Analyses of Flavor Qualities of Vegetable Oils by Gas Chromatography[1]

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ABSTRACT

Soybean oil, hydrogenated soybean oil, and corn oil were exposed to fluorescent light for different periods of time to obtain a wide range of flavor qualities. The flavor qualities of these oils were evaluated by sensory and gas chromatographic methods. Sensory evaluation was conducted using a 10-point hedonic scale to rate overall flavor quality. The sensory panel was made up of 94 members from 8 different laboratories. The correlation coefficients (r) of the flavor scores between sensory evaluation and instrumental analysis for soybean oil, hydrogenated soybean oil, and corn oil were 0.95, 0.97 and 0.97, respectively. These results were very close to the correlation coefficients (r) 0.99, 0.98 and 0.95 obtained from 10 sensory panel members from one specific laboratory.

INTRODUCTION

Flavor quality and stability are usually determined by sensory evaluation. Even though sensory evaluation is a most important and common way to determine the flavor quality of oil, the method is time-consuming, tedious, expensive, variable among panel members, and not always available. With the remarkable advancements in analytical instruments in food science areas during the last 20 years, several papers (1-8) have been published on the evaluation of sensory qualities of oils by instrumental methods, which Min (8) summarized. The AOCS Flavor Nomenclature and Standard Committee (AOCS-FNSC) has been studying objective methods which could complement subjective organoleptic evaluations of oils since 1973 (9). These papers reported a good correlation coefficient of better than 0.90 between actual sensory scores and predicted sensory scores by a gas chromatographic (GC) method. However, most of the sensory evaluations used for the development of correlation coefficients between instrumental and sensory methods (2, 5,6) were performed with a limited number of panel members from one laboratory. Therefore, the scientific validity of excellent correlation coefficients reported in these studies has been questioned by some scientists. Another question has been whether GC analysis done by one laboratory would have a good correlation coefficient with the sensory scores obtained by other laboratories.

This paper reports correlation coefficients between sensory evaluations by 94 panel members from 8 laboratories and one laboratory instrumental GC analysis of soybean oil, hydrogenated soybean oil, and corn oil.

EXPERIMENTAL

Flavor Isolation, GC Analysis and Identification of Flavor Compounds

The detailed procedures for the preparation of the flavor isolation apparatus, flavor compounds isolation from oils, GC analysis of isolated flavor compounds, and identification of flavor compounds by mass spectrometry were described by Min (8) and are essentially the same.

Sample Preparation and Sensory Analysis

Soybean oil (Iodine Value [IV] 135), hydrogenated soybean oil (IV 110), and corn oil (IV 125) were exposed to 700-ft candle light of fluorescence by the method of Moser et al. (10) for different periods of time as shown in Table I.

The sensory analysis used was described in detail by Min (8). Sensory qualities of different oils were evaluated using a hedonic scale of 1-10, where 1 indicated the poorest flavor quality and 10 the highest flavor quality.

RESULTS AND DISCUSSION

The detailed sample description, flavor scores of 94 panel members from 8 different governmental, industrial and academic research laboratories, and the amount of geometric isomers of 2,4-decadienals are listed in Table I. Since these 8 different laboratories are members of the AOCS Flavor Nomenclature and Standard Committee (AOCS-FNSC) and are actively involved in the research on flavor qualities of edible oils, the sensory scores, which were supplied by AOCS-FNSC could be considered to be very reliable and representative. The flavor scores in Table I show that the flavor qualities of the three different oils decreased as the light exposure time increased, as was expected. Table I also shows that as the amount of isomers of 2,4-decadienal increased in the three different oils, the flavor scores of the oils decreased. Therefore, linear regression equations for the different oils were developed to determine the relationship between the sensory scores and the contents of 2,4-decadienal in the different oils. The linear regression equation for predicting flavor scores for soybean oil is $y = 7.94 - 0.0017x$, where y is the predicted flavor scores by a GC method and x is the combined areas of 3 and 4, which are geometrical isomers of 2,4-decadienal in the gas chromatogram. The linear regression equations for predicting flavor scores for hydrogenated soybean oil and corn oil are $y = 8.168 - 0.0037x$ and $y = 7.30 - 0.0013x$, respectively.

