SAUSAGE EMULSION STABILITY UNDER PILOT PLANT TESTS

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The object of this report is to show the application of experimental design and statistical treatment of data for a more complete understanding of sausage emulsion behavior during processing. The tests reported were conducted under pilot plant conditions. Commercially acceptable frankfurter formulations and processes were used in the study. Conventional style equipment was used and included an Alexanderwerk silent cutter of 70 pound capacity, a Buffalo stuffer of 100 pound size, a TY-Linker for linking, and a Julian smokehouse equipped for temperature and humidity control. Since the study is a statistical analysis of objective and subjective measurements, the design of the study, the tables of data, and the data analysis is lengthy. This information is distributed in nine mimeographed pages. Additional copies of these tables are available upon request to the authors.

The factorial design of the experiments permitted statistical evaluation of the influence of extreme variations in processing methods on the stability of the frankfurter emulsion during processing. Experimental treatments were designed to observe the influence of fat levels in the formulation between 24 and 30 percent fat as measured in the finished frankfurter, of chopping temperatures between 36 and 64 degrees F., of a normal or conventional length chopping period and of periods up to twice normal, of a dry smokehouse schedule with a final Relative Humidity of 77 percent, and of a wet smokehouse schedule with a final Relative Humidity of 90 percent.

Criteria for evaluating the extent of emulsion breakdown and fat separation were as follows:

a. Loss in the finished frankfurter's weight on peeling and washing with hot water. This loss was expressed in percent and accounted for all surface fat, fat caps, gelatin deposits, and free juices which may have formed under the cellulose skin of the frankfurter during processing.

b. Subjective scores for white fat caps at the ends of the finished frankfurters.

c. Subjective scores for surface fat which on occasion forms between the frankfurter's meat skin and the cellulose skin of the processed, unpeeled frankfurter.

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d. Subjective scores for the extent of gelatin pockets. No attempt was made to distinguish between gelatin and free juice on this evaluation score.

Criteria for the evaluation of specific palatability characteristics were as follows:

a. Texture scores
b. Wetness scores
c. Greasiness scores
d. Tenderness scores

The major differences in emulsion behavior and in palatability evaluation scores which became apparent through statistical analysis of the measurement appear in the mimeographed tables. They are summarized in the following statements.

Percent weight loss on peeling

This is an objective measurement of emulsion breakdown. Based on this evaluation, longer chopping periods were associated with more frequent emulsion separations and more extensive separations during processing. This undesirable effect of extended chopping periods was more pronounced at higher chopping temperature (up to 64°F.) than at lower temperatures (36°F.). A more humid smokehouse schedule (final R.H. 90 percent) resulted in more extensive emulsion breakdown, as measured by this observation, than a dryer smokehouse processing schedule (final R.H. 77 percent).

White fat caps

This subjective score for one indication of emulsion breakdown as evidenced by the fat cap formation is of particular interest because white caps are occasionally a troublesome occurrence in commercial sausage operations. Even though final chopping temperatures were controlled at recognized, safe levels by means of pulverized dry ice addition, white caps were more pronounced with longer chopping periods. Under most experimental tests the wetter smokehouse schedules produced more white caps.

Gelatin pockets

Extensive formation of gelatin pockets was associated with elevated temperatures during chopping. In addition, a more humid smokehouse processing schedule resulted in a more frequent occurrence of this evidence of emulsion breakdown.

Surface fat beneath the cellulose casing

A higher fat formulation, within the range of 24 to 30 percent fat as measured in the finished frankfurter, was associated with more frequent occurrences of surface fat. This evidence of emulsion breakdown was usually highly significantly associated with longer chopping periods. The
more humid smokehouse processing schedules were significantly associated with more surface fat deposits.

**Palatability panel scores**

1. **Texture**

There is a striking difference in texture among commercially produced frankfurters covering a range from some that are rather soft and even mushy to others which are rather firm and even hard or rubbery. The results reported here are in no way intended to suggest a level of desirability of texture but rather to evaluate associations which may exist between processing methods and texture.

The data indicated that formulations higher in fat content were softer in texture, but this association was statistically significant on only 25 percent of the tests. The more humid smokehouse schedules were accompanied with less product drying and a softer texture.

2. **Wetness**

Although higher fat levels of formulation within the range of 24 to 30 percent were associated with more wet palatability scores, these associations were not statistically significant. Any experimental treatment which induced severe fat separation in processing, of course lowered the oral wetness score which was necessarily based upon the frankfurter meat remaining after processing.

3. **Greasiness in mouth**

Within the range of 24 to 30 percent fat, on only one test in four did the fat in the formulation significantly influence the palatability score for greasiness.

4. **Panel tenderness score**

There was a noticeable association in the data between level of fat in the formulation and a more tender palatability panel score but on only one test of four was the association highly significant. An extended chop time did associate with a more tender score under most tests. On one test of three there was a highly significant association between tenderness and a higher fat percentage in formulation. On occasion a dryer smokehouse schedule was associated with a higher palatability score for "wetness" because the dry schedule failed to break the emulsion during processing with the result that the meat which remained and was presented to the panel was more moist than that from the wet smokehouse schedule which broke the emulsion, caused severe fat and gelatin deposits and produced dry meat product.
These experiments emphasize that there are many factors at work in commercial sausage operations which determine the final character of the finished product. The authors attempted to control all factors in addition to the intended experimental variables. The experimental treatments were rather extreme. The results confirm many popular beliefs pertaining to sausage processing; they also emphasize the need for much more complete information before commercial processing procedures can be guided completely by technical knowledge from laboratory and pilot plant studies.

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DR. WELLINGTON: We saved the anchor position in this committee report for the next speaker, and again we are indebted to the Executive Committee for alerting us to the possibilities of obtaining this talent for this committee report. Our next speaker is the director of the Danish Meat Research Institute at Roskilde, Denmark, and he will speak on Danish research on meat processing. It is indeed a pleasure for me to introduce Dr. Mogens Jul.

DR. JUL: Thank you, Mr. Chairman. I have been very happy to appear on this program under the title "Commercial Problems", but a little bit worried about the title that is given in your program, so much so that I wrote to Ernie Briskey about it and I got from your chairman the following permission to proceed at this time. He said that "The idea to give you a topic of Progress in Processing of Danish Meat Products was based on the premise that you would agree that the progress has been made through research." Incidentally, I cannot agree to this, and Ernie Briskey continues, "You could therefore describe your facilities, organization, etc. and make brief references as you go along to some of the more interesting research results." Thus I hope, with the permission also of you, Mr. Chairman, that I may do. I am quite self-conscious considering the fact that I should have been finished five minutes ago.

(Laughter)

But I have a number of slides to show you, and I am afraid starting on them is like starting on D-Day. Once the signal has been given there is not much we can do about it except carry on and hope we don't encounter any difficulties.

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