i'Tec_B2

May 2007

Keywords: Grinding, grain size, protein, pea

The pea grinding process in a predosing diagram

Influence of pea incorporation rate and grain size on pea protein dispersion in a series of grain size fractions

1. Focus

This test studied how grinding conditions (pea incorporation rate and pea flour grain size) affect pea protein contents in a series of size fractions as part of premix grinds.

2. Equipment and apparatus

2.1. Peas

A batch of Baccara peas with proteins marked with nitrogen N15 was used as a raw material and a nitrogen tracer.

2.2. Formulas

The formulas were produced from a base mix comprising 54% wheat, 18% corn and 28% soyabean cake, with a nitrogen content very similar to that of peas (3.42 and 3.37% of the raw product respectively). A quantity equal to 10, 20 or 30% of the peas was incorporated into this base mix in order to obtain 3 different formulas.

2.3. Grinder

The formulas were ground in predosing using a laboratory blade grinder with a peripheral speed of 59.4 m/s.

3. Method

Flour	Grinding methods Screens (mm)
Fine (Theoretical d50 200 µm)	1st and 2nd operations: 2 3rd operation: 1
Medium (Theoretical d50 500 µm)	Single operation: 3
Coarse (Theoretical d50 1000 µm)	Single operation: 10

Table 1: Predosing grinding methods

The study looked at factors such as mixes (fine d50 from 200 µm, medium d50 at 500 µm and coarse d50 at 1200 µm) and pea incorporation rates (10, 20, 30%), i.e. a total of 9 methods based on a factorial design.
Each formula was predosed manually prior to being ground. Grinding procedures were established based on the findings from previous trials (Table 1). The measured variables were:

- Dumas nitrogen, N15 and dry matter contents in the various formula size fractions (St. Gilles INRA).
- Dumas nitrogen, N15 and dry matter contents of each raw material (St. Gilles INRA).
- Flour grain size: the grain size of the 9 flour samples was measured, after which the samples were separated into their respective size fractions by dry sieving using a Bühler laboratory plansifter; the sieving screen was cleaned manually by tapping at 5-minute intervals. It was decided to use this equipment as its efficacy in separating out the finest grain size fractions had already been demonstrated in a preliminary study.

4. Results and discussion

4.1. Mix grain size

The results are given in Table 2. These showed that the median grain size of each flour depended solely on the grinding channel (screens), and not on the pea incorporation rate. Median diameters for fine-grain flours ranged between 165 to 186 µm, for medium-grain flours between 556 to 626 µm, and for coarse-grain flours between 1 221 to 1294 µm, in accordance with pea percentage and the form used to express the median diameter.
The grain size fractions were then grouped to create 4 categories for each method (Table 3 to Table 5).
Nitrogen contents deriving from the marked peas were analysed for each size fraction.

Type of flour	Fine (Theoretical d50 200 µm)			Medium (Theoretical d50 500 µm)			Coarse (Theoretical d50 1200 µm)		
% peas	**10**	**20**	**30**	**10**	**20**	**30**	**10**	**20**	**30**
d50 Gaussian-log (µm)	186	176	175	562	556	583	1 231	1 221	1 247
d50 Interpolation (µm)	186	175	165	583	589	626	1 256	1 276	1 294

Table 2: Median flour grain size

Grain size fractions (µm)	Weight % of total weight		
	10% peas	20% peas	30% peas
F < 80	28.2	31.2	32.6
80 < F< 160	15.7	14.7	14.5
160 < F< 400	37.1	37.4	35.2
400 < F	18.9	16.7	17.6

Table 3: Fine-grain flour (theoretical d50 200 µm) – Distribution by weight of the various grain size fractions.

Grain size fractions (µm)	Weight % of total weight		
	10% peas	20% peas	30% peas
F1 ≤ 160	12.1	13.2	13.0
160 <F2 ≤ 400	18.8	17.9	16.7
400 < F3 ≤ 1.000	40.3	39.9	38.0
1.000 < F4	28.7	29.0	32.3

Table 4: Medium-grain flour (theoretical d50 500 µm) – Distribution by weight of the various grain size fractions.

