CHEMICAL AND PHYSICAL FACTORS INVOLVED IN FRANKFURTER PEELABILITY

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INTRODUCTION

Since the advent of the skinless frank, new problems have arisen in the sausage field. One of the most serious to the processor is the removal of the cellulose casing or "peeling" of the process frank. Tauber (1958) and Wilson (1960) reported that two of the main factors related to peeling of franks are surface formation or coagulation of the soluble protein by heat to form a "skin" and the moisture relationship between the surface of the frankfurter and the casing. Although surface formation and moisture relationships of the frankfurter are undoubtedly important factors in peeling, neither of the above two authors presented any research information to substantiate their reports, nor was any research information found in the literature concerning this problem.

To investigate this problem, a study was conducted to determine the chemical composition of the surface and the center of a skinless frank as affected by the smokehouse temperature, two different types of fat, the addition of collagen and the relationship of smokehouse temperature and the diameter of casing to the formation of a surface skin.

Further study was made to determine the effects of humidity, temperature, and types and levels of corn-syrup solids on peeling characteristics of frankfurters. These studies were conducted both in the laboratory and in a sausage plant under actual plant conditions.

PROCEDURE

The same basic formula was used for all of the various treatments conducted and is reported by Saffle et al. (1963). All batches were handled in the same manner except where the treatment was involved.

The effect of two extremes in smokehouse temperatures on the migration of chemical constituents was studied by placing one-half of each batch into a smokehouse at 130°F and the other half of the batch into a smokehouse at 170°F for 2 hours. After showering, samples 3 mm in diameter from the center and 1 mm in thickness from the surface of the frankfurter were removed for analysis. Protein, salt, moisture, sugar and fat analyses were conducted on both surface and center samples.

The effect of type of fat was studied by substituting beef kidney knob fat for pork fat and processing at 130°F initial temperature and raising the temperature 10 degrees every 15 minutes until a smokehouse temperature of 180°F was obtained. Casing size was investigated by stuffing into 21 mm casings and 30 mm casings and processing at both 130°F and 180°F initial temperature. The effect of collagen on peeling ease was determined by the

addition of 10% of the meat block as pork skin emulsion and processing in 21 mm casings at the two different initial temperatures, 130°F and 180°F. All frankfurters were processed to 155°F internal temperature in the conventional manner.

The same basic formula and procedures were used to study the effects of corn-syrup solids on peeling ease except that corn-syrup solids having dextrose equivalents (D.E.) of 30.2, 52 and 71 were added at the rate of 0, 1, 2, and 3 percent of the meat block. A second series of studies were made concerning corn-syrup solids except only the 52 and 71 D.E.'s were used. Dextrose equivalent is defined as a measure of the reducing sugar content of a sweetener calculated as dextrose and expressed as a percentage of the total dry substance.

The same basic formula and procedures were used to study the effect of four different levels of relative humidity (27, 52, 74, 88%) and 40, 50, and 60°F temperature levels on peelability of frankfurters.

All of the franks were peeled by a trained panel and scored on a hedonic scale of 11 points ranging from one (extremely difficult) to 11 (extremely easy). The frankfurters were held for at least 6 hours but not more than 18 hours in a constant controlled humidity-temperature cabinet before each peeling panel conducted. Unless otherwise specified the temperature was 50°F and the relative humidity was 88%. The minimum degrees of freedom for any one series of panels were 287.

Plant tests were conducted under actual plant conditions with different levels and amounts of corn-syrup solids. Results were expressed as the percent of those which were peeled by a Model 500 Ty peeler.

RESULTS AND DISCUSSION

Results showed that more protein and fat were found at the surface of the franks than from the center sample in both 130°F and 170°F treatments (Table 1). These differences were highly significant. Soluble protein did migrate to the furface and was deposited as moisture evaporated, forming a smooth skin needed for good peeling. There was more difference in surface and center samples from the 130°F treatment than from the 170°F treatment. This may have been due to a higher internal temperature in the 170° which coagulated the soluble protein before it could migrate to the surface to form a smooth skin. It is postulated that a smoother surface and better peeling is aided by starting the processing at lower temperatures.

