Technological Developments in the Manufacture of Poultry Frankfurters

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A Review

It has been estimated that by 1982, the consumption of poultry in the United States may exceed the consumption of beef or pork. An important factor in this significant change in the meat buying habits of the American consumer has been the "boom" in processed chicken and turkey, including turkey ham and chicken and turkey frankfurters. In 1977, poultry frankfurters accounted for an estimated 2-3% of the total market (*Meat Industry*, June, 1977). In 1980, they accounted for over 8% of the frankfurter market and in some areas, poultry franks have captured market shares of 15-25%.

Low price has certainly been a factor in the increased consumption of poultry frankfurters, but consumer acceptance of the eating quality of the products and positive reaction to nutritional aspects, for example, their lower fat and higher protein content, have also played a role. Although almost all poultry franks are made from 100% mechanically deboned poultry meat, the poultry industry has avoided the controversy associated with mechanically deboned red meats.

Three major developments have contributed to the availability and utilization of poultry as a sausage ingredient. The first is the production revolution that has occurred in the poultry industry over the past thirty-five years. The number of turkeys and chicken broilers produced in the United States has grown at a phenomenal rate. The increased availability of chickens and turkeys had led to marketing innovations such as the merchandising of chicken parts and boneless turkeys in the supermarket and the growth of Food Service processed poultry products.

These changes brought about the second factor—centralized packaging—as gradually more of the packaging operations shifted from the supermarket to the processing plant. With a high demand for chicken breasts and legs and boneless turkeys, and a surplus of chicken necks, backs, and wings, and turkey frames, the processors were forced to seek out and develop new markets.

The third factor, the invention of the deboning machine which removed raw chicken meat from bone with greatly improved efficiency and economy, resulted in the utilization of the surplus chicken and turkey parts as sausage ingredients. One application for the mechanically deboned poultry meat has been as an ingredient in red meat sausage products. The standard for cooked sausage allows for the use of poultry meat in franks and bologna up to 15% of the ingredients except water. Poultry meat is also allowed in nonspecific loaves providing the red meat content exceeds the poultry content. In both cases, the poultry is listed only on the ingredient statement.

Another, more important application which rapidly developed was the use of mechanically deboned poultry meat for the manufacture of all poultry franks and sausage. There are no published USDA standards for poultry sausage, but general sausage standards are currently being applied through label approval systems until regulations specific for poultry sausage can be established. In the absence of regulations for poultry sausage, some differences exist between what is allowed for red meat sausage products and what is allowed for poultry sausage products. Two major differences are that poultry sausage products may be formulated with approved alkaline phosphates and with caseinates, while these ingredients are not allowed in red meat frankfurters, a standard or identity sausage product.

As I stated earlier, almost all poultry franks are made from 100% mechanically deboned meat. The major difference between processing red meat franks versus poultry franks is in the handling of this raw material. Mechanically deboned poultry meat is in a highly comminuted state and is also quite high in moisture. Therefore, it is an ideal medium for the growth of spoilage microorganisms. Ostovar, et al. (1971) reported a microbiological analysis of deboned broiler meat from two commercial plants. The results are shown in this table (1). After the material had passed through the final stage of the deboning process, the average total plate counts were 4.5×10^6 for plant A and 1.94×10^7 for plant B. There were also some Salmonella and Clostridium perfringens samples reported. Considering that these are initial counts for raw materials at a point of origin, they are quite high.

Clearly, in handling mechanically deboned poultry meat, it is necessary to keep it as cold as possible and to utilize the material as quickly as possible. If the material is handled fresh, it should be held at 32-36°F to retard microbial growth, and should be used within 48 hours. If frozen, mechanically deboned meat is subject to the development of rancidity, and therefore must not be held for more than ninety days before use. The product should also be stored at a temperature of −5°F or lower.