Grain size fractions (µm)	Weight % of total weight		
	10% peas	20% peas	30% peas
F1 ≤ 315	7.1	7.9	7.9
315 <F2 ≤ 800	18.8	18.4	17.6
800 < F3 ≤ 2.000	43.7	43.4	42.1
2.000 < F4	30.4	30.3	32.4

Table 5: Coarse-grain flour (theoretical d50 1.200 µm) – Distribution by weight of the various grain size fractions.

4.2. Pea nitrogen content of the various grain size fractions

These analyses revealed that two situations can be identified in a premix: fine-grain flours (theoretical d50 of 200 µm) and other flours (theoretical d50 of 500 or 1,200 µm).
For fine-grain flours with a theoretical diameter of 200 µm, the pea-generated nitrogen content in the two fractions with the smallest grain sizes decreased as the pea incorporation rate increased (Figure 1).
For medium and coarse-grain flours (Figure 2 and Figure 3), the opposite situation was observed in the 3 fractions with the smallest grain size. It should nevertheless be noted that in medium-grain flours, the pea incorporation rate had very little effect on the peas' nitrogen distribution patterns.

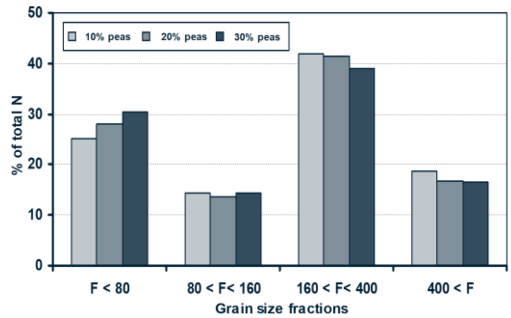

Figure 1: Fine-grain flour (theoretical d50 200µm) - Pea nitrogen in each grain size fraction as a % of total pea nitrogen

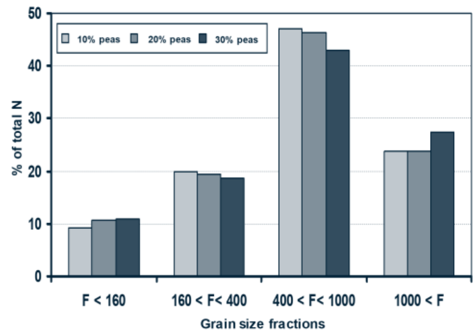

Figure 2: Medium-grain flour (theoretical d50 500µm) - pea nitrogen in each grain size fraction as a % of total pea nitrogen

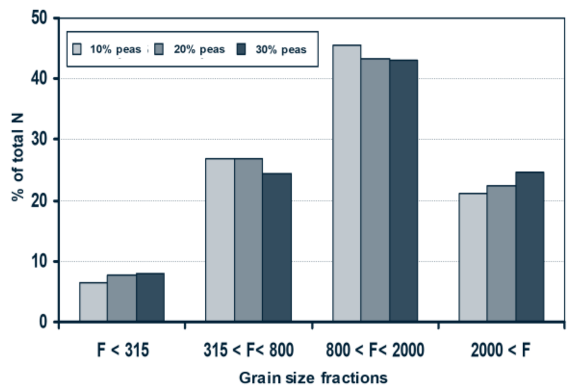

Figure 3: Coarse-grain flour (theoretical d50 1200µm) - Pea nitrogen in each grain size fraction as a % of total pea nitrogen

5. Conclusions

It should therefore be stressed that, as in the case of the pregrind diagram, pea nitrogen distribution patterns in the predosing diagram depend mainly on the flours' grain size distribution, and that this distribution is affected by the screen aperture diameters.

Bibliography

i'Tec_B1 The pea grinding process in a pregrind diagram- Influence of grain size on pea protein distribution in a series of grain size fractions, Décembre 2006.

I'Doc_M7. Valorisation des protéines végétales par des traitements technologiques en alimentation animale (Monogastriques) – Programmes de recherche interrégionaux Bretagne – Pays de la Loire – Rapport final - 2006