A Simple, Graphic Procedure for Authentication of Commercial Fats and Oils Based on Fatty Acid Compositions in Codex Standards

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ABSTRACT

It is likely that fatty acid compositions as derived by gas liquid chromatography will soon become one of the mandatory criteria for authentication of individual (unmodified) commercial fats and oils in the standards of the Food and Agriculture Organization/World Health Organization's Codex Alimentarius Committee on Fats and Oils. A simple graphical procedure for using the Codex Committee's fatty acid composition standards to identify fats and oils has been devised and tested. Except for one sample, the fatty acid-based standards have not been found to conflict with some presently accepted mandatory standards (i.e., iodine value, refractive index, and saponification value).

INTRODUCTION

For several years, following initial proposals by the Canadian delegation, the Food and Agriculture Organization/World Health Organization Codex Alimentarius Committee on Fats and Oils has been considering the use of the gas liquid chromatography (GLC)-derived fatty acid composition as one of the criteria for authentication of individual (unmodified) commercial fats and oils. Canada's proposals were supplemented and developed by information from the International Olive Oil Council, AOCS members (1,2), many national delegations, and from a literature survey by the UK Secretariat of the Committee. At the Tenth Session of the Committee, in December 1978, an up-to-date list of fatty acid ranges for 17 commercial fats and oils was prepared. The Committee agreed to propose to the Codex Alimentarius Commission that fatty acid ranges should be included in the Codex standards as one of the mandatory criteria, with the proviso that supplementary nonmandatory criteria may be employed if considered necessary to ensure that a sample is in compliance with its description (3).

Concurrent with the development of the list of fatty acid ranges, a numerical procedure for using the ranges to identify 10 fats and oils was presented to the Codex Committee by the United States delegation in 1975 (4). The procedure has now been simplified by the use of graphs and, in the form described here, was submitted to the Codex Committee. The procedure received favorable consideration, and the Committee agreed that it could be used at the discretion of countries dealing with fats and oils (3).

MATERIALS AND METHODS

Required materials include standard graph paper (10 x 10 divisions to the centimeter) and a set of transparent overlay grids on which the individual Codex fatty acid composition ranges for each fat or oil have been plotted (see Fig. 1A). Alternatively, one transparent overlay grid could be used for the sample plot, and the Codex ranges for the fats and oils could be charted on individual sheets of graph paper.

Procedure 1

Plot the fatty acid composition of the fat or oil sample (Fig. 1B). Compare each standard with the sample by placing the individual overlays on the sample plot and lining up the coordinates. When all of the points on the sample plot fall within the ranges on one of the overlays, the sample is identified (Fig. 1C).

Procedure 2

If an identification is not made by Procedure 1 (some point(s) fall outside the standard ranges no matter which standard is used), repeat Procedure 1 noting the absolute differences between the sample values and the standard ranges for those points falling outside the standard ranges. Total these differences and identify the sample as that standard giving the lowest total if this lowest total is less than 2% absolute (Fig. 2). Accept no identification if the difference in value for any one fatty acid exceeds one-tenth of the upper limit for that fatty acid.

RESULTS AND DISCUSSION

The same principles apply to the procedures described here and to the method presented earlier to the Codex Committee (4). However, the procedure described here received a more favorable response because it entails fewer calculations and thereby eliminates possible sources of error. Changing from a numerical to a pictorial scheme makes it more amenable to translation, explanation and utilization.

Tests of this procedure with the original data base (4) plus other data which have been received since the first proposal yield the same results as found earlier and thus demonstrate the reliability of the procedure. Of course, the ambiguity between the ranges for safflower seed oil and sunflower seed oil (4) still needs to be resolved before these two oil types can be distinguished by this procedure.

Four of the six standards recently proposed offer certain complications. Low erucic acid rapeseed oil (LEAR) and palm oil are unique enough to be easily distinguished from the others. However, coconut, palm kernel and babassu oils are too similar to be identified by fatty acid composition and must for these purposes be considered together. Similarly, the fatty acid ranges proposed for edible grapeseed oil make it impossible to distinguish from both safflower seed and sunflower seed oils by GLC data.

An addition incorporated into Procedure 2 was proposed by the delegation from the U.K. because erroneous identifications may be made when fatty acids present (or specified) in relatively low concentrations are critical to a particular fat or oil. For example, the range for $C_{22:0}$ in arachis oil is 1.0–5.0% (4). If a sample was found to meet all the other specifications but contained 7% $C_{22:0}$, then it would fall within the allowable 2% absolute total difference. However, it would certainly be atypical for an arachis oil. Limiting the allowable deviation to one-tenth of the higher value for any range (e.g., 0.5% for $C_{22:0}$ in arachis oil), as suggested by the UK, would indeed help to avoid possible misidentifications.