In an effort to establish better raw material control, many

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Table 1. Microbiological analysis of partial and fully commercial deboned broiler meat obtained from plants "A" and "B"*

Source[a]	Avg. Total Microbial Counts/G[b]	Range MPN Fecal Coliforms/G	No. Salmonella Positive	No. C. Perfringens Positive	No. S. Aureus Positive
Plant A					
RS	6.36×10^5	460 - > 1,100.0	1	0	0
FS	7.39×10^5	460 - > 1,100.0	1	0	0
SS	9.57×10^5	460 - > 1,100.0	1	1	0
TS	4.50×10^6	460 - > 1,100.0	0	0	0
Plant B					
RS	1.82×10^6	460 - > 1,100.0	1	2	0
FS	2.29×10^6	460 - > 1,100.0	1	1	0
SS	1.94×10^7	460 - > 1,100.0	1	0	0

[a]Source: RS = rough separator; FS = first strainer; SS = second strainer; TS = third strainer.
[b]Average of nine samples.
*Ostovar et. al., 1971. J. Food Sci. 36:1005-1007.

processors require the suppliers of mechanically deboned poultry to meet strict product specifications. A set of recommended specifications published in the June, 1977 issue of *Meat Industry* include the following:

A total microbial count	not to exceed 500,000/gram
Coagulase positive staph	not to exceed 1000/gram
E. Coli	not to exceed 100/gram
A fat content	not to exceed 25%
A bone content	not to exceed 0.5%
A TBA value	not to exceed 1 mg/kilo

In order to specify proper raw materials for the manufacture of high quality poultry sausage products, it is necessary to fully understand the nature and composition of mechanically deboned poultry meat.

In poultry frankfurter processing, the term "Chicken" refers to mechanically deboned chicken, including meat, skin and fat in their natural proportions as an ingredient. This material has a protein content of approximately 9.5 to 13.0 percent, a fat content of 17.0 to 23.0 percent, and a moisture-protein ratio in the range of 6.50 to 1.00. The term "Chicken Meat" refers to deboned white and dark meat (muscle only). This material has a protein content of approximately 12.0 to 14.0 percent, a fat content of 14.5 to 18.8 percent, and a moisture-protein ratio in the range of 5.50 to 1.00.

Both chicken and chicken meat are permissable as ingredients in all poultry and red meat franks. However, if the quantities of white and dark meat are not in their natural proportions, there must be a qualifying statement in conjunction with the name indicating the type of meat actually used.

For mechanically deboned turkey, the distinction between "Turkey" and "Turkey Meat" also exists. Mechanically deboned turkey differs from mechanically deboned chicken, however, in that it is generally obtained from whole carcass frames after hand deboning, while mechanically deboned chicken is obtained from chicken parts.

The natural skin content of whole carcass turkey is 15%. The natural proportion of skin for whole carcass chicken is 20%. Mechanically deboned chicken, therefore, is often higher in fat. (Table 2).

Table 2. Natural proportions of skin for chicken and turkey*

Product	Skin %
Chicken - Whole Carcass	20%
Chicken - Wings	35
Chicken - Necks	40
Chicken - Cooked Whole Carcass	25
Turkey - Whole Carcass	15
Turkey - Cooked Whole Carcass	20

*J. C. deHolt, 1978
Encylopedia of labeling meat and poultry product

The most common source of materials for mechanically deboned chicken are back meat (with skin), neck meat (with and without skin), and breast meat. The fat content of back meat with skin is in the range of 22-28%; neck meat without skin has a fat content of 8-12%, while neck meat with skin is in the range of 22-26%. Breast meat deboned from rib frames has a fat content of 13-16%.

Froning (1970) reported moisture, protein and fat content for mechanically deboned poultry from various sources including deboned chicken backs, deboned chicken backs and necks, and deboned turkey frames. The results are shown in this table (3). For both the deboned chicken and turkey products, the protein content was in the range of 13-14%. The fat content of the deboned chicken products was higher than that reported for the deboned turkey (17.6% and 21.2% for chicken, versus 11.5% for turkey).

The pricing for mechanically deboned poultry is based on whether the material is all muscle or includes skin, on the fat content, and on whether it is fresh or frozen. The pricing structure may be illustrated by examining the Urner Barry Price Current Report. Quoting the report dated June 17, 1981, the classes and prices for mechanically deboned poultry are as follows:

There are four classes of frozen comminuted turkey:

1. Turkey Meat (Salmonella free) at a price of $0.31 per pound.
2. Turkey Meat—20% fat—at a price of $0.25 per pound.
3. Comminuted Turkey—20% fat—at a price of $0.25 per pound; and
4. Comminuted Turkey—over 20% fat—at a price of $0.20 per pound.

