

Rapeseed press cake – Composition and results in pig testing

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ABSTRACT

In a monitoring 23 rapeseed press cakes (RPC) from 10 decentral oilmills were investigated regarding main nutrients, selected amino acids and minerals (macro- and trace elements). A representative RPC at increasing dietary levels was tested in an experiment with 4 x 40 fattening pigs. In the monitoring mainly the fat content differed. The lysine content related to the protein was at least one tenth higher than in rapeseed meal solvent extracted (RSM). A glucosinolate (GSL) concentration of 19.0±4 mmol/kg DM represents twice the content of RSM and this is disadvantageous for RPC. In pig experiment as comparison with the control (0/0g RPC per kg diet) at the highest dietary level (75/125g RPC per kg feed in the 1st and 2nd fattening period) feed intake and weight gain were reduced, as tendency, however, the feed:gain ratio was also decreased. Thyroid was enlarged by RPC with heaviest glands at the highest level of untreated RPC. In general RPC lowered thyroid iodine concentration compared with the control. A moisture-heat treatment diminished the GSL content by one half and alleviated the impaired performance and iodine and thyroid status, resp.. RPC increased the polyunsaturated fatty acid (PUFA) concentration of the body fat – at the highest dietary level significantly, whereas the RPC-mediated increase of n-3 PUFA fraction in the depot fat showed significance already at the lowest dietary RPC level tested.

Key words: Rapeseed press cake– glucosinolates – pigs – thyroid - iodine – fatty acids backfat

INTRODUCTION

Rapeseed feedstuffs - the second most popular protein feed in the EU behind soya-bean meal – are represented mainly by the solvent extracted rapeseed meals (RSM). [The production of RSM includes treatment with steam and drying (i.e. toasting) for removal of the solvent, however, this necessary step affects also the feed value]. Rapeseed press cake (RPC), the by-product of oil extraction in smaller presses, is estimated to be produced in 400 German decentral enterprises at an amount of some hundred thousand tons per year (Remmele 2010, personal communication) which contributes at one tenth to the total rapeseed feeds' consumption. The present investigation consisted of a monitoring of RPC produced in smaller oilmills in Thuringia and Hesse and an experiment with fattening pigs testing increasing dietary RPC levels. At the highest level the RPC was also tested after a moisture heat treatment. In the monitoring dry matter (DM), ash, main nutrients, feed relevant amino acids, mineral compounds and glucosinolates (GSL) should be detected. The animal responses measured were feed intake, live weight gain and the feed to gain conversion ratio, some carcass measurements, the iodine and thyroid status and the fatty acid profile of backfat.

MATERIALS AND METHODS

In the **monitoring** 23 RPC from 10 oilmills (1,500 – 100,000 tons seed processing capacity per year) were investigated for dry matter (DM), ash, main nutrients, mineral constituents and GSL. The determination of lysine, methionine and cystine and threonine was carried out only in 14 samples. The methods followed the rules of VDLUFA (1976,2007,2008). The GSL were determined with the official method of the European Commission (1990) by HPLC.

In the **dose response experiment** with a total of 160 fattening pigs (cross-breeds of Pietrain x Landrace x Large White) diets which differed in the RPC level were compared with a control diet without rapeseed feeds. In the four groups with 40 pigs each (31 kg mean body weight at the beginning) during the grower/finisher period diets containing 50/75g and 75/125g RPC per kg were tested in comparison with the control (0/0g RPC per kg diet). The fourth group represented the highest dietary level of RPC after moisture-heat treatment. RPC contained 349 g crude protein (CP), 116 g ether extract (EE) and 20.4 mmol GSL per kg DM. Treatment diminished GSL content at 10.5 mmol per kg DM. The diets consisted mainly on wheat, barley, triticale and soybean meal (diets`

composition in WEBER and SCHÖNE, 2008). The sampling of blood and iodine analysis method and the determination of fatty acids (FA) in backfat samples were described elsewhere (Schöne et al., 2001, 2002).

RESULTS

In the monitoring the main nutrients and mineral constituents were in an expected range (Table 1). The fat content differed immensely, minimum 120 g/kg DM, maximum 173 g/kg DM. The lysine content of 6.2 g/100g CP is at least one tenth higher than in rapeseed meal solvent extracted (RSM). A mean GSL concentration of 19 mmol/kg DM represents twice the content of RSM and this is disadvantageous for RPC.

Table1: Constituents of the rapeseed press cakes from 10 oilpreeses in the monitoring 2006 (1-3 samples per enterprise, mean \pm standard deviation, SD)

Constituents (No. samples analysed)		Concentration mean \pm SD
Dry matter, DM (23)	g/kg	915 \pm 12
Crude nutrients and fibre frations (23)	g/kg DM	
Crude protein (CP)		347 \pm 17
Ether extract		142 \pm 21
Crude fibre		129 \pm 8
N free extract		322 \pm 2
Neutral detergent fibre (NDF)		246 \pm 24
Acid detergent fibre (ADF)		185 \pm 11
Lignin		84 \pm 4
Ash		66 \pm 3
Amino acids(14)		
Lysine	g/kg DM	21.2 \pm 0.5
Methionine + cystine	g/kg DM	13.8 \pm 0.6
Threonine	g/kg DM	14.9 \pm 0.5
Lysine	% des RP	6.2 \pm 0.2
Methionine + cystine	% des RP	4.0 \pm 0.2
Threonine	% des RP	4.4 \pm 0.2
Macro- and trace elements (23)		
Calcium	g/kg DM	7.1 \pm 0.4
Phosphorus	g/kg DM	10.7 \pm 0.8
Sodium	g/kg DM	0.3 \pm 0.3
Potassium	g/kg DM	12.4 \pm 0.9
Magnesium	g/kg DM	4.5 \pm 0.4
Copper	mg/kg DM	3.4 \pm 0.7
Manganese	mg/kg DM	64 \pm 7
Zinc	mg/kg DM	65 \pm 6
Iron	mg/kg DM	131 \pm 18
Glucosinolates, as total (23)	mmol/kg DM	19.0 \pm 4.0

In the dose response experiment RPC, untreated, at the highest dosage tested, lowered feed intake and weight gain (P=0.06) and decreased the feed:gain ratio. Thyroid was enlarged by RPC with heaviest glands at the highest level of untreated RPC. In general, RPC lowered thyroid iodine concentration compared with the control. However, also the difference between untreated and treated RPC at the same high dietary level was significant indicating a reduced goitrogenicity caused by partial GSL inactivation via moisture/heat treatment.