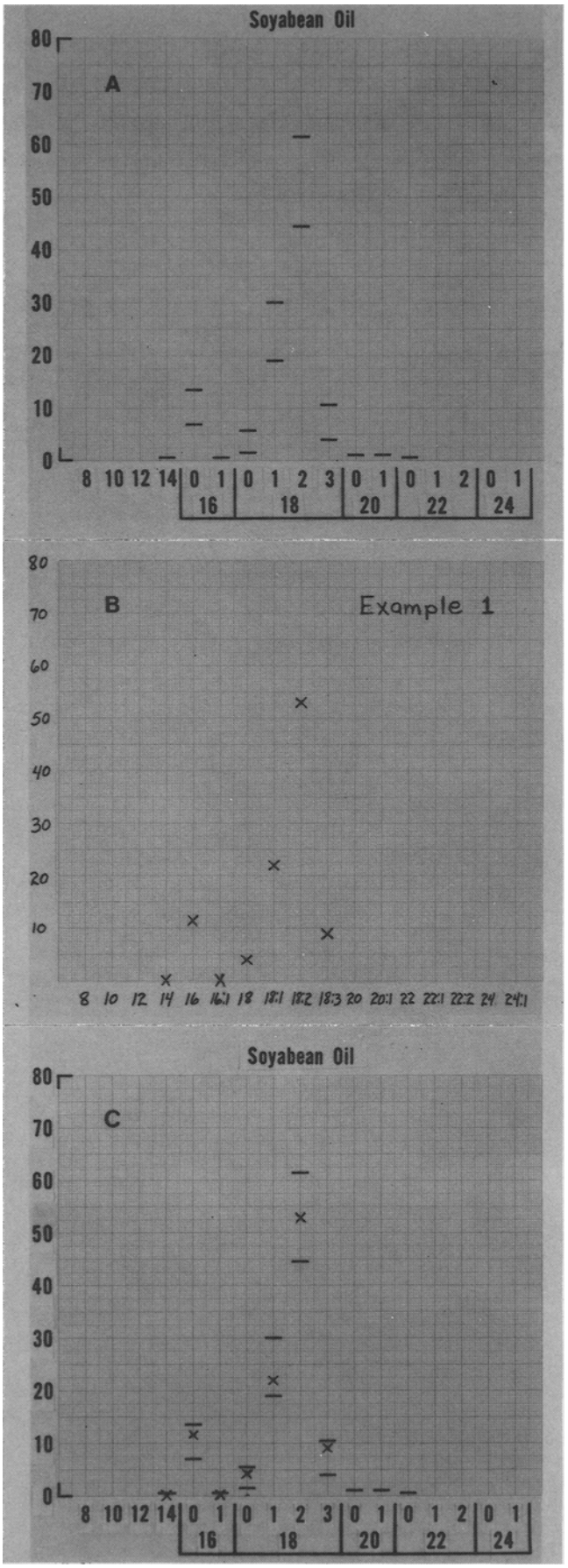

FIG. 1. An example of applying graphic standards for oil authentication. A = Overlay with standard for soybean oil. B = Plotted values for a sample. C = Soybean overlay on sample plot. Authentication is thus completed.

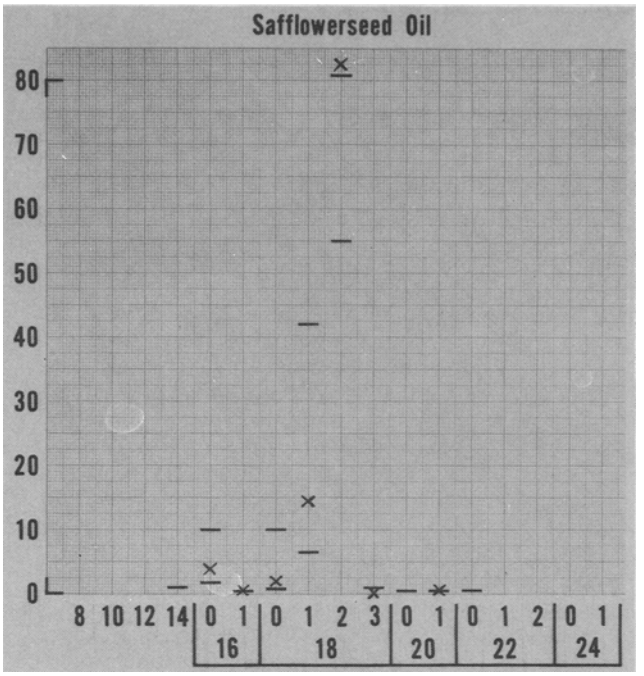

FIG. 2. Authentication by Procedure 2. Safflower standard overlaid on sample plot showing an absolute total deviation of 2% in 18:2.

Another concern was that the GLC-based procedures might conflict with other Codex mandatory standards such as iodine value, refractive index or saponification equivalent for a particular fat or oil. Experimental values for the samples in our test data base were not reported so calculated values based on the fatty acid compositions were obtained. An oil's iodine value can be calculated from its fatty acid composition by using the constants for oleic, linoleic and linolenic acids as given in the Official and Tentative Methods of the American Oil Chemists' Society (AOCS), 3rd Ed., Method Cd 2-38, together with constants easily derived for unsaturated acids with other chain lengths. (This derivation involves only the application of a simple molecular weight correction to the constant for the appropriate degree of unsaturation.) The validity of such a calculated iodine value has been discussed elsewhere (5). From this iodine value, a refractive index can then be calculated, because a linear relationship between iodine value and refractive index has been found over a wide range of iodine values (6). Also, a saponification equivalent can easily be calculated from the fatty acid composition. Values calculated for each sample fell within the appropriate Codex standard ranges except for the iodine value calculated for one coconut oil sample that gave a calculated value 2 units higher than the upper limit of the Codex standard (13 vs. 11). Therefore, no appreciable conflict between the fatty acid-based criterion and other criteria was found.

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