There are three classes for frozen comminuted chicken:

1. Comminuted Chicken Meat at a price of $0.23 per pound.
2. Comminuted Chicken—20% fat—at a price of $0.18 per pound; and
3. Comminuted Chicken—24% fat—at a price of $0.18 per pound.

For fresh, refrigerated, mechanically deboned poultry meat, the upcharge is in the range of 1-3¢ per pound.

Baker et al., (1968) studied the effect of level of skin on the eating quality of chicken franks. The results of this study are shown in the following table (Table 4). Skin levels in the range of 5-20% had little effect on the tenderness or juiciness of the finished product. The authors reported that the addition of skin did not make the finished franks mushy; that, on the contrary, at levels above 20%, the franks were judged as more firm and chewy. It was concluded in this study that the quantities of skin found in commercial, mechanically deboned chicken would have little effect on the product texture.

Schnell et al., (1973) (Table 5) also studied the effect of percent skin on the eating quality of chicken frankfurters and reported that in addition to increasing the fat content of the product, the presence of skin in the formulation increased tenderness and viscosity. Again, at levels of skin in the range found in commercial, mechanically deboned poultry, the skin did not adversely affect the overall acceptability of the finished product. At a level of 30%, however, there was a significant decrease in product acceptability.

In the same study (Table 6), the authors also reported the effect of selected additives on the texture and eating quality of chicken frankfurters. The addition of 3 percent Sodium Caseinate significantly increased the firmness of the product, but the addition of 3 percent acid whey, 0.5 percent phosphate (KENA), or the addition of 1.75% salt to the poultry meat before mechanical deboning had little effect on the eating quality of the finished frankfurters. The authors also reported that the addition of the alkaline phosphates markedly decreased the viscosity of the raw emulsion and that the addition of sodium caseinate increased emulsion viscosity.

Table 3. Moisture, protein and fat content of various poultry meat sources

	Moisture	*Protein*	*Fat*
Paoli Deboned Chicken Backs and Necks	66.6	14.5	17.6
Beehive Deboned Chicken Backs	62.8	13.2	21.2
White Hand Deboned Chicken Meat	73.8	23.3	1.2
Dark Hand Deboned Chicken Meat	73.1	18.5	6.4
Paoli Deboned Turkey Frame Meat	73.3	13.5	11.5

Fronig, 1970. Poultry Sci. 49:1625-1631

Table 4. Effect of added skin on chicken frankfurters (taste panel scores)*

Level of Skin	*Tenderness*		*Juiciness*	
%	*Cold*	*Hot*	*Cold*	*Hot*
		Series 1		
0	6.15	6.31	5.69	6.31
5	6.00	6.03	5.22	5.88
15	5.31	5.50	4.91	5.47
		Series 2		
0	5.28	5.75	4.84	6.17
10	5.34	5.97	4.81	5.35
20	5.13	5.72	4.78	5.94
		Series 3		
0	6.09	6.31	4.88	5.81
30	4.94	5.53	4.53	5.34
40	4.94	5.38	4.63	5.50
50	4.31	5.16	4.91	5.18

*Baker et. al., 1968. Poultry Sci. 48:1989-1996.

Table 5. Effect of percent of skin on the palatability of frankfurters made from chicken puree*

Meat Source	Skin %	Taste Panel Scores[1] Tenderness	Juiciness	Flavor	Overall Acceptability
MDPM	0	7.3_{ab}[2]	6.6_{a}	6.3_{ab}	6.1_{ab}
	10	7.5_{a}	6.7_{a}	6.3_{ab}	6.1_{ab}
	20	7.6_{a}	6.8_{a}	6.3_{ab}	6.1_{ab}
	30	7.6_{a}	6.9_{a}	5.9_{b}	5.6_{b}
Commercial Puree	0	6.6_{d}	6.5_{a}	6.5_{a}	6.3_{a}
	10	6.9_{cd}	6.6_{a}	6.3_{ab}	6.2_{ab}
	20	7.0_{bc}	6.8_{a}	6.3_{ab}	6.1_{ab}
Total Carcass	0	5.4_{c}	6.0_{b}	6.0_{ab}	5.9_{ab}

[1]Taste panel scores represent the mean of 64 judgements.
[2]Means followed by the same subscript letter are not significantly different from each other ($P < 0.05$).
*Schnell et. al., 1973. Poultry Sci. 52:1363 1369.

