EFFECT OF EXPANDER – COKING ON SME AND QUALITY OF RAPESEED – FABA BEAN MIXTURES

Leszek Mościcki,[*] Jan Pokorny,[**] Halina Kozłowska,[***]Dick J. Van Zuilichem[****]

[*]Lublin Agricultural University, Poland
[**]Prague Institute of Chemical Technology, Prague, Czech Republic
[***]Institute of Food Science PAN, Olsztyn, Poland
[****]Wageningen University, the Netherlands

In Central Europe, rapeseed and faba beans (*Vicia faba)* play an important role in animal feeding as acceptable and widely-used raw materials. Their high protein and energy content can partly replace imported soya meals in animal diet. However to improve their feeding value additional thermal treatment has to be applied to inactivate the presence of antinutritional factors (ANF's). According to the results obtained in recent years, the use of HTST baro-thermal treatment, such as extrusion-cooking and/or expander cooking, is beneficial both nutritionally and economically [4, 5, 10].

Investigations presented in the paper show how expander-cooking, in particular different process conditions, affect the physical and chemical changes occuring in the used rapeseed and faba beans. Also, during the processing, some energy consumption aspects have been reported which determine the costs of baro-thermal treatment.

MATERIALS AND METHODS

The following raw materials were processed by expander-cooking: faba beans, (dehulled, crumbled into fine grits) and full-fat 'double zero' rapeseed ("00"). The composition of raw materials used is shown in Table 1.

Before the processing the raw materials were mixed together in varied proportion and were conditioned with water to achieve moisture contents of between 12% and 20% (this represented a total of 24 different samples which were prepared). The thermal treatment was carried out on an annular-gap expander of Dutch design (Contivar AL 150) showed in Figure 1 and 2.

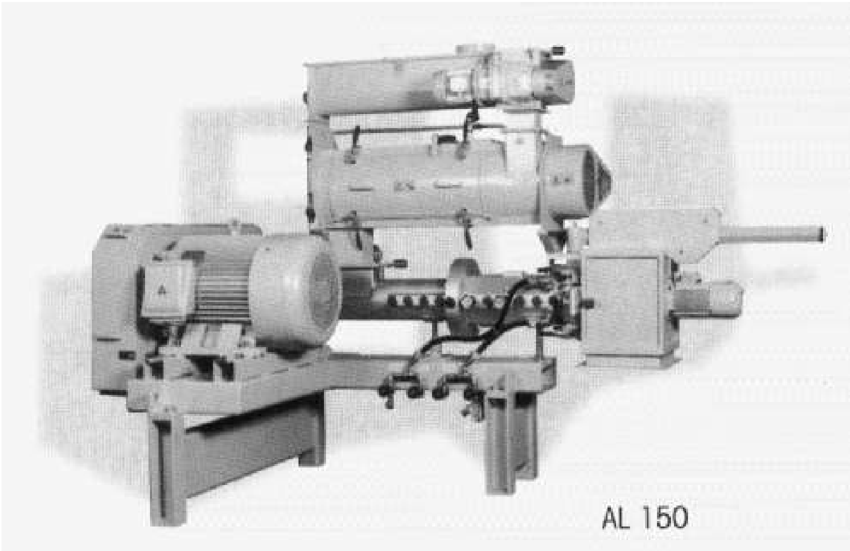

Fig. 1. View of Almex AL150 Expander-conditioner

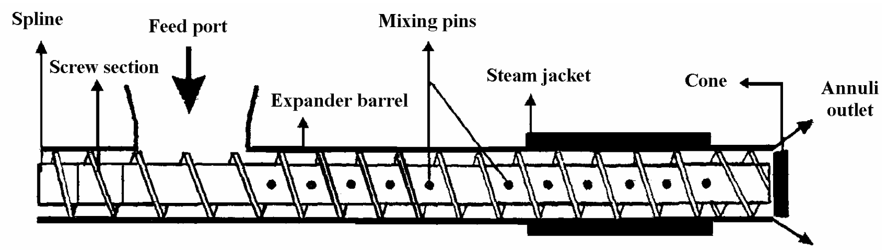

Fig. 2. Cros section of the expander

The technical characteristics of the used equipment are presented in Table 2. During the processing, the output and specific mechanical energy consumption (SME) was measured along with the propensity of the products to agglomerate, later by pellet press. Total energy consumption was measured including heating and powering of the installation.

Commonly used methods for the determination of antinutritional compounds in the processed mixtures, as referred to and specified below, were used.

– Protein Dispersibility Index (PDI) was determined according to AACC method 46-24 [9];

– Oligosaccharides were determined by an HPLC method according to Muzquiz M. et al.[8];

– Glucosinolates were determined by an HPLC method according to Ciska [1];

– Fat was determined by Soxhlet;

– Total extractable phenolic substances were determined by spectrophotometry in defatted samples according to Kolovrat [3].

