Measurement of Emulsion Stability by Pulsed Nuclear Magnetic Resonance (NMR)

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ABSTRACT AND SUMMARY

The stability of emulsions can be measured rapidly and accurately using pulsed nuclear magnetic resonance (NMR).

In a previous report, we described a pulsed nuclear magnetic resonance (NMR) method for obtaining an accurate estimate of rate of creaming in emulsions (1). One of the disadvantages of this method is that a large batch of emulsion must be prepared in order to fill a number of columns, each of which can be analyzed only once. Another disadvantage is that the emulsion is limited to those containing oils having melting points below ambient temperature since solid or plastic fats cannot be pumped through the flow cell.

A method has been devised which eliminates these disadvantages. The pulsed NMR analyzer was modified (Fig. 1) to accept a long precision bore tube (350 mm x 10 mm). The NMR tube is filled to 300 mm with the emulsion (ca. 20 ml) and driven at a constant rate through the analyzer. The drive mechanism consists of a synchronous recorder motor which makes two revolutions per min (The A.W. Haydon Company, Westbury, CT). The drive shaft is fitted with a rubber wheel which has a diameter of 7.96 mm. Activation of this drive mechanism will cause the tube to pass through the detector at a rate of 50 mm per min. In this manner, the concentration of the oil throughout the emulsion can be measured.

Besides the reduction in the size of the tube, the method also requires less emulsion due to the fact that a single tube can be analyzed repeatedly. The pumping used in the former method mixed the emulsion, therefore, it had to be discarded after a single reading. This method for measuring oil distribution can now be used as a tool to observe stability differences between emulsions stored over any time period. Figure 2 shows a profile of an unstable emulsion analyzed by the pulsed NMR method

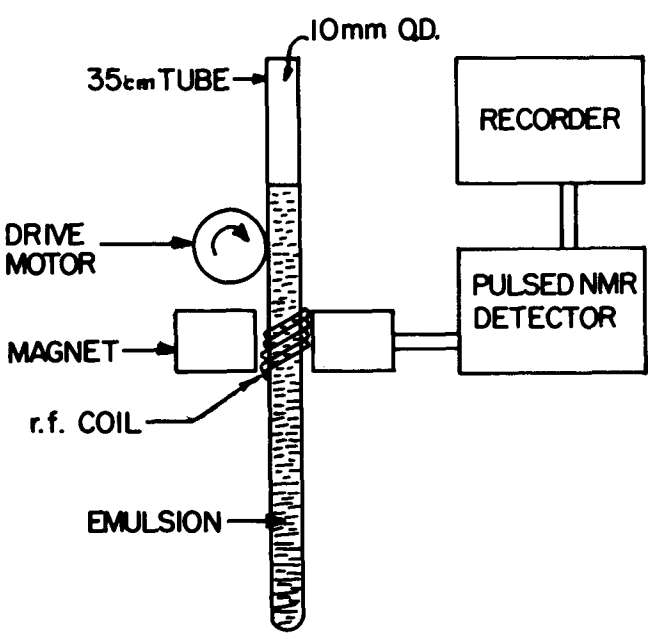

FIG. 1. Schematic of the apparatus used to determine the fat distribution of emulsions.

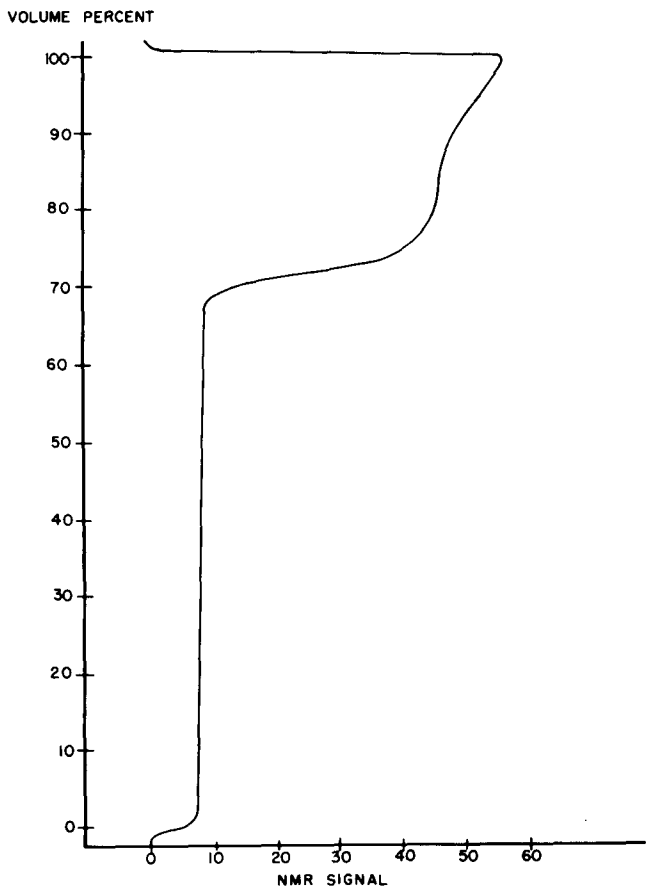

FIG. 2. Fat distribution profile of an unstable emulsion.

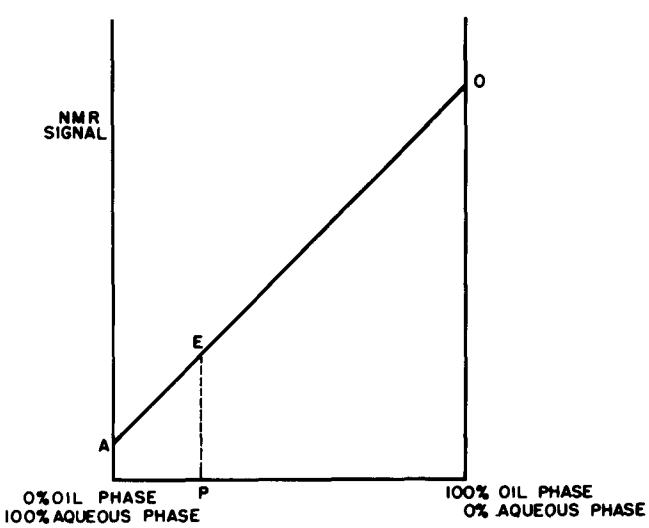

FIG. 3. Standard curve for oil distribution determination.

described above.

The oil distribution can be calculated from the NMR profile by preparing a standard curve. This is done by measuring the oil phase (0) and the aqueous phase (A) separately and plotting them on a simple phase diagram (Fig. 3); the oil signal at 100% oil and the aqueous phase at 0% oil. The NMR signal is linear throughout the entire range. When the emulsion is prepared from these two phases and analyzed by pulsed NMR, the signal (E) will correspond to the percent oil in the emulsion (P).

REFERENCES

1. J. Trumbetas, J.A. Fioriti, and R.J. Sims, JOACS 53:722 (1976).

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