Table 6. Effect of selected additives on the palatability of frankfurters made from chicken puree*

Meat Source	Additive	Taste Panel Scores[1] Tenderness	Juiciness	Flavor	Overall Acceptability
MDPM	None	6.9_{a}[2]	6.5_{a}	6.5_{a}	6.4_{a}
	Sodium Caseinate	6.0_{b}	5.5_{b}	6.3_{lg}	6.3_{a}
	Acid Whey	6.4_{ab}	6.3_{a}	6.4_{ab}	6.5_{a}
	Kena	6.9_{a}	6.4_{a}	6.3_{ab}	6.3_{a}
	NaCL[3]	6.9_{a}	6.5_{a}	6.1_{ab}	6.5_{a}
Commercial Puree	None	6.2_{b}	6.3_{a}	5.9_{b}	5.9_{ab}
	Sodium Caseinate	5.9_{b}	5.7_{b}	6.0_{b}	5.8_{b}
	Acid Whey	6.0_{b}	6.2_{a}	6.3_{ab}	6.2_{ab}
	Kena	6.2_{b}	6.3_{a}	6.2_{ab}	6.2_{ab}

[1]Taste panel scores represent the mean of 64 judgements.
[2]Means followed by the same subscript letter are not significantly different from each other ($P < 0.05$).
[3]NaCl was added before putting meat through pupler, instead of during emulsion preparation.
*Schnell et. al., 1973. Poultry Sci. 52:1363-1369.

Table 7. Mean total and salt-soluble protein in various fresh broiler tissues and their calculated binding constants and binding coefficients

Tissue	Total Protein %	Salt Soluble Protein[1] %	Mo. Oil Emulsified 100 MG. Sol. Pro.	Constant Bind Value[2]	Binding Coefficients[3]
Light Muscle	24.2%	42.1%	16.1	6.76	1.64
Dark Muscle	18.9	34.4	22.3	7.67	1.45
Gizzard	18.3	28.1	26.6	7.47	1.37
Heart	15.3	24.7	29.4	7.56	1.15
Neck and Back	13.2	42.7	27.5	11.74	1.17
Bone Residue	17.2	22.0	36.1	7.94	1.37

[1]Expressed as a percentage of total protein.
[2]% Salt-soluble protein × ML. oil emulsified/100 MG. soluble protein.
[3]Constant bind value × % total protein.
Parkes and May 1968. Poultry Sci. 47:1236-1240.

Mechanically deboned poultry meat should not be considered as a low bind ingredient. Parkes and May (1968) reported total protein, salt soluble protein and calculated bind values for various fresh broiler tissues. The results are shown in this table (Table 7). Clearly, the protein content of all of the materials is high, as are the bind values and binding coeficients.

Hudspeth and May (1969) (Table 8) reported the constant bind values and binding coeficients of skin, gizzard, heart, light muscle and dark muscle for four classes of poultry—turkey, hen, duck, and broiler. These results also illustrate the adaptability of these materials as functional sausage ingredients.

Table 8. Constant bind value and binding coefficient for various poultry tissues*

Tissue	*Class of Poultry*	*Constant Bind Value*[1]	*Binding Coefficient*[2]
Skin	Turkey	3.47	0.28
	Hen	5.75	0.55
	Duck	6.42	0.35
	Broiler	5.71	0.71
Gizzard	Turkey	3.92	0.85
	Hen	4.57	0.92
	Duck	4.88	0.81
	Broiler	7.56	1.33
Heart	Turkey	4.94	0.82
	Hen	4.63	0.74
	Duck	5.96	0.97
	Broiler	7.26	1.05
Light Muscle[3]	Turkey	4.39	1.03
	Hen	5.98	1.45
	Duck[4]	8.04	1.41
	Broiler	6.79	1.52
Dark Muscle[3]	Turkey	4.53	0.93
	Hen	5.97	1.46
	Broiler	7.57	1.42

[1]% Salt-soluble protein × ML oil emulsified/100 MG soluble protein.
[2]Constant bind value × % total protein.
[3]Calculated from data of Hudspeth et. al. (1967).
*Hudspeth and May, 1969. Food Technology 23:99-100.

