i'Tec_G5
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Keywords: Pelleting, Pilot

Comparison of two pilot presses – Scaling options

1. Focus

The aim of this study was to establish whether two pilot presses with different operating principles (vertical pelleting and ring pelleting) can be adjusted so as to provide similar pelleting conditions.

2. Equipment and apparatus

2.1. Feedstuff

This study used a "standard" formulated broiler feed.

Median diameter (µm)	621.1
Standard geometric deviation	*1.79*
Bulk density (g/cm^3)	593.2
Angle of repose (°)	41.4

Table1: Physical properties of the feed

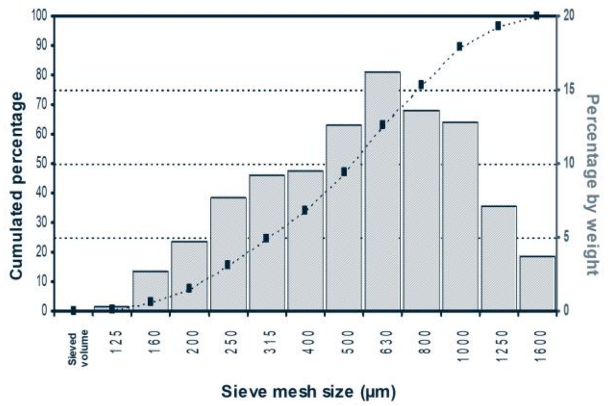

Figure 1: Animal feed particle size distribution

2.2. Tracer

The RF-blue lake microtracer has an acknowledged affinity for pelleting. In these tests, it was incorporated at a range of concentrations from 5 to 500 ppm.

2.3. Pelleting presses

2.3.1. Vertical flat-bed press

This press comprises an incoming meal feed via a twin screw system, a conditioner designed by INRA Nantes where steam is injected into the feed, and a Kalh-brand flat die pellet press (Figure 2). The Kahl press is of the type 14-175, with a 3-kW drive motor.

It has a nearly complete instrumentation range that can record:

- initial temperature
- conditioning temperature (control setpoint)
- temperature in one of the die channels
- power demand of the press's main drive motor

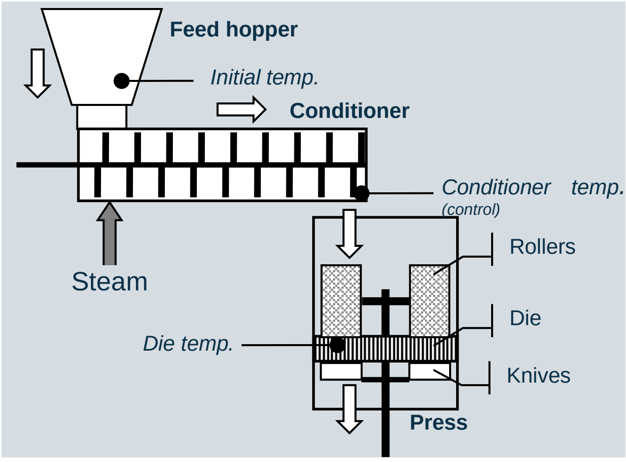

Figure 2: Diagram of the vertical press

2.3.2. Ring press

This is an 11-kW CLM 12-type pellet mill press, similar to an industrial press, but with a lower capacity: the die rotates at a speed of between 2.05 and 6.08 m/s, with an output rate of between 50 and 800kg/h. The line housing this press comprises:

- a hopper
- a single feed screw
- a conditioner. This component has a cylindrical compartment with length 80 cm and diameter 15 cm containing a rotating shaft fitted with blades angled at 15°. A control probe is fitted at its output.
- the press.

The line is also fitted with temperature probes (T-type thermocouple, accurate to +/-1°C):

- outside the pelleting line (ambient temperature)
- at the hopper output (initial temperature)

- at the conditioner output (control)

2.4. Cooler and die

The coolers and dies used at the pelleting output are pilot size, counter flow and designed by Tecaliman and the company Sabe. They have a maximum capacity of 6 kilograms.

3. Method

3.1. Mixing

Three batches were mixed containing increasing tracer concentrations of 5, 50 and 500 ppm.
One fraction from each feedstuff was processed on each of the two pilot lines.

3.2. Pelleting conditions

For both presses, it was decided to use a 4-mm diameter die with 20-mm channels, i.e. with a compression rate of 5. The targeted output rate conditions were chosen to ensure identical residence times in each die according to the number of die channels. These conditions were set with a rate of 33 kg/h on the vertical press and 100 kg/h on the ring press.
Output rates were spot checked as soon as a steady-state output was reached.
The pelleting temperature was 90 °C on both presses. This temperature was controlled by a probe fitted at the press conditioner outputs.

