BLENDING STUDIES OF CANOLA WITH OTHER EDIBLE OILS

N.A.M. Eskin (1), S. Durance-Tod (1), L. Malcolmson (1), R. Przybylski (1) and M. Vaisey-Genser (1)

(1) Department of Foods and Nutrition, University of Manitoba
Winnipeg, Manitoba
CANADA R3T 2N2

INTRODUCTION

The susceptibility of edible oils to oxidative rancidity is related to the degree of unsaturation of their fatty acids. For example linolenic acid (C18:3) undergoes oxidative degradation three times faster than linoleic acid (C18:2) and twenty to thirty times faster than oleic acid (C18:0) (Labuza, 1971). Linolenic acid may initiate autoxidation and thus catalyze the oxidation of other fatty acids (Evans et al., 1972; Mounts et al., 1978). A relatively simple procedure for reducing C18:3 involves the blending of high C18:3 oils with low C18:3 oils. This paper reviews some of the work conducted in this laboratory on blending cottonseed, sunflower, palm, palm olein and soybean oil with canola oil.

MATERIALS AND METHODS

Study I:

Refined and deodorized canola and sunflower oil containing 0.04% antioxidant G-50C (10.7% BHT, 4.7% BHA, 4.0% propyl gallate and 4.0% citric acid in carrier oil) were provided by CSP Foods Ltd. (Saskatoon, SK). Refined cottonseed oil was provided by Canbra Foods (Lethbridge, AB) and deodorized at POS Pilot Plant Corporation (Saskatoon, SK) to which was added 0.04% G-50C. Canola oil blends were prepared by incorporating from 0 to 100% of sunflower or cottonseed oil in 25% increments.

Study II:

Refined, bleached and deodorized canola, soybean, palm and palm olein oils were provided by POS Pilot Plant Corporation (Saskatoon, SK). None of these oils had antioxidants added to them. Canola oil blends were prepared by incorporating from 0 to 100% of palm, palm olein, or soybean in 25% increments.

Storage Conditions:

1. Schaal Oven Test

To test the oxidative stability of blends in both studies, accelerated storage was carried out using the Schaal Oven Test over 12 days. Samples (50 ml) were stored in the dark at 60 or 65°C in open 80 ml red pyrex cups with oil samples removed initially and at two day intervals. Oil samples were transferred to glass vials, flushed with nitrogen and stored at -20°C prior to sensory and chemical analyses.

2. Photochemical Oxidation

To test for photochemical oxidation, oil samples (50 ml) were placed in disposable petri dishes (8.6 cm x 1.2 cm) and exposed to white fluorescent light (250˜25 ft. cdls.) at 40°C. Samples were stored for 4 days in study I and 7 days in Study II. Samples were removed initially and at 1 day intervals and treated as described previously.

Chemical Analyses

In both studies, oxidation was monitored by measuring peroxide value (PV) and thiobarbituric acid value (TBA) (Cocks and van Rede, 1966; Walker, 1985). Fatty acid composition of all oils were determined by esterification with sodium methoxide (Bannon et al., 1985) and separated on a capillary column (30 m x 0.25 mm i.d.) coated with DB-225 (J & W Scientific, Folsom, California). Column temperature was isothermal at 200°C. Total volatiles were measured by gas chromatography (Przybylski and Eskin, 1988). For quantitative analysis, tridecane was used as an internal standard at a concentration of 200 ng per sample. All analyses were conducted in duplicate.

Sensory Analyses

Samples (50 mL) for sensory assessment were placed in screw cap glass bottles and placed in waterbaths heated to 50°C. In study I, a ten-member trained panel evaluated all the oils and oil blends for perceived odor intensity using a 15 cm unstructured line scale ranging from band to very strong. In Study II, 7 trained panelists evaluated the oil blends for five main odor characteristics including painty, fishy, buttery, hay-like and grassy using a 15 cm unstructured line scale ranging from bland to very strong.

Results and Discussion

Study I

The C18:3 content of the parent oils ranged from 6.6% for canola oil, 1.9% for cottonseed oil and 0.4% for sunflower oil. The C18:3 content of canola oil was lower than expected due to unusually dry growing conditions that year.

