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COMPARISON OF SUNFLOWERSEED, PALM AND SOYBEAN OILS FOR THE PREPARATION OF FROZEN FRENCH FRIED POTATOES

By

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Abstract

Oil from sunflowers grown in the northern United States was compared to soybean and palm oils for the preparation of frozen French fried potatoes. Freshly cut potatoes were blanched and then par-fried in the three oils. During frying make-up oil was added until one turnover of oil was complete (equilibrium). After equilibrium condition was reached, an additional 4.5 kilograms of fresh potatoes were fried, quick frozen and stored at -4 C for 3 months. All oils were sampled at regular intervals throughout the frying and were analyzed for changes in free fatty acids, fatty acid composition and for stability as measured by the active oxygen method (AOM). The unsaturated fatty acids and AOM values for all the oils decreased with increase in time of frying until equilibrium was reached. Sunflower oil had the lowest accumulation of free fatty acids with 0.19% as compared to 0.49 and 0.47% for soybean and palm oils respectively. Frozen French fried potatoes prepared in each oil averaged between 2.6 and 2.8% oil. Oil extracted from the stored fries showed no deterioration as measured by free fatty acids, peroxide values and fatty acid composition. Flavor evaluation of oven baked fries prepared in each oil and stored for 3 months showed no clear preference for any of the oils.

Introduction

Over the past 10 years a number of studies have demonstrated that sunflower oil is acceptable as an oil for deep fat frying (1,3,4,10-12). All studies showed that sunflowerseed oil has good oxidative and flavor stability and could be used interchangeably with oils commonly in use. A large commercial market for frying oils is in the preparation of potato chips. Potato chips have a somewhat limited shelf-life because the absorbed oil deteriorates when exposed to light and oxygen at room temperature. However, the preparation of par-fried frozen French fries also is a large market for potatoes. Both commerical and individual consumers are using increasing quantities of par-fried potatoes because they are easy to prepare and store. Oil deterioration is seldom a problem in this product even during storage for 3 months (13).

Frozen French fries can be finish-fried or oven baked. In the oven-baked fries the oil absorbed during par-frying would affect the final flavor (13).

With the large increase in the production of palm oil, larger amounts of this oil are being used in place of domestic vegetable oils (14). However,

little is known about the flavor characteristics of palm oil and its performance when used in par-fried products. In the United States most of the sunflowers are grown in the same area as potatoes. Possibly small co-ops could use sunflower oil to produce a high quality, marketable product with these locally produced raw materials.

In this study we compared sunflower oil to palm and hydrogenated soybean oils for the preparation of frozen par-fried French fried potatoes.

Materials and Methods

The oils used in this study were commercially refined and deodorized and contained 0.1 percent Tenox 20A antioxidant. The oils were frozen until used.

Russett Burbank potatoes were purchased in 56.7 kg lots from a local market. The potatoes were peeled and cut (10.2 x 0.95 x 0.95 cm) daily and were immersed in water, and as needed .45 kg lots were blanched at 75 C for 12 minutes. Strips were par-fried in a 4.7 liter household deep fat fryer at 180 C. Initially 1500 ml of oil was added to the fryer. Blanched potatoes were fried for 60 seconds in 0.45 kg lots. After every 10 lots, 150 ml of make-up oil was added until 1500 ml of oil, one complete turnover, had been added. This represents the equilibrium operating condition used in all continuous commercial deep fat frying conditions. Because of the high turnover of oil due to oil absorption by the product, and subsequent addition of fresh oil, the oil is constantly replenished and an equilibrium condition exists. After the equilibrium condition had been reached, an additional 4.5 kg of potatoes were fried and quick-frozen in dry ice for subsequent flavor and chemical evaluation.

Oil samples for chemical analysis were taken after 11.3, 22.7, 34.0, 45.4 and 49.9 kg of potatoes had been fried. Each sample was evaluated in two complete frying runs and each analytical datum in the tables is the average of two runs. Each sample of frying oil was analyzed in duplicate for percent free fatty acids (7), active oxygen method (AOM) values (8) and fatty acid composition (2).

Total oil content was determined in triplicate on the par-fried potatoes prepared in the equilibrium-condition oil. The potatoes were freeze-dried, ground and extracted in a butt tube for 6 hours with petroleum ether (bp 35-60c).

Oil extracted from potatoes fried in the equilibrium-condition oil was analyzed for percent free fatty acids, peroxide values (9) and fatty acid composition. Peroxide values and percent free fatty acids were also determined on the oil extracted from par-fried potatoes that had been stored for 0 and 3 months.

Flavor of potatoes was evaluated by a twenty member untrained panel. Par-fried potatoes were placed on a cookie sheet and baked at 232 C for 25 minutes. Each panelist was presented with three different coded samples and asked to ignore texture and to rate the flavor. Panelists also were asked to select the most and least preferred sample if a difference could be determined. Each sample was evaluated at four sessions.

Discussion

The fatty acid composition of the oils used in this study and the composition of the equilibrium-condition oils are shown in Table 1. During heating hydrogenated soybean oil decreased markedly in oleic acid but not in linoleic acid; this oil had been hydrogenated so no linoleic acid was present. Palm oil, which is high in saturated fatty acids, decreased only slightly in both oleic and linoleic acids. However, the northern produced sunflower oil in spite of its high percentage of linoleic acid showed almost no change in fatty acid composition during heating.