In the vertical press, the pelleting temperature was determined continuously using a probe in contact with one of the die channels. In the ring press, spot readings were taken using a temperature probe inserted into a mass of pellets collected at the die output in an adiabatic vessel.

3.3. Sampling

The samples were taken as soon as the control temperature was reached. The samples were first taken at the press output for pellets, and then a second time at the conditioner output for meal (Figure 3).

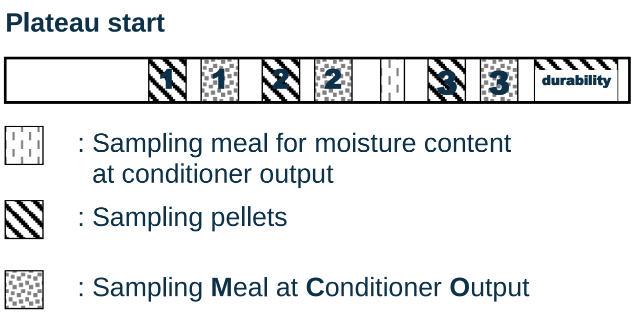

Figure 3: Sampling rates around the press after reaching the plateau

3.4. Analyses

3.4.1. Tracer

The RF-blue lake microtracer analysis was performed in duplicate on three 100-g samples for each concentration and at the three sampling points:

- Pre-treatment (Base)
- Conditioner output: MCO
- Press output after cooler and die: Pellets

3.4.2. Moisture content

Feed moisture content was checked at each stage of production according to Standard NF V 18-109. The pellets were ground prior to cooling. The analysis was made on test portions of approx. 5 g of uniform, ground feed. Each measurement was made twice on each sample. The test portions were then placed in metal wells inserted into a Chopin type oven at 103°C for at least 4 hours, until reaching a constant weight. After cooling, the wells were closed and placed in a dessiccator until the ambient temperature was reached.
The moisture content was determined by three weighings:

- Weight of the empty well: m_{cv}
- Weight of the full well: m_{cp}
- Weight of the full well after cooling: m_{as}

- Moisture content = 100 x (m_{as} - m_{cv})/ (m_{cp} - m_{cv})

The weight loss determined using this process corresponds with all volatile substances below 103°C, rather than with water from which it differs slightly.

3.4.3. Durability

The tests were carried out on 500-g samples for a period of 20 seconds using the "Eurotest" system. The samples were sieved through 3.2-mm screens - pre-measurement, on a quantity greater than 500 g in order to establish the amount of fines, and post-measurement, on a quantity of 500 g in order to determine durability. These measurements were repeated three times on each sample.

3.5. Processing the results

The effect of the treatment was analysed by studying durabilities and how pelleting impacts on concentration levels according to sampling point. To make it easier to read the concentration results, values obtained at 5 ppm were multiplied by 10 and values for 500 ppm were divided by 10.

4. Results

4.1. Actual pelleting conditions

Expected concentration (ppm)	Vertical press	Ring press
5	32.9	96.5
50	31.0	100.5
500	32.8	102.5

Table 2: Output rates (kg/h) determined for each test on both presses

The output rate conditions sought for each of the two presses were effectively reached (Table 2). Under these conditions, therefore, feed residence times in the dies can be estimated as similar.

Expected concentration (ppm)	Vertical press Kahl		Ring press Mecanica	
	Conditioner	Die	Conditioner	Die
5	90.3	82.6	90.4	89.8
50	89.8	83.1	90.3	89.7
500	90.0	83.1	90.4	89.6

Table 3: Treatment temperatures (° C)

The targeted treatment temperature of 90 °C was accurate to the nearest degree in each test (Table 3). It should be noted that pellet temperature in the Kahl vertical press die was significantly lower than the control temperature, by approx. 7 °C, in contrast to the pellets at the die output in the Mecanica press which deviated from the control temperature by less than one degree. This difference can be explained by the fact that the pelleting bowl in the Kahl press has an outward facing opening that allows steam to escape, thus lowering the temperature (see Figure 2).

Expected concentration (ppm)	Vertical press Kahl			Ring press Mecanica		
	Initial	After steam injection	Variation	Initial	After steam injection	Variation
5	11.4	14.5	+ 3.1	11.4	14.9	+ 3.5
50	11.4	14.5	+ 3.1	11.4	14.9	+ 3.5
500	11.4	14.5	+ 3.1	11.4	14.9	+ 3.5

Table 4: Results of discrete moisture content measurements made during the tests

In relation to this temperature loss, a slight variation in moisture absorption was recorded between the two presses (Table 4). Conversely, as with the control temperature, no variation in moisture absorption was recorded between each of the 3 tests performed on the same press.