Increasing the amount of fat, even to the point of "greasing out" or forming "whitecaps" will improve the peeling of franks but results in a greasy, uneconomical product. The substitution of a higher melting point, less unsaturated fat, beef kidney knob, for pork fat in the formula resulted in less fat migration to the surface of the frank during processing. However, franks with pork fat had higher peeling scores than franks with beef fat probably due, in part, to the greater amount of fat on the surface. This effect is shown by a comparison of treatments 3 and 5 (Table 2).

Treatments 3 and 6 (Table 2) show the effect of initial processing temperatures on the peeling ease of the frank. The lower starting temperature

of treatment 3 allowed time for a greater migration of soluble protein to the surface, thus creating a smoother surface and aiding peelability of the frankfurter.

The effects of casing size on peeling is shown by comparison of treatments 1 and 4 (Table 2). The difference of the mean peeling scores was significant and cannot be explained by only surface formation due to soluble protein migration as the low temperature frankfurter (treatment 4) should have a thicker skin. There is no evidence that a surface skin can be too thick as far as peeling ease is concerned. A possible explanation might be that at a higher temperature more fat migrates to the surface due to melting point characteristics, thus aiding peeling.

A comparison of treatments 2 and 7 (Table 2) shows that franks with pork skins added at a rate of 10% of the meat block and processed at an initial temperature of 180°F have greater peeling ease than those processed at 130°F initial temperature. This may be partially explained by the formation of a glue-like material from collagen, heat, and moisture in the franks processed at a lower temperature which would not form as completely in the franks processed at higher temperatures due to insufficient time. Also, franks processed at higher temperatures may have prevented the migration of collagen to the surface where its concentration could have affected the peeling of the franks. The reasons for these differences are not known and warrant further study.

An analysis of the salt content of surface and center samples of frankfurters before and after showering revealed that showering leaches the salt from the surface, thus resulting in lower salt concentration (dry wt. basis) on the surface than in the center of the frank (Table 1).

The results as shown in Table 3 revealed that peeling ease increased as the percent relative humidity increased for each temperature. It is postulated that one of the factors necessary for good peeling is a layer of moisture between the frankfurter and the casing. This lack of moisture

Table 1. Chemical analysis (dry weight basis) of frankfurthers heat processed at 130°F and 170°F.

	130°FC	130°FS	170°FC	170°FS
Protein	45.86	46.79	38.60	39.23
Salt	6.16	3.83	5.58	3.03
Fat	46.28	47.38	54.46	56.54
Sugar	1.70	2.00	1.36	1.20

C = center sample

S = surface sample

Table 2. Duncan's Multiple Range Test for mean peeling panel scores as affected by types of fat, pork skins, casing size and processing temperature.

Treatment Number	Type of Fat	% of Pork Skins	Casing Size (mm)	Initial Temp. of Smokehouse	Mean Peeling Panel Scores
1	Pork	0	30	180	6.86
2	Pork	10	21	180	6.25
3	Pork	0	21	130	5.56
4	Pork	0	30	130	5.53
5	Beef	0	21	130	5.22
6	Pork	0	21	180	5.04
7	Pork	10	21	130	4.11

] = any two or more means enclosed by the same bracket are not significantly different from each other at the 0.05 level of probability (total degrees of freedom = 503)

is probably the reason that frankfurters will not peel immediately after heat processing. It is believed that the layer of moisture between the frankfurter and the casing comes from the humidity in the air and/or the moisture migrated from the center of the frankfurter and the higher humidity retarded the evaporation of this layer of moisture.

For any one day the panel only peeled frankfurters at only one temperature. To have a better comparison of the effect of temperature on peelability a second study was made holding relative humidity constant at 88% and varying the temperature. The mean values for each temperature were 8.12, 7.74, and 8.72 for 40, 50, and 60°F., respectively. These differences were highly significant according to Duncan's Multiple Range Test, indicating that higher temperatures increased peeling ease.

The addition of various D. E. levels and amounts of corn-syrup solids showed that the 52 D. E. corn-syrup solids were significantly superior to the 31.2 and 71 D.E. corn-syrup solids at both 45% and 88% relative humidity with the greater peeling ease again being at the higher relative humidity. At the 88% relative humidity the 1 and 2% level of 52 D. E. corn-syrup solids were not significantly different from each other but were significantly superior to all other treatments. To substantiate these findings, another series of panel determinations were made at 88% relative humidity. Duncan's Multiple Range Test showed that the 52 D. E. corn-syrup solids were significantly superior to the 71 D. E. corn-syrup solids (Table 4). It was postulated that the aid to peeling by corn-syrup solids could be due

to their hygroscopic nature at the surface of the frank. The degree of hygroscopicity increases as the D. E. increases; thus, the higher D. E.'s should be most effective. However, there is a tendency for the adhesiveness to increase as the D. E. increases which might explain the reduction in peeling ease at higher D. E.'s.

