A Practical Analytical Method for Attaining Uniformity in Shortenings

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UNIFORMITY in shortenings is dependent in part upon the analytical controls that are used during their preparation. This applies both to hydrogenated and standard or blended types. An investigation of known analytical methods used for control on shortenings, was made at the Armour Laboratories. The purpose of this investigation was to improve these methods so that they would be better control guides, or to develop a new and better method. The result of this investigation was the development of a mechanical device labeled the "C" Number Machine, in which the "C" represents consistency. The machine principle has proved to be more valuable than methods such as iodine value, Wiley melting point, congealing point, and cloud-point determinations.

The principle involved in this machine is the increasing viscosity in an oil as crystals form during a temperature drop. The application of this principle is accomplished as follows: A standardized glass tube containing a definite volume of liquid fat or oil is immersed vertically to a set depth in a constant temperature cold water bath. A reciprocating plunger of special design mounted on a titer thermometer moves in the tube at a definite rate similar to a piston in a cylinder. A cap on the tube acts as a guide for the thermometer. As the oil is cooled in the water bath, crystals form. The friction between the plunger and the oil increases as a result of increasing viscosity of the oil until a point is reached at which the tube rises and falls with the plunger. When the rise of the tube reaches a definite height, an electric switch is closed, and the resulting flow of current causes a buzzer to sound. A temperature reading is taken on the thermometer to which the plunger is attached. This value is the "C" number in degrees Centigrade.

Definite advantages of this machine over other methods are its accuracy, sensitivity, and speed.

The purely mechanical aspect of the determination eliminates the subjective errors common in other methods. Reproducibility of results by inexperienced operators is the rule rather than the exception. In one series of check runs the maximum variations among five operators was 0.3°C.

The sensitivity advantage of the "C" number makes it an ideal control for hydrogenation, because greater uniformity in finished shortening is possible. Sensitivity of the "C" number is illustrated in the curves of figure number one. Samples of soybean oil were removed at intervals during hydrogenation and analyzed for Wijs iodine value, congealing point, and "C" number. A plot of the iodine number against the other constants is illustrated. It should be noted that the slopes of all of these curves change rather abruptly at about the same iodine value. This iodine value is called the critical point. Below it the physical characteristics of the hydrogenated product begin to change more rapidly for small decreases of the iodine

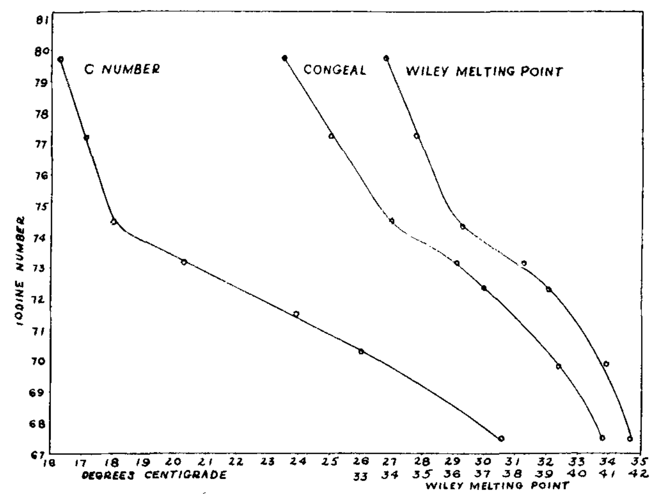

FIG. 1.

number. A comparison of the sensitivity of the various methods depended upon their rate of change beyond the critical point. In table number one is listed

TABLE I

Iodine Value	"C" Number	Congeal	Wiley M.P.
75	17.8	26.3	35.5
74	18.7	27.3	36.4
73	20.8	29.4	38.3
72	22.9	30.4	39.4
71	24.9	31.4	40.1
70	26.5	32.2	40.7

the various analytical results between iodine values of 70 and 75. Between the values 73 and 75, the sensitivity of the three methods was comparable. However, in the iodine range of 70 to 73, the variations per unit iodine value of the three methods were about as follows:

"C" number....................................2°C.
Congealing point..............................1°C.
Wiley melting point........................0.8°C.

The greater sensitivity of the "C" number plus the speed of its determination makes it a superior method. Normally a "C" number determination requires only five minutes.

Because the "C" number was an arbitrary value, it became necessary to determine the appropriate hydrogenation end-point range. Uniform plasticity in the finished shortening was the criterion used in determining this end-point range. During the course of the hydrogenation of soybean oil, samples of varying "C" numbered product were removed. These samples were plasticized, and penetration determinations were run on the shortenings at 70°F.

ILLUSTRATED in figure number two is a plot of the penetrations on two separate hydrogenations against the "C" number. The penetration values as given in figure number two were determined by the method described by A. D. Rich (1). The expressed

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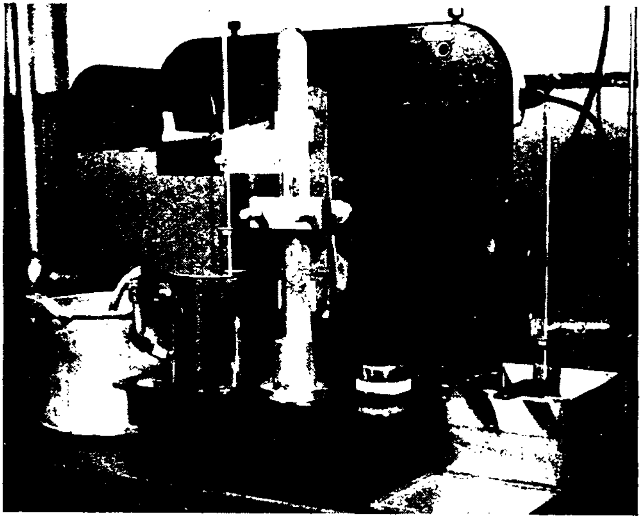

"C" Number Machine.

The first column lists the actual "C" numbers of the blends and the second column predicted "C" numbers based on percentage composition and calculated from the curves. The agreement is indicated in the third column which lists the difference between the actual and calculated values. The agreement may be seen to be fairly good over the wide range in "C" numbers from 16.6 to 46.9.

TABLE II

Actual "C" No. (C)	Calculated "C" No. (C)	Actual Calculated (C)