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Poultry Meat as an Ingredient in Beef and Pork Processed Meats.

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The statistics of world meat consumption throughout the past 20 years show cyclical peaks and troughs, regional variations and switches from one species to another. However, one general and significant trend persists, and that is that poultry meat represents an increasing percentage of total meat consumed. The reasons, undoubtedly economic, not only relate to the inflationary costs of producing red meats, but to the success of the poultry industry, simultaneously producing birds faster and with a higher conversion of feed to meat.

There is a limit to the amount of poultry meat that any household can consume in the form of whole birds or joints. So, as the increasingly attractive economics encourage higher poultry meat production volumes, pressures will build for the utilisation of the excess poultry meat in other forms. In the U.S. we already see the development of fresh poultry butchery techniques feeding a wide range of applications, firstly as new poultry products, slicing rolls, etc; as an ingredient in traditional red meat products, at low levels not requiring label changes; and finally products made from poultry only with the characteristics of traditional red meat products, e.g. the chicken frankfurter and turkey salami. Other countries are at different stages in this evolution, but in most there is a base of available mechanically deboned poultry meat, of highly variable quality, which meat processors are finding increasingly interesting. It is prudent to assume that to the meat technologist, poultry meat, in one form or another, will become of significance, whether to make processed poultry products or as an economic ingredient in existing red meat products.

We have therefore begun to study the behaviour of this ingredient against our red meat experience, and we have found many similarities, but, more importantly, significant differences which must be understood and controlled.

Methodology

As in previous studies, to make our work more meaningful to practical meat technologists, we have developed model meat systems to assess the performance of meat ingredients and the effect of processing. Each model system is designed to reflect the processing and formula constraints of the product being studied; for example, in this study all meat had been frozen, thawed, minced through a 5 mm plate and randomised. Unless described as "meat alone", all samples had added water at a level of 25% of the weight of meat. Mixing, in a Hobart speed I, for 5 minutes, represents a low common denominator of energy, typical of some factory experiences. To standardise cooking conditions or heat penetration, we use cans, and this allows uniform diameter and, very importantly, density, if filled to a fixed weight and air space. Samples are cooked to pasteurising temperature; and for poultry we use 75°C.

Separation was physically measured, as in a practical situation, and yield expressed as a percentage of the raw meat used. Samples were subjectively examined, but the number of samples is too low to give statistically accurate results, so at this stage only obviously significant subjective comments are given. The Hunter Lab Colorimeter was used to measure and record the colour changes. The obvious subjectively texturally different samples were used to calibrate the usefulness of the new Stephens C.R. Texture Analyser. Correlation has certainly been established, but for the more sensitive differences we will meet in later work, further probes will be required. Samples were also retorted at 121°C (as we were not using nitrite) to confirm and measure how sensitive the behaviour was to the higher heats of baking and frying.

Results

Both turkey and chicken meat have been studied, and the trends described are common. Poultry protein alone is a poor water binder, losing approximately 20% of its weight at pasteurising temperatures. Whereas this can also be said about red meats, the detrimental effect on flavour, and particularly texture, is more severe.

Figure I shows how the water binding capacity (WBC) changes with pH. The shape of the curve is very similar to those produced using the Hamm and Grau technique. Lactic acid and sodium carbonate were used to alter the pH of the meat. When the pH is altered by the addition of phosphate blends, acid and alkali, the shape of the curve is the same, although there are significant and very important differences in the area of the initial reduction of pH. The unadjusted samples are highlighted. Even though the pH of dark meat is significantly higher than that of white, it has an inferior WBC. At all points on the pH scale, dark meat has an inferior WBC to white meat. This is typical of poultry meat from six different suppliers.

Table I shows that this is also true at various salt or phosphate levels. This is a deviation from red meat experience. In red meat applications it is generally accepted that the effect of phosphates on WBC reached a maximum at 0.5 - 0.65%.

TABLE I

Cooked Chicken Meat :: The Effect of Salt or Phosphate on Yield.

