End-point Temperature Control of Meat Meal Dryers

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Introduction

Meat meal is dried to preserve it against microbial deterioration, so it can be stored for extended periods before use as an ingredient in ani feed. Considerable quantities are exported, which also requires that the meal have good storage qualities.

Controlling meal moisture content is therefore very important. If the moisture level is too high, the meal can spoil by microbial growth. If too low, overdrying has occurred so energy is wasted and the nutritional properties of the meal will have been reduced by the excessive treatment used.

Meat meal moisture content has proved notoriously difficult to measure. Most plants tend to use operator experience rather than an objec measurement to determine when the drying cycle is finished.

The three most widely tried and tested methods used to derive a target meal moisture content are:

1. Electrical conductivity
2. Product temperature end-point
3. Manual (based on operator experience)

Manual control, although popular, is very subjective. Electrical conductivity suffers from poor sensitivity in the region of interest and do not account for the variations caused by meal composition. Product end-point temperature may suffer similar problems in terms of m composition.

Meal composition may have a significant effect on any technique used to measure meat meal moisture content. Meal essentially consis protein, bone, fat and moisture. When properly dried, meal moisture content is in equilibrium with atmospheric moisture. The fat and b components of meal do not contain significant amounts of moisture and so add only to the dry weight against which the moisture is be assessed. Because protein is the component of meal affected by over or under drying, it may be more appropriate to express the moistur meal as a percentage of its protein content.

This paper discusses a series of drying trials conducted using a pilot scale Iwell type meal dryer, to assess the effects of meal compositio the measurement of meal moisture content using product temperature during drying.

Experimental

A series of batch drying runs was conducted at pilot scale. The raw material composition for each run was adjusted by adding either bone tallow to the wet solids from a low temperature rendering plant (MIRINZ Low Temperature Rendering System or MLTR). Bone for addi was obtained by sifting dried meal taken from a commercial plant before milling. Additional tallow was obtained from normal rendering p stocks of 'K' grade material. The meal composition for each drying run is shown in Table 1. Although not evident in these analyses, composition differences were visually obvious, especially with samples that were high in fat and/or bone.

Samples for compositional analysis were taken during the drying cycle when the meal reached a temperature of about 117°C. The samples were analysed for moisture, ash, fat and protein (AOAC, 1995).

Additional samples were taken a regular intervals and analysed for moisture content only, to determine the progress of the drying operation. All samples were taken from a port in the lower side of the vessel (through the steam jacket) while drying was in progress.

A number of temperatures were recorded during each batch drying run including:

1. Product temperature, measured by an insulated probe inserted through the steam jacket of the vessel (right side of vessel).
2. Product temperature measured by an insulated probe inserted through the end-plate of the vessel (left side of end of vessel).
3. Product temperature measured by an uninsulated probe inserted through the end-plate of the vessel (right side of end of vessel).

Table 1 Raw material mixes for each of the dryer runs.

Batch run	Protein	Fat	Ash	Moistur
1	45.6	4.6	39.3	6.1
2	49.6	3.7	41.5	7.4
3	52.1	3.6	34.3	5.6
4	34.4	2.8	34.5	4.7
5	44.4	10.9	32.7	7.7
6	45.9	6.8	35.4	9.3
7	50.0	5.0	37.2	5.9
8	50.1	2.8	39.9	4.7
9	48.9	3.4	38.7	5.2
10	47.4	6.9	35.3	6.7
11	46.1	9.8	27.4	8.5

To determine the equilibrium moisture level for meal, samples from one drying run were allowed to equilibrate in atmospheric conditions of about 23°C and 60% relative humidity for one week. During equilibration the samples were spread out in a thin layer in trays protected from verm by wire gauze.

Results

Typical temperature profiles and a moisture profile recorded during a drying run are shown in Figure 1.

The "right side" temperature trace shows the influence of the steam heated vessel jacket on the sensor, which, although in an insulated probe, was significantly affected by the temperature gradient. The "right end" temperature trace also shows the effects of the steam jacket, which was close to the uninsulated probe recording that temperature (on the end plate of the dryer). The "left end" trace is from an insulated sensor in the end plate of the dryer. The relatively low meal-end plate temperature gradient and the insulation surrounding the actual sensing element, which was part of the probe design, resulted in the temperature staying at water boiling point longer before following an expected steady linear rise as the product heated. Because this sensor was relatively unaffected by the steam jacket temperature, it gave the best indication of the meal temperature.