Due to the variation in the fat content of mechanically deboned poultry meat, when formulating poultry franks it is a good practice to establish a fat target for the raw meat ingredients. This will assure that the finished product will have a more consistent finished fat level and overall chemical composition. The fat content of most poultry franks is in the range of 20-25% and the protein content is in the range of 12-14%. Baker and Darfler (1975) (Table 9) studied the effect of protein level on taste panel scores for frankfurters made with mechanically deboned poultry meat and determined that the overall acceptability of the product was significantly higher for franks with a protein content of 15%, suggesting that within limits, a lean poultry frank is preferred. This level is slightly higher than the protein content of most commercially available poultry franks.

Table 9. Effect of level of protein on taste panel scores for frankfurters made from MDPM*

Protein Level %	*Parameter*			
	Tenderness	*Juiciness*	*Flavor*	*Overall Acceptability*
9	8.9_a(1) (2)	8.6_a	6.8_a	3.6_c
12	7.9_b	7.8_b	6.9_a	5.3_b
15	5.6_c	5.8_c	6.6_a	6.9_a
18	3.8_d	4.6_d	6.9_a	4.9_b

(1)Each mean is the average of 16 judgements for each of the two runs.
(2)Means followed by the same subscript letter are not significantly different at the 5% level.
*Baker and Darfler, 1975. Poultry Sci. 54:1283-1288.

Newkirk et al., (1978) (Table 10) reported proximate analysis and cholesterol content of chicken versus meat and beef frankfurters. All samples were commercial products obtained from area supermarkets. In this study, there was very little difference in the chemical composition between the red meat franks and chicken franks, but in every case, the red meat frank contained considerably less fat than the maximum allowable level of 30 percent. It is interesting to note that the cholesterol levels reported for the chicken franks were over twice as high as the level reported of meat and beef franks.

Table 10. Proximate analysis and cholesterol content of frankfurters*

Sample	*Proximate analysis, G/100G of Product Cholesterol, MG/100G of Product*				
	Water	*Protein*	*Ash*	*Total Fat*	*Cholesterol*
Frankfurters					
Beef-Pork 1	54.2	12.6	2.5	26.6	41
Beef-Pork 2	51.0	14.5	2.6	25.1	44
Beef-Pork 3	51.0	14.5	2.6	28.4	55
All Beef 1	48.7	13.9	2.4	26.4	41
All Beef 2	52.4	13.7	2.4	23.9	35
All Beef 3	51.0	13.9	2.4	26.3	44
Chicken 1	54.2	13.9	2.5	24.9	100
Chicken 2	54.0	13.1	3.4	22.3	86
Chicken 3	54.1	13.1	3.0	22.9	96

*Newkink et. al., 1978. J. Agric. Food Chem. 26:348-350

Recently, I selected duplicate samples of three brands of commercial chicken franks and three brands of commercial turkey franks and had the samples analyzed for fat, moisture, protein, salt and calcium. The results are shown in the following tables:

The chicken franks (Table 11) had fat levels in the range of 20.1% to 27.5%. On averaging the duplicate samples, all three products had fat levels in the range of 20%-25%. The protein levels ranged from 12.8 to 13.9%.

Table 11. Composition of selected commercial chicken frankfurters

Product	Moisture %	Fat %	Protein %	Salt %
A_1	59.2%	23.2%	12.9%	2.6%
A_2	58.8	22.8	12.8	2.6
B_1	58.1	22.7	13.9	2.4
B_2	54.4	27.5	13.5	2.5
C_1	60.4	20.1	13.5	3.5
C_2	60.3	20.4	13.5	3.0

The turkey franks (Table 12) generally contained slightly more moisture, more protein and less fat than the chicken franks. The fat levels for turkey franks ranged from 15.5% to 24.0% and the levels of protein ranged from 12.7% to 14.4%.