% Phosphate	←	Nil	→	
% Salt	0.	1.0	2.0	3.0
Yield with white	86.4 (5.8)	100.2 (5.8)	107.6 (5.6)	110.4 (5.6)
Yield with Dark	84.8 (6.4)	95.9 (6.2)	100.0 (6.1)	101.0 (6.1)
% Salt	←	Nil	→	
% Phosphate *	0.	0.5	1.0	3.0
Yield with White	86.4 (5.8)	98.3 (6.1)	114.3 (6.2)	124.6 (6.9)
Yield with Dark	84.8 (6.4)	98.2 (6.6)	105.3 (6.85)	115.6 (7.4)

* pH of phosphate = 9.0

As shown here, there would appear to be an optimum WBC point, which both white and dark meat can eventually reach. The effect of added phosphate seems more dramatic in dark than in white meat. This is a major reason for processing white and dark meats separately, combining them just before cooking, but perhaps the most important lesson to be learnt here is the need for purchasers, of poultry meat for further processing, to check incoming meat for added phosphates. Our apparently cheap raw material, which has already had part of its potential in improved yield satisfied, in a spin chiller, could result in very expensive final product rejection, not only from an increased water separation point of view as will be shown now.

Colour

One of the most important quality aspects of poultry products is colour, and the known tendency for the meat to assume a nitrite cured like colour. By far the easiest way around these problems is to develop a range of nitrited cured meat products. Incidentally this is also a fine way of reducing, and even eliminating, the typical chicken or turkey flavour. However, for most technologists the problem of colour has to be faced. In the first place, whereas nitrite contamination, at very low levels, will cause pinking, this will occur for other reasons. We measure pinking using the Hunter Lab 'A' value, an index which we have used extensively when maintaining the colour of cured red meat, and correlated these values with trained sensory panel results. Not only can changes in 'A' values be found below the level at which the eye can detect them, but they are accompanied by changes in the L value (brightness, whiteness index) and in the B value. For example, the slide shows that for white meat in the pH range 6.0 - 7.5, which is of importance to technologists, there is a significant increase in 'A' value (pinkness) and a significant decrease in L value (brightness). The next slide shows that this is equally true for dark meat. Whether it is a pH effect or not, phosphate blends, acid and alkaline produce these colour changes too.

Whereas it may be interesting to show that the WBC of poultry meat is increased by the addition of salt plus phosphates, Figure 2, typical of many results, shows the deleterious effect on the "brightness" of the meat:

Figure 2

Effect of Salt, Phosphate on Brightness. L. Value.

	Turkey White	Turkey Dark	Chicken White	Chicken Dark
Meat	72.5	53.0	73.5	50.5
Meat + Phosphate 0.5%	71.0	50.0	72.0	47.0
Meat + Phosphate + Salt 1%	66.5	46.5	68.0	45.5
Meat + Phosphate + Salt 3%	63.5	46.5	67.0	44.0
Meat + Phosphate + Salt 1% + 25% Water	70.0	51.5	71.5	47.5
Meat + Phosphate + Salt 3% + 25% Water	68.5	50.5	69.0	48.0

The L value falls increasingly with the addition of phosphate, salt and a higher level of salt. It is restored by dilution with water, but again the effect of increasing the salt can be seen. The increase in 'A' value and the decrease in L value are exaggerated at higher temperatures. White meat with an acceptable 'A' value of 1.0 will "pink" significantly at sterilising temperatures of 120°C. This is an indication of what will happen during frying or roasting.

Figure 3 shows what heating does to 'A' values:

Figure 3

'A' Value of Chicken Meat

	Temperature of Cooking	Meat	+ 1% Salt + Phosphate
White	75°C	1.5	1.8
	120°C	3.3	4.5
Dark	75°C	4.25	4.8
	120°C	6.25	7.0

We have studied the reverse effect of acid phosphates on colour changes during cooking, and we are able to contain them to a considerable extent. The loss in yield is not significant, but there is a loss of cohesion. Depending on the product, this may be an unacceptable solution. However, it is clear that high alkaline phosphates, pH 8.0 to 9.0, suitable for red meats, will be a major contributor to colour problems in poultry meat. Again, we emphasise that purchasers of poultry meat for processing, must know if phosphates have been used during the abattoir operation.

