3	Methyl ketone
3	1.5	–	0.9	1.2	Trace	0.1	Ethyl ketone
4	2.0	0.13	2.9	3.0	1.5	2.3	Propanal
5	2.5	–	–	–	–	–	Butanal
6	2.75	–	–	–	–	–	Pentanal
7	3.25	3.21	6.9	6.1	4.6	5.2	Butanoic acid
8	3.75	–	–	–	–	–	1-Hexanol
9	4.5	16.0	13.5	15.6	17.2	16.4	2-Hexanol
10	5.5	–	–	–	–	–	Unidentified
11	6.0	1.21	2.1	2.2	1.5	2.3	Hexanal

Table III (Continue)

Percentage of Volatile of Margarine

Peak no.	tR	Control	Metal can		White plastic package		Component
			4th month	7th month	4th month	7th month	
12	6.5	0.99	1.00	1.2	Trace	Trace	Unidentified
13	7.0	5.20	5.5	3.2	4.9	4.3	Methyl valerate
14	7.5	6.10	5.5	3.7	4.9	3.97	Hexanoic acid
15	8.0	6.32	6.1	4.2	5.12	4.86	Methyl hexanoate
16	9.0	2.03	3.2	3.1	3.0	3.40	Heptanal
17	9.5	–	1.8	2.2	Trace	2.0	Heptanol
18	10.0	–	–	–	–	–	Unidentified
19	10.5	1.01	2.0	2.3	1.04	1.9	Octanal
20	11.25	–	–	–	–	–	1-Octanol
21	11.75	–	–	–	–	–	Methyl heptanoate
22	12.5	5.82	5.8	4.2	5.1	4.3	Methyl octanoate
23	13.0	–	–	–	–	–	Unidentified
24	13.75	0.85	1.0	–	Trace	0.5	Unidentified
25	14.5	0.12	Trace	–	–	Trace	Nonanal
26	15.5	0.74	1.4	1.6	1.4	1.7	Unidentified
27	16.0	–	–	–	–	–	Decanal
28	18.0	0.62	1.1	2.2	1.1	1.2	1-Octen-3-ol
29	18.5	0.10	1.0	1.1	Trace	1.6	Hendecanal
30	19.0	–	–	–	–	–	Unidentified
31	19.5	0.16	1.2	1.5	0.99	1.5	Octanol
32	20.0	–	–	–	–	–	Unidentified
33	20.5	1.71	Trace	2.1	1.2	1.9	Dodecanal
34	22.0	20.24	16.1	18.4	17.9	16.5	Decanoic acid
35	23.0	7.66	3.5	4.2	7.4	4.3	Nonenal
36	24.5	3.20	2.2	2.6	2.4	2.1	2,5-Hexadione
37	25.1	8.30	6.1	5.2	6.9	5.2	2,4-Nonadienal
38	25.5	5.07	3.0	3.0	4.1	3.3	3-Ethyl hexanone
39	29.0	1.80	2.4	1.2	2.9	2.8	3-Ethyl heptanone
40	30.5	1.30	1.6	1.5	2.7	3.0	3-Ethyl octanone
41	31.5	–	–	–	–	–	3-Ethyl nonanone
42	33.0	–	–	–	–	–	2,4-dodecadienal
43	35.5	–	–	–	–	–	Undecanol
44	37.5	–	–	–	–	–	Unidentified

Figure 1-4 show the characteristic volatile components of cottonseed oil, partially hydrogenated palm oil and margarine during storing period. From these figures we can trace:

– Propanal increased in both metal cans and white plastic package after 7th month storage, while hexanal increase in both 4th and 7th months storage in two kinds of package in cottonseed oil.

– Decanoic acid was highly increased in margarine in both 4th and 7th months storage and in the two kinds of packaging materials.

– Nonenal and 2,4-nonadienal were highly increased in partially hydrogenated palm oil in both kings of package.

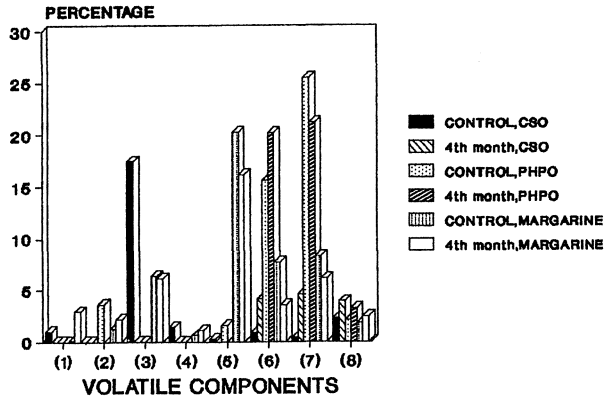
Generally from all these results it could be traced that propanal might arise from 1-decomposition of the hydroperoxide of linolenate, 2-stepwise oxidation of n-nonanal through the C_{2-4} alkanals to propanal (10) and 3-oxidation of n-propanol with alcohol dehydrogenase.