The initial odor of cottonseed oil was rated moderately intense but after 4 days this intense odor had abated. Fig 1a and b show the change in odor intensity for both canola/sunflower and canola/cottonseed oils during accelerated storage from day 4 to day 12. The 100% canola oil developed a significantly more intense odor upon storage than either the 100% sunflower or 100% cottonseed oils. Blending 25% canola with either 75% sunflower or 75% cottonseed produced combinations which were similar in odor stability to that of the dominant sunflower or cottonseed oil.

Of the chemical indices of rancidity, TBA was found to correlate best with sensory analyses (Durance, 1986). The 100% canola oil oxidized at a significantly ($p<0.05$) greater rate, as measured by TBA value, compared to the 50% sunflower blend. No significant ($p<0.05$) difference was evident between 100% canola and the 25% sunflower blend. In the case of cottonseed oil, canola had significantly ($p<0.05$) higher TBA values than blends containing 25% and 50% cottonseed oil. No significant difference was observed between the 75 and 100% cottonseed samples.

Canola oil developed a more intense odor than sunflower oil following a 4 days exposure to fluorescent light (Durance, 1986). In sharp contrast, cottonseed oil developed the strongest odor of the three parent oils. The latter was attributed to the development of a "light-struck" odor as described by Fan and co-workers (8) due to photodegradation of the cyclopropanoid fatty acids. For example, the addition of 50% cottonseed to canola oil increased the mean odor intensity from 3.5 to 4.7. The opposite effect was observed when 75% sunflower was blended with canola oil resulting in a significant ($p<0.05$) decrease in mean odor intensity from 3.5 to 2.9 during exposure to fluorescent light.

These results demonstrated an improvement in the stability of canola oil to storage at 65°C in the dark when its C18:3 content was reduced by blending with cottonseed or sunflower oils. It is evident that canola oil can be successfully blended with 75% sunflower or cottonseed oil to produce combinations which are similar in odor stability to that of the dominant sunflower or cottonseed oil. Blending of sunflower oil also increased the stability of canola to fluorescent light with 25% canola not significantly affecting the stability of sunflower oil. The opposite effect was observed for cottonseed with a 75% blend of canola oil substantially improving the stability of cottonseed oil to fluorescent light exposure.

STUDY II.

The C18:3 content was 10.4% for canola oil, 8.7% for soybean oil to 0.2% for either palm or palm olein.

Of the five odor characteristics evaluated, painty was the only attribute found to increase consistently during storage typical of rancidity. Perceived painty odor was affected by both the proportion of the blend and storage interval for all blends examined. For example, canola/palm oil blends were significantly more intense in painty odor compared to palm oil, while 75% canola was more painty than the corresponding blends containing 50 or 25% canola oil. Painty odor increased with storage time and by day 12 was significantly greater than any of the other samples (Fig. 2a).

With respect to canola/soybean blends, the 100 and 75% canola blends were more painty than any of the other canola/soybean oil blends with the 12 day sample being significantly more painty than any of the other samples (Fig. 2b).

The results for canola/palm olein showed no apparent improvement in painty odor when blended with palm olein. Palm olein, itself, was shown to have a strong painty odor to begin with.

Chemical indices of rancidity showed a decrease in PV for all blends during the 12 day period with a substantial reduction in the presence of palm or palm olein compared to canola oil. A more modest decrease occurred with canola blends containing increasing amounts of soybean oil which became more marked at 12 days of accelerated storage. Data for TBA was less clear although blending canola oil with palm or palm olein and soybean did appear to slow down the production of secondary oxidation products. Measurement of total volatiles confirmed the improved stability of canola/palm oil blends. Based on total volatiles, however, canola and soybean oils behaved in a similar manner (Table 2). Palm olein reduced the accumulation of total volatiles in canola oil during storage which was quite contrary to the sensory data. The latter finding is an anomaly which remains to be elucidated.

In examining the effect of light on canola blends, a significant increase in painty was observed with increasing levels of palm olein. Based on chemical indices including total volatiles, which showed the opposite effect, this phenomenon can only be attributed to others factors present in palm olein (Table 2). In sharp contrast an ameliorating effect was observed for canola blends with palm or soybean oil. Mounts and co-workers (9) reported canola to be far more stable to light than soybean in the presence of citric acid. Since these oils did not contain any antioxidants, addition of citric acid could chelate metal ions responsible.