TABLE 1. Fatty acid composition of cooking oils (area %) before and after frying.

	Hydrogenated Soybean		Palm		Sunflower	
Fatty acids	Initial	Final[a]	Initial	Final	Initial	Final
16:0	10.8	11.7	43.3	49.3	6.0	6.5
18:0	7.7	9.7	4.0	3.9	3.9	4.4
18:1	75.5	70.1	38.5	36.9	17.4	18.1
18:2	4.5	4.6	11.9	8.6	70.6	69.4

[a] Sample was taken of 45.4 kg of potatoes that had been fried and represented one complete turnover of oil.

The build-up of free fatty acids in each oil after frying increasing quantities of potatoes is shown in Table 2. For oils in continuous use 1.0 percent free fatty acids generally is considered to be the upper limit with free fatty acids of between 0.4 and 0.7 percent as the level at oil equilibrium (13). Table 2 shows that none of the oils approach 1.0 percent free fatty acids and all oils would be considered of good quality by this index. Sunflower oil performed exceptionally well with maximum free fatty acids of 0.19%.

TABLE 2. Percent free fatty acid (% as oleic) in cooking oils on heating.[a]

Kilograms of potatoes fried[a]	Hydrogenated Soybean	Palm	Sunflower
0	0.16	0.16	0.12
11.3	0.14	0.13	0.09
22.7	0.23	0.27	0.12
34.0	0.29	0.30	0.14
45.4	0.38	0.40	0.16
49.9	0.49	0.47	0.19

[a] 45.4 kilograms represent one complete turnover of oil, 49.9 kilograms equilibrium condition oil.

Table 3 shows the AOM values of the oils after increasing quantities of potatoes were par-fried. As has been shown (3) the AOM value of a fresh oil is a poor indicator of the oil's ability to retain its oxidative stability on heating.

TABLE 3. Active oxygen method values[b] of cooking oils on heating.

Kilograms of Potatoes fried[a]	Hydrogenated Soybean	Palm	Sunflower
0	262.0	150.0	30.0
11.3	64.0	11.0	9.5
22.7	44.0	4.9	6.6
34.0	25.5	13.2	7.3
45.4	20.3	6.6	6.3
49.9	7.3	6.5	5.4

[a] 45.4 kilograms represent one complete turnover of oil, 49.9 kilograms is the equilibrium condition oil.

[b] Numbers of hours to reach a peroxide value of 100.

The initial AOM values for the oils used ranged from a high of 262 hours for the hydrogenated soybean oil to a low of 30 hours for the sunflower oil; palm oil had an intermediate value of 150 hours. All oils rapidly lost oxidative stability during the frying of the first 11.3 kg of potatoes. In spite of the great difference in initial AOM values, all three oils had essentially the same AOM value at equilibrium condition oil. With respect to oxidative stability, both the palm and sunflower oils reached an equilibrium condition fairly early, even before one complete turnover of oil, while the soybean oil took much longer.

As with potato chips the oil in which par-fried potatoes are prepared is an important factor in the flavor of the finished product (13). Due to the convenience and greater flexibility in meal preparation allowed by oven baking par-fried potatoes, the quality of the oil in which the potatoes are prepared plays an ever increasing role (13). Generally, oil content is 4-7% in par-fried potatoes (15) and 7-15% in finish-fried French fried potatoes (5.6). If the frozen par-fried product is finish-fried, the large proportion of oil that is absorbed during frying should have the most dominate effect on flavor. If the product is baked, the par-frying oil would dominate the flavor of the final product.

Table 4 shows the results of analyses conducted on the oil extracted. Total oil extracted from the par-fried potatoes ranged from 2.6 to 2.8 percent, nad was similar for all oils (Table 4). The quality of the oil in the potatoes did not deteriorate during storage; changes were small in peroxide values and essentially basent in the amount of free fatty acids. Fatty acid composition of the oil extracted from the stored par-fries, as expected, differed little from the equilibrium condition oil.

Table 5 shows the results of a sensory evaluation of the baked par-fried French fries. The total number of responses from four different panel sessions are given. Tabel 5 shows that there was no difference in panel preference and that all were equally acceptable. In addition no panelist was consistent in discriminating oils throughout the four panel sessions suggesting these oils had no effect on the flavor of the fries and each oil could be used interchangeably in the preparation of frozen par-fried potatoes.

TABLE 4. Chemical characteristics of oils extracted from par-fried potatoes.

Oils	Total oil (%)	Peroxide values storage time (months) 0	3	Free fatty acids (as % oleic) Storage time (months) 0	3	Fatty acid composition (area %) 16:0	18.0	18.1	18.2
Hydrogenated soybean	2.8	5.7	7.6	0.53	0.56	12.4	8.4	72.7	3.6
Palm	2.6	9.2	6.5	0.57	0.52	50.2	2.9	35.7	9.4
Sunflower	2.8	9.6	11.5	0.34	0.34	6.1	3.3	17.0	72.0

TABLE 5. Sensory evaluation of oven baked par-fried french fried potatoes.

Preference[a]	Hydrogenated Soybean oil	Palm oil	Sunflower oil
Most liked	28[b]	26	23
Least liked	27	20	21

[a] If two samples were evaluated as being equal but preferred or disliked over the third, both samples were recorded as being preferred most or least.

[b] Number of times preferred.

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