Alcohols may be derived from unsaturated acids by the formation and reduction of the corresponding aldehydes (17). 2,4-nonadienal could be postulated as being formed from linoleic acid as proposed by Hoffmann (18). These results are in agreement with the peroxide value of bleaching cottonseed oil, partially hydrogenated palm pol and margarine (Table IV).

Table IV

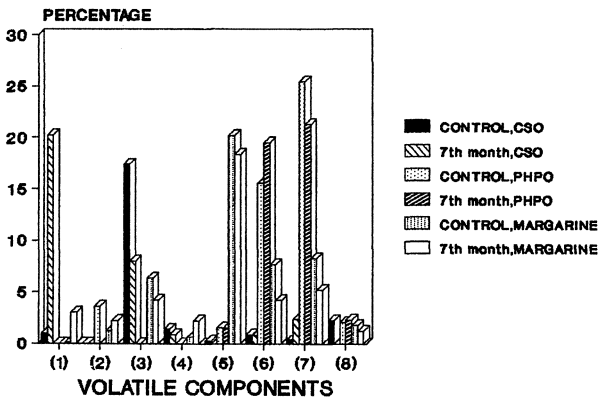
Peroxide values of different samples

Sample	Control	Metan can		White plastic	
		4th	7th	4th	7th
Bleaching cottonseed oil	0.4	16.3	35.1	19.0	24.0
Partially hydrogenated palm oil	4.1	20.3	45.5	24.2	35.0
Margarine	2.0	38.3	84.6	33.9	75.4



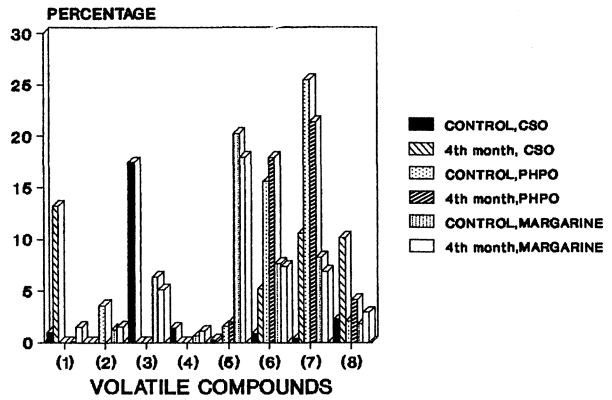
(1) Propanal (2) Hexanal (3) Methyl hexanoate
(4) 1-Octen-3-ol (5) Decanoic acid (6) Nonenal
(7) 2,4-Nonadienal (8) Ethyl heptanone

Figure 1
Volatile components of cottonseed oil, partially hydrogenated palm oil and margarine stored in metal cans for four months



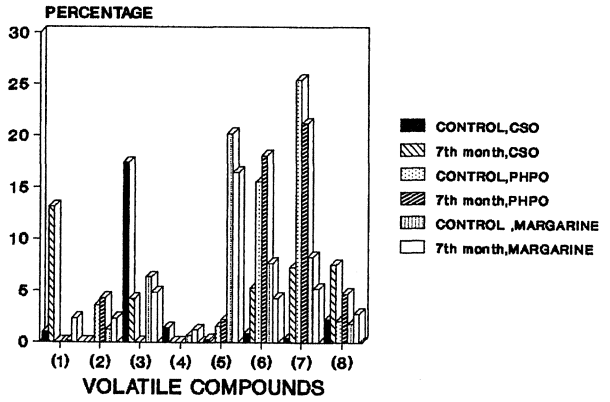
(1) Propanal (2) Hexanal (3) Methyl hexanoate
(4) 1-Octen-3-ol (5) Decanoic acid (6) Nonenal
(7) 2,4-Nonadienal (8) Ethyl heptanoate

Figure 2
Volatile components of cottonseed oil, partially hydrogenated palm oil and margarine stored in metal cans for seven months



(1) Propanal (2) Hexanal (3) Methyl hexanoate
(4) 1-Octen-3-ol (5) Decanoic acid (6) Nonenal
(7) 2,4-Nonadienal (8) Ethyl heptanone

Figure 3
Volatile components of cottonseed oil, partially hydrogenated palm oil and margarine stored in white plastic bottles for four months



(1) Propanal (2) Hexanal (3) Methyl hexanoate
(4) 1-Octen-3-ol (5) Decanoic acid (6) Nonenal
(7) 2,4-Nonadienal (8) Ethyl heptanone

Figure 4
Volatile components of cottonseed oil, partially hydrogenated palm oil and margarine stored in white plastic bottles for seven months.

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