CONCLUSIONS

1. These studies show that the stability of vegetable oil blends to heat accelerated autoxidation and photochemical oxidation reflects the stability of the dominant parent oil.

2. Blending canola oil with cottonseed oil enhanced its stability to heat accelerated storage in the dark but lowered its stability to photochemical oxidation.

3. Blending canola oil with sunflower oil, palm oil or soybean oil improved its stability to heat accelerated storage in the dark and photochemical oxidation; all these oils were lower in C18:3 than canola oil. With respect to canola/palm and canola/soybean oil blends, however, no antioxidants were added.

REFERENCES

BANNON, C.D., CRASKE, J.D. and HILLIKER, A.E. 1985. Analysis of fatty acid methyl esters with high accuracy and reliability IV. Fats with fatty acids containing four or more carbon atoms. J. Am. Oil Chem. Soc. 62: 1501-1507.

COCKS, L.V. and van REDE, C. 1966. "Laboratory Handbook for Oil and Fat Analysis." Academic Press, London and New York.

DURANCE, S. 1986. The stability of canola oil blended with sunflower oil or cottonseed oil. M.Sc. Thesis. University of Manitoba.

EVANS, C.D., WARNER, K., LIST, G.R. and COWAN, J.C. 1972. Room odor evaluation of oils and cooking fats. J. Am. Oil Chem. Soc. 49: 587-582.

LABUZA, T. 1971. Kinetics of lipid oxidation. CRC Crit. Rev. Food Technol. 2: 355-404.

MOUNTS, T.L., WARNER, K., LIST, G.R., FREDRICH, J.P. and KORITALA, S. 1978. Flavor and oxidative stability of hydrogenated and unhydrogenated soybean oils: effect of antioxidants. J. Am. Oil Chem. Soc. 55: 345-348.

PRZYBYLSKI, R. and ESKIN, N.A.M. 1988. Comparative study on the effectiveness of nitrogen or carbon dioxide flushing in preventing oxidation during the heating of oil. J. Am. Oil Chem. Soc. 65: 629-633.

WALKER, R.O. 1985. (ed.) Official Methods and Recommended Practices of the American Oil Chemist's Society, 3rd edn., AOCS, Champaign, IL.

WARNER, K., FRANKEL, E.N. and MOUNTS, T.L. 1989. Flavor and oxidative stability of soybean, sunflower and low erucic acid rapeseed oils. J. Am. Oil Chem. Soc. 66: 558-564.

ACKNOWLEDGEMENTS

The authors acknowledge the assistance of Mr. J. Mickels of the POS Pilot Plant Corporation in carrying out this work. The authors are grateful to the Canola Council of Canada for their financial support of this work.

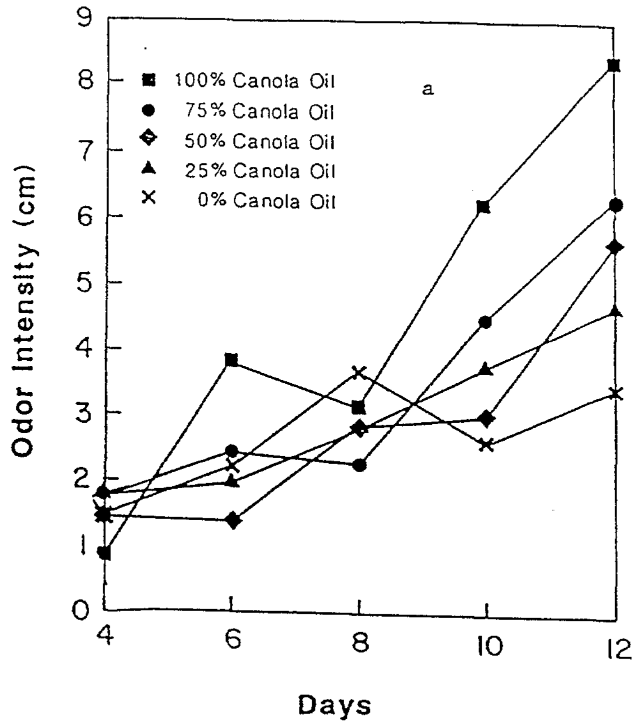

Fig. 1. Changes in odor intensity value of canola/sunflower (a) and canola/cottonseed (b) blends during accelerated storage at 65°C.