As a result of these studies, an appropriate soy protein isolate has been designed, with the requisite properties, which significantly improves the yield and the quality of poultry products. Being a pure protein, the nutritional arguments are obvious but, in addition, the textural improvement given by the coagulation of the protein, makes this a logical ingredient. Therefore the economics of the production of quality products call for the sum of the effects of a limited level of salt, an appropriate phosphate blend, around neutrality, and the incorporation of a special soy protein isolate.

Mechanically Deboned Meat (MDM)
It has been known for many years that the quality of MDM, from whatever species, depends on the quality of handling the bone to be used, the type of the process of recovery, and of course the post production chilling or freezing. We have used meat produced using the Protecon machinery, from well treated bones and with an adequate post pressing handling. We have also studied Protecon produced meat from a number of processors, and have seen highly significant quality variations from one supply to another. We have begun to study poultry MDM from the newer generation of separators produced in the U.S.

Initially we would say that they show major improvements in the quality of the meat they produce. It is therefore dangerous to be too specific when describing this valuable source of meat, which has such a variety of performance. However, the following comments may be of help.

Firstly, it is essential to mix MDM at low temperatures. Fat seems to separate very easily with agitation. This is independent of the source of bones used: necks, or those bones associated with dark or white meat. 50°C seems to give the best compromise, as at lower temperatures the salt effect is not efficient. On one experiment 14% yield improvement was obtained by reducing the temperature of mixing from 15°C to 5°C.

Typically, MDM has L values of 52 - 58, although of course selection of the bones could produce different values. 'A' values of MDM are of course of major importance, approximately 4 - 5. This is one of the limiting factors in its use. MDM is highly sensitive in its colour reaction to changes in pH. One sample, as the slide shows, decreased in 'A' value from 4.5 to 2.5, and 3.5 when the pH was adjusted using phosphate blends. In sterilised heated samples the colour, without any contamination by nitrites, had 'A' values associated with highly coloured cured meat products.

Poultry MDM has one other significant difference from red meat MDM. Its WBC is relatively more stable at higher temperatures, when salt, phosphate and water are added.

As most poultry product manufacturers agree, the big breakthrough for poultry processors will come when we produce dark meats with the colour of white meats. If an L value of 70 - 80 is taken as typical for white meat, 50 - 55 for dark meats, then MDM is in the 40 - 45 range. Poultry skins are widely accepted as a flavour contributor, not forgetting the economics of their use.

A soy protein isolate of the emulsifying type, allows us to emulsify skins hot, at a ratio of 8 - 10 parts of skin per part of isolate, which has the added advantage of brightening the colour of MDM. Poultry fat, if available, can also be used for this effect. We have set ourselves the L value target of 80, and so far have been successful in increasing the L value of MDM from 45 to 70. At this level the texture of MDM changes, and we have had to add back an isolated soy protein in the form of a fibre.

Again we must look back to the abattoir if we are to achieve this success consistently. Heat singeing has to be controlled. Over-heated skins cannot be used to give this effect, as they are very difficult to emulsify. If the meat processor has to deal with a supply of over-singed skins, then he should take the poultry fat route to give a bright colour, and the skins for flavour only.

Conclusions:

Poultry meat has many of the behavioural characteristics of red meats. However, the experience of predicting performance on pH, much favoured by red meat technologists, needs checking. It need not apply in poultry meat processing. The technical approach to maintaining the colour/brightness, of major importance in poultry products, contradicts the priority of maintaining yields. Soy Protein Isolates, properly designed, understood and used, could be beneficial. At least three types of isolate are required:

a) an isolate to be introduced into the muscle itself;

b) an emulsifying isolate to aid colour/brightness using skins and fat;

c) a fibred isolate to restore texture to MDM.

However, what is of primary importance is the understanding of the interaction of salt, the proper phosphate blends and poultry ingredients, on a much wider sample. Seasonal and breed effects, not to mention pre and post mortem treatments, will all have to be studied before we can be as secure as we are now with the traditional red meats.