Table 12. Composition of selected commercial turkey frankfurters

Product	Moisture %	Fat %	Protein %	Salt %
A_1	54.7%	24.0%	14.2%	2.4%
A_2	55.2	23.2	14.4	2.5
B_1	64.5	15.5	13.4	2.9
B_2	64.2	16.1	13.7	2.9
C_1	61.3	19.1	12.8	3.1
C_2	61.9	18.9	12.7	3.1

It is interesting to note the variation in calcium content between the products. For chicken franks (Table 13), product B had substantially more calcium than products A or C, indicating higher levels of bone in mechanically deboned poultry meat used for formulating product B.

Table 13. Calcium content of selected commercial chicken frankfurters

Product	CA/MG/100 GM
A_1	88
A_2	81
B_1	278
B_2	302
C_1	83
C_2	88

In comparing the calcium levels of the turkey franks (Table 14), the results were remarkably consistent between the three products and were generally higher than the calcium level found in the chicken franks.

In the actual manufacture of poultry franks, the procedures used are similar to those used for red meat franks, but there are important differences. If the mechanically deboned poultry meat is handled fresh, it may be added directly to a blender where salt, spices and cure are added and mixed for extraction of salt soluble muscle proteins and the dispersion of spices and cure. If water is used it would also be added into the blender. Due to the high moisture content of the mechanically deboned poultry meat, the levels of water added during processing would be less than that added to red meat franks and often no water is added at all.

Table 14. Calcium content of selected commercial turkey frankfurters

Product	CA/MG/100 GM
A_1	136
A_2	144
B_1	147
B_2	147
C_1	143
C_2	140

The blended material would then be either chopped or passed through an emulsifier to further reduce the particle size, to stabilize the meat better, and to provide for a uniform texture.

If the mechanically deboned poultry meat is handled frozen, it must either be tempered before use or prebroken in a grinder before blending. In an operation geared to frozen raw materials, the blender would probably be equipped for live steam injection or would be steam jacketed in order to elevate the temperature of the mechanically deboned meat.

Some manufacturers have a chopper oriented operation for handling mechanically deboned poultry. Here the chopper is used to break up frozen mechanically deboned meat, for mixing with other ingredients and for reducing particle size, stabilizing the batter, and establishing a uniform texture. When using a chopper, however, the manufacturer should consider the fact that the mechanically deboned poultry meat is already in a comminuted state and over-chopping should be avoided. In addition, if an emulsifier is used in conjunction with a chopper, the chopping time should be substantially reduced.

Baker et al., (1974) (Table 15) reported the effect of chopping time on frankfurters made from mechanically deboned poultry meat from three deboning machines. In this study all products were chopped to an end temperature of 12°C (53.6°F) independent of chopping time. This was accomplished by adjusting the starting temperature of the raw materials. The chopper was not used in conjunction with a emulsifier in this study. The authors reported that chopping time had little effect on the results of objective textural measurements or taste panel evaluations. This table, however, shows differences between the mechanically deboned poultry meat from the three machines with respect to cooked stability and heating loss in relation to chopping time. This suggests that for some mechanically deboned poultry products it is possible to under-chop. These differences may have been due to differences in the degree of comminution of the mechanically deboned poultry meat from the different deboning

Table 15. Effect of chopping time* on frankfurters made from MDPM from three sources

Machine	*Chopping Time*	*Yield* %	*Cooked Stability* %	*Heating Loss* %
A	Short	87.9	$+0.4_{a}$**	1.2_{a}
	Medium	87.4	$+0.4_{a}$	1.4_{a}
	Long	87.6	$+0.2_{ab}$	1.4_{a}
B	Short	88.9	-2.2_{b}	2.0_{a}
	Medium	88.4	$+0.3_{ab}$	2.1_{a}
	Long	88.8	$+0.2_{ab}$	1.7_{a}
C	Short	87.0	-6.4_{c}	10.9_{c}
	Medium	86.8	-2.2_{b}	4.9_{b}
	Long	87.7	-1.6_{ab}	5.4_{b}

*Short chopping time 1.5 to 3 minutes, medium = 5 to 11 minutes, long = > 15 minutes.
**Means followed by the same letter are not significantly different from each other, according to Duncan's multiple range test ($P < 0.05$).
Baker et. al., 1974. Poultry Sci. 53:156-161

machines. The results also indicate that there is little to be gained from a long chopping time for poultry frankfurters and generally, it is in the best interest of the processor to minimize chopping time for increased production efficiency.