Results of plant runs also verified that increased peeling ease was obtained by the use of 2% of 52 D. E. corn-syrup solids over 2 and 3% levels of 30.2 and 71 D. E. corn-syrup solids. In the former group 97% of the batch was peeled while the highest of the latter groups only 83.3% peeled.

Table 3. Effects of temperature and relative humidity on peeling ease as expressed by panel mean scores.

% Relative Humidity	Constant Temperatures 40°F	50°F	60°F
27	6.33	5.91	3.03
52	6.27	6.51	3.66
74	6.87	7.62	4.47
88	8.01	8.53	8.12

] = any two means enclosed by the same bracket are not significantly different from the other at the 0.05 level of probability.

Table 4. Duncan's Multiple Range Test for the effects of 2 types of corn-syrup solids at 3 levels at 88% relative humidity on peeling ease as indicated by mean panel scores.

D. E.		71			52		
% of C.S.S.	0	1	3	2	2	1	3
Means	5.04	5.22	5.49	6.30	9.10	9.56	10.02

Any two means underscored by the same line are not significantly different.
D. E. - Dextrose equivalent.
C.S.S.- Corn-syrup solids.

SUMMARY

1. Protein and fat migrated to the surface of franks during processing and are important factors in peeling ease.

2. Franks in 21 mm casings peeled easier when processed at lower (130°F) initial smokehouse temperature.

3. Franks in 30 mm casings peeled easier when processed at higher (180°F) smokehouse temperature.

4. The addition of collagen in the form of 10% pork skins resulted in easier peeling of franks processed at higher smokehouse temperatures as compared with those processed at lower smokehouse temperatures.

5. Less fat migrated to the surface when beef fat was substituted for pork fat which resulted in poorer peeling characteristics.

6. Showering lowered the salt content of the surface of the frank.

7. The 52 dextrose equivalent corn-syrup solids resulted in superior peeling characteristics as compared with other dextrose equivalents tested in both the laboratory and commercial plant studies.

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MR. SAFFLE: I think we are picking up some time here, and we do have time for some discussion. If anybody has questions

to anyone of the previous three speakers, we would be happy to have them at this time.

MR. GEORGE BRISSEY: I think Jim Price mentioned the tensile strength measurement of the bologna, and I wonder if you could tell us, Jim, how you made that measurement?

MR. PRICE: I'm not sure I can cite the reference that Harold used to design the instruments, I didn't see it, and I don't know if anyone else here can tell us or not.

MR. SWIFT: I could answer that, this was a design that a man in Beltsville made in a study of bologna about fifteen years ago and we got his permission to describe it in a paper and Dr. Bratzler had it duplicated with some minor modifications rounding off some corners, and what it simply is that across a couple of blocks he stretches a strip of product and adds weight in the middle until it snaps, and in this way he measured the strength of this strip of product.

MR. SAFFLE: Any other questions?

If not, Jim, I'll turn it back to you.

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CHAIRMAN KEMP: We will now have a recess of about twelve minutes.

MR. SAFFLE: I don't believe everybody is back in yet, but we are trying to make up our time and we are about on schedule again and we will go into the second part of our Meat Processing Committee's program which is Meat Pigments, which in virtually all cases or most cases, whether it is fresh or processed, we find that the shelf life is basically dependent upon the color. If the color fades we have lost the shelf life, and it is basically a matter of color rather than spoilage per se.

In the area of color, of course, a number of schools have worked in this area, and I believe that in the way of fundamental information that became available concerning some of the pigments, etc., we would have to take our hats off to the A.M.I.F., and specifically to J. B. Fox, who will present the area under the Fundamental Properties of Meat Pigments and Chemistry of Curing.

DR. J. B. FOX (A.M.I.F.): To cover the first part, I should have had some slides, but I will cover some of the basic characteristics on the blackboard.

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