i'Tec_Q8
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Influence of hydrothermal processing conditions on the bulk density and flowability of animal meals

1. Background and focus

As part of a research programme conducted jointly with ACTA, ITAVI, INRA – Nouzilly, ITCF and UCAAB, TECALIMAN assessed various methods for characterising heat-treated meals.
During this study, it was observed that this type of treatment helps to densify animal meals and improve their flowability.
The correlations and regressions between these values were identified in order to determine how process control settings affect the variables that describe product densification and flowability.

2. Apparatus and methods

The control settings studied were treatment time and temperature.
The various meals were characterised according to 2 variables: bulk density (BD) and apex angle of repose (flow) (ATES). These variables were chosen based on their usefulness in measuring animal meal densification and flowability.
The apparatus and methods used to manufacture, process and characterise the feedstuffs are presented in i'Tec_Q7 (TECALIMAN, 2002).

3. Results

The results are given in Table 1.

Animal meal	Treatment temperature (°C)	Treatment time (sec.)	BD (g/cm^3)	ATES (°)
Feedstuff A - Ploughshare mixer	Untreated	Untreated	0.650	54.5
	75	60	0.688	48.9
	75	300	0.684	49.9
	75	600	0.682	50.2
	85	60	0.687	47.6
	85	300	0.690	49.2
	85	600	0.688	48.5
	95	60	0.685	48.1
	95	300	0.690	48.1
	95	600	0.688	46.8
	105	60	0.696	46.2
	105	300	0.691	46.4
	105	600	0.703	47.1
Feedstuff A - Blade mixer	Untreated	Untreated	0.631	54.1
	92	450	0.724	44.9
	92	180	0.703	46.4
	85	180	0.692	46.5
	85	60	0.683	46.9
	65	20	0.683	48.7
Feedstuff B - Blade mixer	Untreated	Untreated	0.655	53.6
	92	450	0.751	45.2
	92	180	0.748	43.4
	85	180	0.734	45.3
	85	60	0.723	47.9
	65	20	0.706	51.0

Table 1

3.1. Correlations between process control settings and the descriptive variables for animal meals

A study of the correlations revealed that, for this area of study, treatment temperature was the only setting that affected these variables, particularly in terms of meal flowability (Table 2).

Process control	Variables describing the meals	
	BD	ATES
Temperature (TPT)	0.67	- 0.89
Time (TEM)	0.29	- 0.35

Table 2: Correlation factor (R)

3.2. Regression between treatment temperature and descriptive variables for animal meals

3.2.1. Density and treatment temperature

The linear regressions established for the 3 series of feedstuffs have high determination coefficients, above 0.85 (Table 3).

Products	Regression	Regression coefficient (R^2)
Feedstuff A Ploughshare mixer	BD = 0.001 t + 0.6432	0.88
Feedstuff A Blade mixer	BD = 0.0005 t + 0.6102	0.86
Feedstuff B Blade mixer	BD = 0.0013 t + 0.6275	0.96
All feedstuffs	BD = 0.0007 + 0.6397	0.44

Table 3: Regression between bulk density and treatment temperature

The bulk density of animal meals increases with increasing treatment temperature (figure 1).

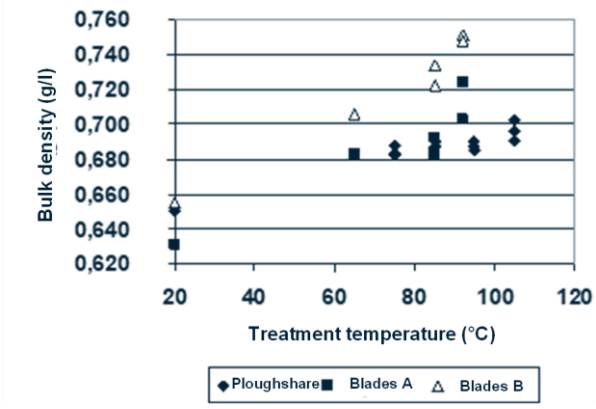

Figure 1: Density of animal meals according to treatment temperature

While the slopes and straight line constants are very similar for all the feedstuffs, the deviations between the various "feedstuff-process" associations cannot be used to determine a reliable regression that fits the entire dataset (R^2 = 0.44)
Blade mixers are more effective at increasing the bulk density of animal meals than ploughshare mixers.

3.2.2. Angle of repose (flow) and treatment temperature

The linear regressions have high determination coefficients (Table 4).

Products	Regression	Regression coefficient (R^2)
Feedstuff A Ploughshare mixer	ATES = - 0.0939 t + 56.523	0.93
Feedstuff A Blade mixer	ATES = - 0.1157 t + 56.383	0.98
Feedstuff B Blade mixer	ATES = - 0.1274 t + 57.056	0.83
All feedstuffs	ATES = - 0.0997 t + 56.102	0.76

Table 4: Regression between the apex angle of repose (flow) and treatment temperature

A study of the slope coefficients and Figure 2 reveals that the Apex Angle of Repose (Flow) decreases as treatment temperature increases.

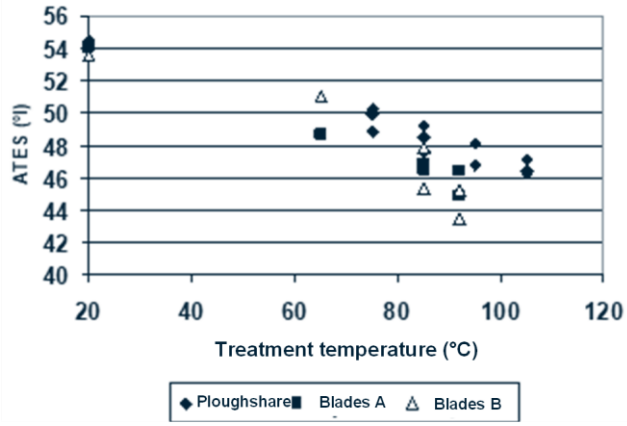

Figure 2: Apex angle of repose (flow) of animal meals according to treatment temperature

The variances in slopes and constants for each "feedstuff-process" association are generally less than for density. It follows that the regression calculated for the dataset as a whole has a larger coefficient (R^2 = 0.76).
These results also demonstrate that the blade mixer is more effective at increasing meal flowability than the ploughshare mixer.

4. Conclusions

Of the two process control settings studied, time and temperature, only temperature impacted on animal meal density and flowability.
The treatment, and therefore the temperature, mainly impacts on meal flowability.
The two treatment processes, blade mixer or ploughshare mixer, gave different results. The ploughshare mixer gave a lower performance rating (lower densification and flowability, smaller particle size), which could be due to fragmentation of the agglomerates that form during the treatment process.

5. Bibliography

Bouvarel Isabelle, Barrier-Guillot Bruno, Guillou David, Melcion Jean Pierre, Novales Bruno, Riou Yves, Picard Michel, 2001. 4èmes Journées de la Recherche Avicole, Nantes, 27-29/03/2001.