The next manufacturing step is the stuffing of the raw meat batter. This is accomplished using the same procedures as are used for red meat frankfurters, usually a positive displacement transfer pump in conjunction with a frankamatic. Baker et al., (1970) studied the effect of stuffing variables—specifically casing type and stuffing speed—on tenderness, juiciness, flavor and shear values. Although no difference was found in tenderness, juiciness or flavor for the interior of franks stuffed into cellulose (skinless) collagen or natural casings, overall acceptability scores showed a definite preference for "skinless" frankfurters.

The stuffing speed (varying from hand stuffing to high speed stuffing) had no significant effect on the finished product as measured by taste panel scores or shear values.

Generally, stuffing variables are not critical, provided good manufacturing practices are followed and the poultry franks are processed in cellulose casings for marketing as "skinless" frankfurters.

The thermal processing of poultry franks is an area of importance to the manufacturer due to concerns for the eating quality and the microbiology and shelf life of the finished product. As pointed out earlier, poultry franks have a high protein content and therefore will form a skin very quickly under normal humidity conditions in a smokehouse. In order to avoid a tough external skin, it is necessary to process poultry franks at a higher relative humidity than is generally used for red meat franks.

Mast and MacNeil (1975) studied the effects of pasteurization time and temperature on the total bacterial counts of mechanically deboned poultry meat. The results of their study is shown in the following tables (16 and 17). At temperatures representing fully cooked poultry frankfurters, 65°-71°C, a six-minute period at the endpoint temperature reduced the bacterial load sufficiently. Within limits, however, a higher than minimal endpoint temperature is desireable to assure a proper thermal kill and thus extend the shelf life of the product. An endpoint temperature of 71°C (or approximately 160°F) is, therefore, recommended.

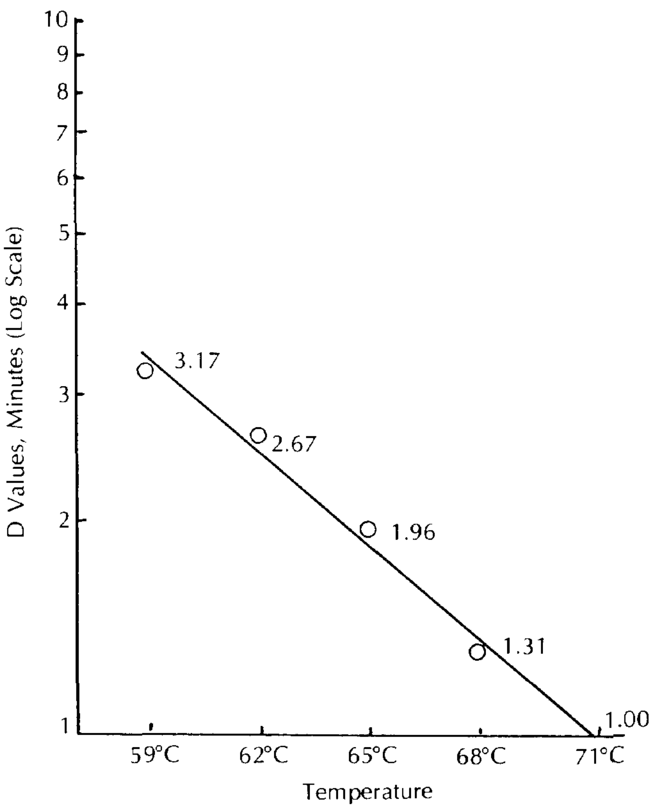
The finished poultry frankfurter is generally darker in color than red meat frankfurters and has a characteristic flavor that is different from beef or meat franks, but apparently is well accepted by a large number of consumers. Processors have improved the flavor of poultry franks through better handling of raw materials, thus reducing the oxidized character of