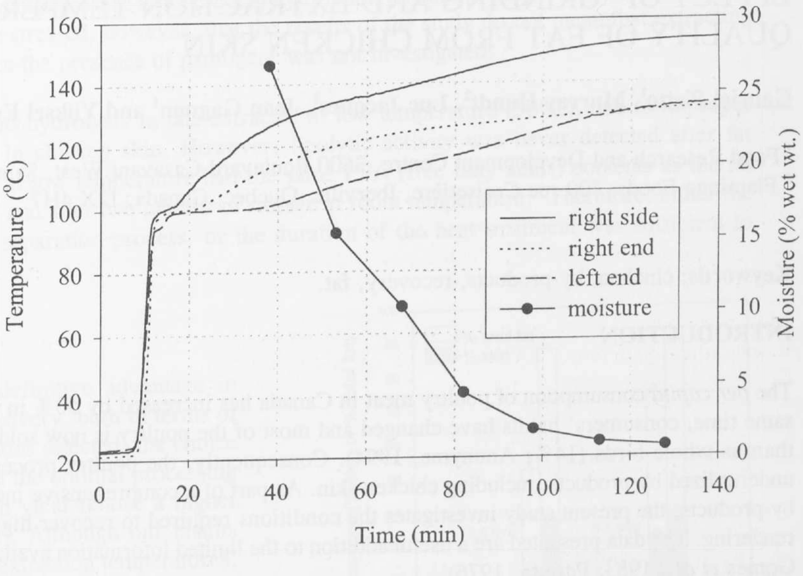

Figure 1 A typical temperature and moisture (% wet wt. Total solids) profiles during meal drying

The moisture trace of Figure 1 can be plotted as moisture vs (left end) temperature. Figure 2 shows this relationship for all samples taken during all of the experimental runs combined. The moisture content for this analysis was expressed on a wet protein basis rather than on a total solids basis as was done for Figure 1.

Of the samples equilibrated to atmospheric moisture, one sample, having a total solids moisture content of 6.8% (wet wt. of total solids: 3.8% wet wt. protein only) showed very little change in total weight (i.e. there was little gain or loss of moisture to atmosphere).

Discussion

The temperatures shown in Figure 1 illustrate the importance of maintaining insulation of the product temperature sensor from the surrounding plant temperatures.

If meal is dried to atmospheric equilibration and moisture content is expressed in terms of meal protein (because bone and fat do not contain moisture), the graph in Figure 2 suggests that end-point temperature control can be used to attain moisture levels of about 14% (moisture in protein) to an accuracy of about ±5% for a product temperature measurement accuracy of ±1°C. This translates to an accuracy of better than ±3% moisture (total solids basis).

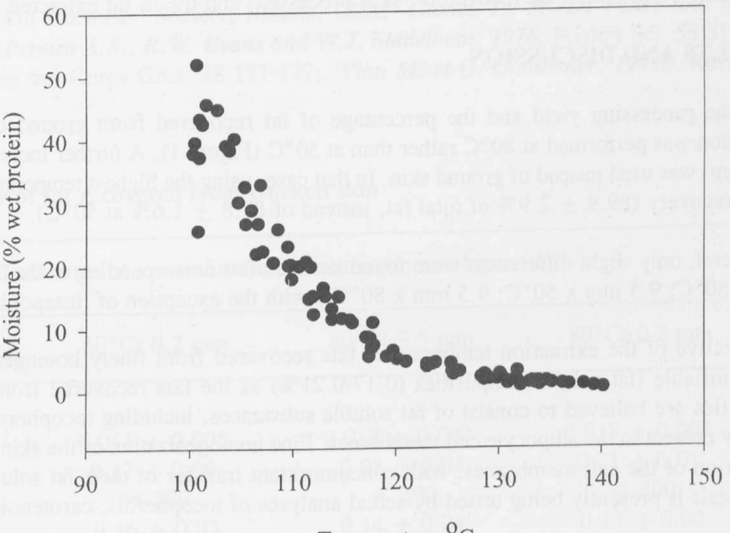

Figure 2. Relationship of meal moisture (based on wet protein content) and temperature for all experimental runs

Conclusions

Product temperature during drying is an adequate measure of meat meal moisture content provided the temperature measurement is done carefully avoiding the effects of nearby plant temperatures on the sensor. Therefore, care must be taken when specifying the probe and its mounting position in the dryer.

The use of meal temperature to determine drying end-point and therefore the end-point meal moisture level appears relatively unaffected by significant variations in meal composition in spite of the small influence these had on actual meal protein content.

Acknowledgements

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Reference

AOAC (1995), Official methods of analysis of the AOAC International, 16th Edition, AOAC International, Virginia, U.S.A.