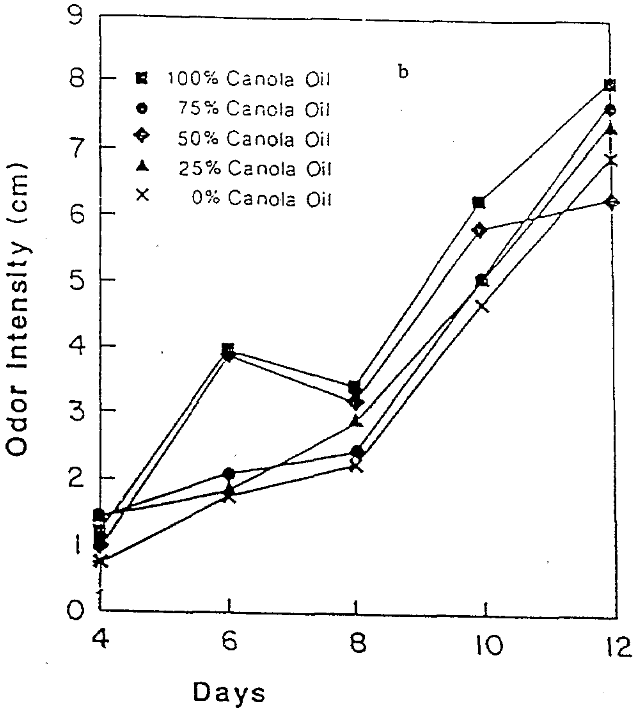

Fig. 1. Changes in odor intensity value of canola/sunflower (a) and canola/cottonseed (b) blends during accelerated storage at 65°C.

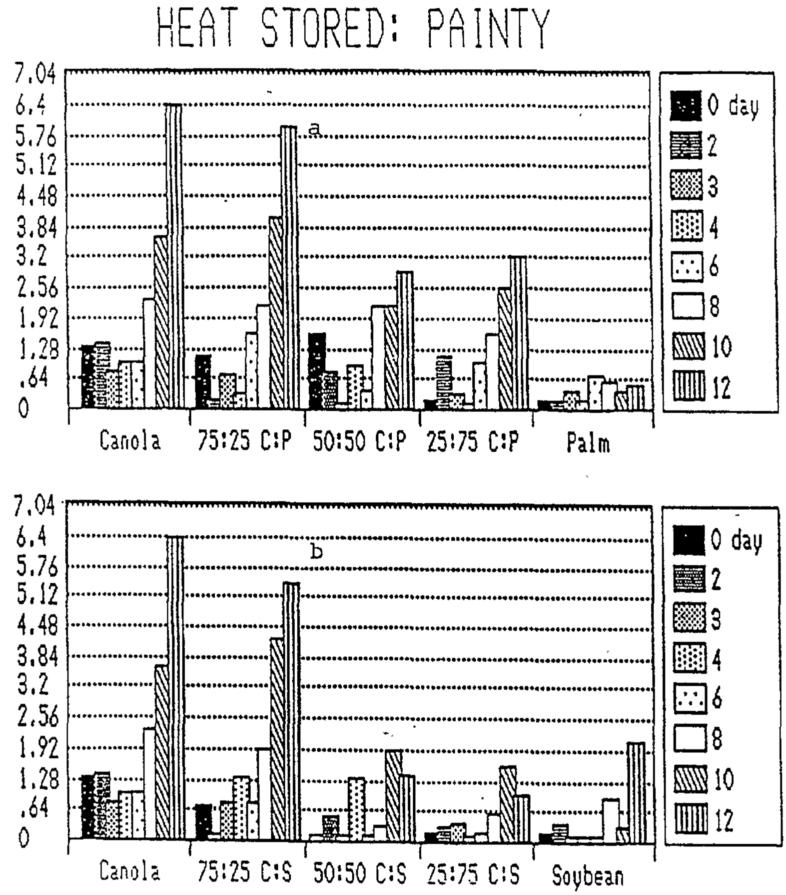

Fig. 2. Changes in painty odor of canola/palm (a) and canola/soybean (b) oil blends during accelerated storage at 60°C.