Table 16. Effects of pasteurization time and temperature on total bacterial counts of mechanically deboned poultry meat*

Pasteurization Time (Minutes)	*Pasteurization Temperature*				
	59°C	*62°C*	*65°C*	*68°C*	*71°C*
0	1.41×10^5	2.46×10^5	3.16×10^5	2.96×10^5	1.13×10^7
1	9.01×10^4	1.93×10^5	1.84×10^5	2.47×10^5	6.82×10^6
2	6.82×10^4	8.85×10^4	8.39×10^4	1.06×10^5	1.52×10^6
3	2.15×10^4	2.62×10^4	1.98×10^4	1.71×10^4	3.14×10^5
4	7.69×10^3	8.48×10^3	4.50×10^3	2.23×10^3	1.01×10^3
6	3.50×10^3	2.67×10^3	7.45×10^2	9.69×10^1	2.72×10^2

*Mast and Mac Neil, 1975. Poultry Sci. 54:1024-1030

Table 17. Termal destruction curve for microorganisms in mechanically deboned poultry meat*



*Mast and Mac Neil, 1975. Poultry Sci. 54:1024-1030

mechanically deboned poultry meat and through improvements in the use of spices and flavorings.

In conclusion, the poultry frankfurter industry has experienced phenomenal growth over the past several years and this growth will continue into the future. An important factor in this growth has been the improvement in the technology for production of mechanically deboned poultry and in the formulating and manufacture of poultry frankfurters. This technology, in combination with the positive nutritional attributes of poultry, has established poultry frankfurters as a high quality product deserving of the consumer acceptance it now enjoys.

Discussion

Don Kropf, Kansas State: I have two questions. Do you have any comments on the maximum emulsion temperature attained when chopping or emulsifying chicken franks? And the second question is, what percentage seasoning increase do you recommend for poultry frankfurters?

Marsden: The first question, which referes to the end point temperature that poultry frankfurters are chopped or emulsified to, I can answer only by experience and say that 45 to 50 degrees seems to be preferable. In the study I cited today, I think it was 60 degrees Fahrenheit which is, in my opinion, a little high for poultry franks. Regarding the changes in spicing for poultry frankfurters versus beef or pork or meat franks, you have to remember that the poultry itself is very low in flavor so, generally, you would want to make up for this by adding more spice. I'd say, generally, you add around 50 percent more spice to poultry franks. Another thing that's important is smoke flavoring. It's tricky because of the high protein content you don't want to toughen the skin which you get with a heavy concentration of smoke, but you do want a smoke flavor. Some processors add the smoke flavor directly into the emulsion. Smoke flavor seems to be particularly helpful in covering the poultry type flavor in franks.

Hendrickson, Oklahoma: You Indicated that skin was providing an undesirable characteristic? Do you care to speculate why?

Marsden: Well, I think basically what we are looking at is the effect of having a reasonable amount of fat in the product. If you don't have the skin, the protein level is going to be too high and the fat level is going to be too low. It's not going to be as juicy or as tender. The fat content should be at least 18 or 20 percent or even higher from an eating point of view.

Huffman, Auburn: Have you had any experience on the utilization of spent hens?

Marsden: No, I haven't.

Naumann, Missouri: I was interested in the cholesterol level you reported. Is this characteristic to be that much higher?

Marsden: I understand that it is actually higher.

Trout, Colorado State University: Is there any problem in maintaining the low calcium or bone chip level in these types of products?

Marsden: There seems to be variation in calcium content which directly relates to bone. With USDA approval for poultry for some time, it is not subject to the same problems as red meat. There has been development in the technology of deboners. For poultry it seems that the Beehive is very often used. Other machines such as the Yieldmaster and the Meat Maker tend to do a very good job with this type of product.

Mawson, Colorado State University: Can you comment on the relative binding effectiveness of poultry meats versus red meats.

Marsden: In binders that were used in the studies I cited, the poultry meat had quite high binding capacities. In my experience in adding poultry at the 50 percent level, I haven't found that it is as good as cow meat, 85 percent beef trimmings or something like that. In all poultry franks, it has been my experience that it's difficult to fat out a poultry emulsion.

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