4.2. Durability

Expected concentration (ppm)	Vertical press Kahl	Ring press Mecanica
5	92.9	93.3
50	92.8	93.3
500	93.0	93.4

Table 5: "Eurotest" durability (%)

Given that the production conditions were designed to provide similar die residence times and identical treatment temperatures, the durability results (Table 5) demonstrated that these conditions also gave similar results while the durability test used is one that has the highest discriminating power.

4.3. Tracer

As anticipated, the results obtained with the Kahl (Figure 4) and Mecanica (Figure 5) presses revealed that the microtracer was damaged during pelleting of this broiler feed. In addition to the fact that, irrespective of tracer concentration, this damage remained moderate following steam injection in both presses, it is also worth noting that similar damage patterns were observed in both presses, particularly in the case of the two highest concentrations.

The largest oscillations between samples collected at the same stage of the treatment or between stages, were recorded at the lowest concentrations. It was also demonstrated that this related primarily to the variation in the number of particles in the 100-g samples, rather than to any effect of the heat treatment itself. Evidence of this effect on a certain inconsistency in the results was provided, in particular, by the fact that higher concentrations were obtained after injecting steam into both presses at this 5-ppm concentration, while tests at other concentrations clearly demonstrated the existence of a deterioration.

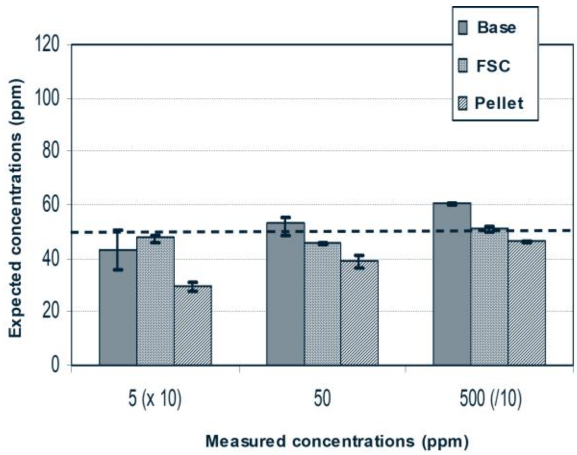

Figure 4: Relationship between expected and measured concentrations at three stages in the treatment, and for the three tests performed with the Kahl-brand vertical press.

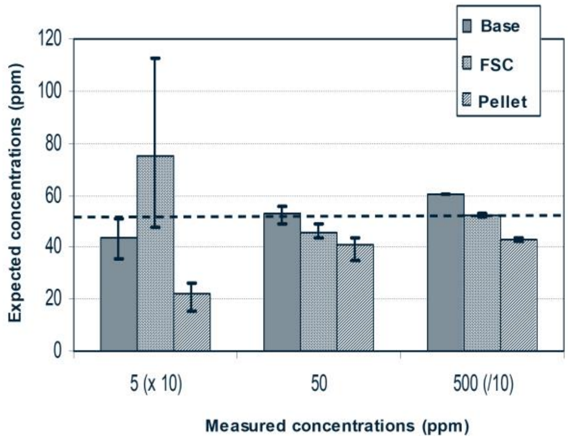

Figure 5: Relationship between expected and measured concentrations at three stages in the treatment, and for the three tests performed with the Mecanica-brand ring press.

Linking up the concentrations measured on samples collected post-treatment (steam injection or pelleting) on the two presses (Figure 6) provides an alternative view of the deviation between the two results obtained at low concentrations and the agreement between the results obtained at the other two concentrations in relation to the first bisector.

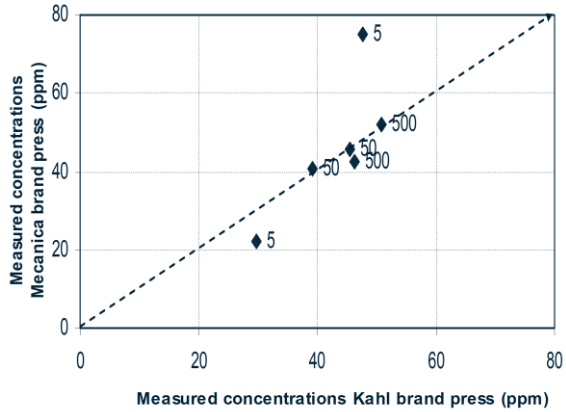

Figure 6: Relationship between the concentrations measured on samples collected following steam injection and pelleting during the three tests carried out on each press

5. Conclusion

These results appear to demonstrate that, providing that pelleting conditions with similar residence times are used, it is possible to scale up or down between two presses with different capacities and operating principles.
The use of identical residence times would prevent any change in durabilities and result in similar levels of thermal degradation in microtracers.