RPC increased the PUFA concentration of the body fat – at the highest dietary level significantly, whereas the RPC-mediated increase of n-3 PUFA fraction in the depot fat showed significance already at the lowest dietary RPC level tested.

DISCUSSION

A content of 17 mmol GSL per kg RPC (910 g DM per kg) is nearby the 20 mmol GSL per kg which characterize rapeseed feeds with lower quality in pigs according to statement of a working group at the 11th Int. Rapeseed Congress in Copenhagen 2003. However, 20 mmol GSL per kg focus on RSM with its traces of fat and calculated for fat free matter the RPC had and about 15% higher content of GSL. The quality rules of German breeders aim at a maximum of 18 mmol per kg seed = 30 mmol GSL per kg fat free matter and the EU allows for seed for sowing even 25 mmol per kg seed = 40 mmol glucosinolates per kg fat free matter (European community, 1999). Indeed, GSL limit the acceptance of rapeseed feeds resulting in decreased daily weight gain and according to an upper tolerable level of 1.5 mmol GSL/kg pig feed the maximum percentage of RPC should be restricted to 5 - 10 % considering the RPC in the monitoring (Table 1) with a range from 9 to 23 mmol GSL per kg DM. Such recommended RPC percentages in pig feed result from the present experiment (Table 2), however, also from former experiments with RPC and ground rapeseed (Schöne *et al.*, 1994;1996; 2001). The role of GSL as main causative agents for performance depression in pigs was confirmed by the benefit of GSL degradation through moisture heat treatment. Several compounds from GSL degradation by activation of rapeseed-own myrosinase (thioglucoside glucohydrolase, EC 3.2.3.1) due to crushing and the wet medium seem to be volatile, e. g. isothiocyanates (ITC) and nitriles. Other compounds, e. g. oxazoli-dinthions and thiourea derivatives which are created by reactions of free amino acids with ITC, seem to persist in the moisture/heat treated RPC. The persisting compounds from GSL degradation together with the rest intact GSL might represent an inhibitory effect on thyroid expressed by significant increased gland weight and lowered thyroid iodine concentration in the pigs of the group fed the moisture/heat treated RPC (in comparison with the control without rapeseed feeds).

Table 2 :Results of the experiment on fattening pigs, mean±SD (31 -116 kg weight range tested, in the groups 96 - 99 days duration, 38 pigs/group, thyroid and backfat investigation in 9 pigs per group)

Rapeseed press cake	g/kg diet	Without (control)	50/75 ¹	75/125 ¹	75/125 ¹
Glucosinolates	mmol/kg diet		1.0/1.5 ¹	1.5/2.6 ¹	0.8/1.3 ¹
Feed intake ²	kg/day	2.50	2.42	2.30	2.32
Weight gain	g/day	893±91	869±95	853±88	876±102
Feed : gain ratio ²	kg feed/kg weight	2.83	2.81	2.73	2.68
Thyroid weight	mg /kg body weight	74 ^b ±18	100 ^a ± 29	114 ^a ±23	99 ^a ±16
Thyroid iodine	µg/g	1580 ^a ±380	931 ^c ±137	842 ^c ±131	1096 ^b ±181
PUFA	g/100g backfat FA	10.6 ^b ±0.9	10.7 ^b ±0.6	11.8 ^a ±0.6	11.8 ^a ±1.4
n-3 PUFA	g/100g backfat FA	0.72 ^b ±0.08	0.90 ^a ±0.06	1.19 ^a ±0.07	1.03 ^a ±0.13

PUFA = polyunsaturated fatty acids

^{ab} different indices in the same line indicate significant differences

¹ 60-day growing period/finishing period ² group feeding – no SD

Regarding the connection between feed fat and body fat an increase of 1 % units polyunsaturated fatty acids, PUFA (from 100% total backfat FA) per 10 g rapeseed oil equivalents/ kg feed was in the magnitude of the results of former experiments (Schöne *et al.*, 2002). The relation of n6- to n3-PUFA fell from 14 : 1 in the control till 9 : 1 in the groups fed the highest percentage RPC. A pig fat with more PUFA and a lower relation of n6- to n3-FA is closer to the recommendations of Nutrition Societies (D A CH 2000). The production of longer storable sausage, e.g. salami, or ham; requires a harder pigfat and so the PUFA content should be lower than 15%. Considering this upper limit the effect of the RPC administered and of the respective rapeseed oil equivalents was moderate and neglectable for storability of the previously mentioned meat products.

As conclusion, there were no significantly negative effects of RPC on performance and also the thyroid enlargement and the decrease of the thyroid iodine concentration were in a tolerable range. The highest proven RPC level (7.5%/12.5% of the diet in the grower /finisher period of fattening) reduced the feed intake and daily weight gain (tendency), but improved the feed to gain ratio. A moisture heat treatment alleviated the negative effects of RPC and should be investigated furthermore.

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