Table 1. Composition of the used raw materials

Component	Dehulled faba beans	Full-fat rapeseed
Dry matter (%)	87,03	93,74
Water (%)	12,97	6,36
Protein (N x 6,25)	31,10	20,30
Crude fibre (%)	1,40	6,50
Ash (%)	3,70	4,10
Oil (% of dry matter)	0,75	41,44
Available lysine (g/kg of d.m.)	26,02	18,86
Glucose (g/kg of d.m.)	0,30	4,10
Glucosinolate fraction (%)	0,00	100,00
Phenolics (g/kg of d.m.)	0,29	13,41

Table 2. Technical details of the used expander

Maker/type	Almex/Contivar AL 150 Single screw
Motor power, (kW)	22
Max screw speed, (rpm)	143
Max barrel temperature, (°C)	140
Max capacity, (kg/h)	800
Residence time, (s)	5-20
L/D ratio	16

RESULTS

Due to its high fat content, the presence of rapeseed in the mixture prevented a constant flow, and proper pressure development and reduced the energy consumption and agglomeration of the products during expander-cooking (Fig. 3).

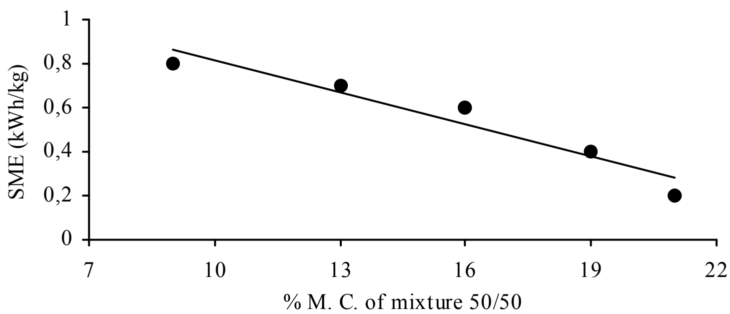

Fig. 3. SME versus moisture content during expander-cooking (process temperature fixed to 130°C)

In general expander-cooking is a HTST low-shear thermal treatment. Using the expander for thermal processing of rapeseed-faba bean is more economical and gave moderately better results than using the extruder-cooker [4, 7]. However, especially the twin-screw extruders give us possibility to create, so called “engineered” products, due to higher costs, their application in the feed sector is limited to particular production tasks (for example for petfood and/or aquafeed).

An analysis of the expandates showed that the extractable oil content decreased during the expander-cooking, mainly in samples with high initial water content (Table 3). The difference can be explained by structure formation from which oil is not extractable with non-polar solvent.

Losses of polar lipids are still more pronounced. Polar lipids may form complexes with proteins bounded by multiple hydrogen bonds, and partially by covalent bonds in the case of oxidized lipids.

Table 3. Changes of liposoluble components in expandates (50/50)

Component	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5*
Moisture content (%)	20.80	24.80	14.30	15.30	14.50
Oil (%)	16.75	19.97	21.80	21.18	28.80
Polar lipids (%)	2.07	2.75	4.37	4.25	5.75
Conjugated dienes (mg/kg)**	79.00	106.80	173.10	156.00	42.80
Fructose (%)	0.282	0.254	0.583	0.223	0.299
Glucose (%)	0.407	0.369	0.571	0.379	0.320
Sucrose (%)	2.876	2.407	2.381	2.659	3.021
Available Lysine (%)	1.55	1.53	1.58	1.59	1.62

* mixture of raw materials, ** measured at 233 nm, in dry matter

Losses of sucrose of up to 12% were observed during expander-cooking due to the higher temperatures, which was far less than in extrusion-cooking [7].

Losses of available lysine were small and did not exceed 2% of the original amount. This could be due partly to the relatively short residence times during the processing. Depending on mixture composition, moisture content and the process temperature, the available lysine content decreased by 1.45-2.18%. Browning reaction probably took place only in the primary step.

Glucosinolate degradation was not influenced significantly during expander-cooking. Its contents changed by maximum 20% of the original value.

CONCLUSIONS

After the performance of all the trials in order to obtain high quality products, the maximum recommended percentage of rapeseed in the mixture is 50% for expander cooking.

However at expander-cooking in low-shear thermal treatment an evident influence of moisture content on SME was observed. Higher moisture content resulted in lower energy consumption.

The best product's quality was obtained during the processing of the mixture of rapeseed-faba bean (50/50) with 16-18% moisture content, and the total energy consumption – 0.4 kWh/kg.

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SUMMARY

The utility of baro-thermal full-fat rapeseed and faba bean (broad bean) mixtures, using expander-cooking technique is reported. Changes in the nutrient contents during the thermal treatments of the materials used in the experiments are reported and analysed. Attention was focused also on the specific mechanical energy consumption, which determines the economic aspects of the processing.