The predicted flavor scores for the three different oils obtained by using the linear regression equations are shown in Table I. The comparisons of the sensory flavor scores and the predicted flavor scores by gas chromatography show that results obtained by the two methods are in very good agreement. The correlation coefficients (r) between the instrumental gas chromatographic analyses and sensory evaluations for soybean oil, hydrogenated soybean oil, and corn oil were r = 0.95, 0.97, and 0.97, respectively, which may be considered excellent. These excellent correlation coefficients were obtained when 2,4-decadienals were isolated from oil at 160 C. However, if the 2,4-decadienals were isolated from oil at 180 C or other temperatures, there may be different correlations from these reported because these compounds are sensitive to heat applied during isolation. The careful temperature control for flavor compounds isolation is essential to obtain good reproducible results.

Min (8) reported that the predicted sensory scores obtained by a GC method using linear regression analysis for soybean oil, hydrogenated soybean oil, and corn oil were

[1]Presented at the 73rd annual meeting of the AOCS, Toronto, May 1982.

TABLE I

Sample description, sensory score and area of 2,4 decadienals and flavor scores of different oils

Type of oil	Light exposure (hr)	Area of 2,4 decadienals in GC[a]	Taste panel flavor score[b]	Predicted flavor score by GC[c]
Soybean	0	102	7.82	7.77
	1	164	7.97	7.66
	8	520	6.49	7.05
	45	1498	5.41	5.39
Corn	0	494	6.55	6.65
	1	879	6.20	6.15
	4	989	5.93	6.00
	44	1210	5.54	5.72
Hydrogenated	0	157	7.83	7.58
	1	112	7.46	7.74
	8	528	6.38	6.21
	27	681	5.48	5.63

[a]Peak area was calculated by electronic integrator in the gas chromatograph.
[b]Mean value of 94 panelists. (Reprinted by permission of *JAOCS* 59:116A, 1982.)
[c]Calculated by an individual linear regression equation for individual oil.

very close to actual sensory scores obtained by a sensory panel of 10 members from one laboratory. The correlation coefficients for soybean oil, hydrogenated soybean oil, and corn oil were r = 0.99, 0.98, and 0.95, respectively, which are very close to the results for the combined 94 sensory panel members from 8 different laboratories in this report.

Even though this work used only four samples each of corn oil, hydrogenated soybean oil, and soybean oil, when a large number of 20 different soybean oils were analyzed for flavor quality by a GC method and sensory analysis, an excellent correlation coefficient of 0.98 was reported by Jackson and Giacherio (6). Williams andApplewhite (7) also reported a correlation coefficient (r) of 0.88 when 23 soybean oils were evaluated by a gas chromatographic method and a sensory method. The evaluation of soybean oil flavor quality by different GC methods and sensory analysis has been extensively studied, and the results indicate that correlation coefficients of flavor scores between these two methods were excellent (2,3,5,6). However, no systematic study on the flavor quality evaluation of hydrogenated soybean oil and corn oil by GC methods and sensory method has been reported.

Therefore, it would appear that instrumental gas chromatography can be used to evaluate the flavor quality of vegetable oils. The present results support those of Dupuy et al. (2,3), Williams and Applewhite (5), and Jackson and Giacherio (6) for soybean oil and suggest further that instrumental flavor analysis is applicable to hydrogenated soybean oil and corn oil and probably all vegetable oils, treated or untreated.

ACKNOWLEDGMENTS

Samples of soybean oils, hydrogenated soybean oils, and corn oils with different flavor qualities were prepared by the USDA Northern Regional Research Center, Peoria, IL. AOCS Flavor Nomenclature and Standard Committee supplied flavor scores.

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[Received January 18, 1982]