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Supplementary xylanase improves metabolisable energy of rape seed meals obtained by cold pressed hexane extraction when fed to turkey poults

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Background

Feed represents approximately 70% of the production cost in modern commercial poultry production

As a main ingredient dietary protein contributes greatly to the overall production costs of compound poultry diets

The European/UK poultry industry relies heavily on imported soybean meal (SBM) as a protein source in feed as SBM contains high levels of digestible protein and a well-balanced amino acid composition

Background

Over recent years, the demand for sustainable feed ingredients has risen, strengthening the need to develop alternative protein sources for modern poultry production

Rapeseed is the largest oil crop grown in the UK and Europe, with the majority of modern and currently available cultivars registered as “double zero” (00) due to their low erucic acid and glucosinolate (GLS) content

Conventional, pre-press solvent extracted rapeseed meal (RSM), is the second most widely used protein feedstock and is commonly used in poultry diets

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Background (ME for broilers)

Variable	Country	Year	ME (MJ/kg DM)		CP%	
			SBM	RSM	SBM	RSM
NRC	USA	1994	9.96	8.37	47.2	38.0
INRA	France	2002	9.80	6.03	47.2	33.7
NARO	Japan	2009	10.26	7.29	47.1	37.3
FEDNA	Spain	2010	9.96	7.12	47.5	33.8
MPA	Russia	2014	9.63	7.54	47.0	35.5
CVB	Netherlands	2021	8.97	7.13	46.7	33.9
Premier	UK	2025	10.70	7.02	48.8	33.5

Background

Although RSM is relatively high in dietary fibre, particularly non-starch polysaccharides, it is still a valuable source of protein for poultry

However, the process of oil recovery influences its nutritional value, e.g. reducing the exposure of the RSM to preliminary thermal treatments prior to solvent extraction may increase content of metabolisable energy (ME), amino acid digestibility and reduce the content of indigestible fibres in RSM for broiler chickens

Oil extraction methods

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Pre-press solvent extraction: cooking at 80 - 90° C for about 45 min, followed by mechanical pressing, solvent extraction & then desolventization for 60-80 minutes, where temperatures can range from 95-115°C for between 60-80 minutes (< 5% residual oil).

Expeller extraction: cooking at up to 160° C for about 45 min, followed by mechanical pressing (8-15% residual oil).

Mild processing mechanical pressing followed by solvent extraction (app. 60 °C and desolventization (about 115°C for approximately 90 min (residual oil, similar to pre-press solvent extraction).

Supercritical carbon dioxide extraction (ScCO2).

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Pre-press solvent extraction

Pre-press solvent extraction is the most used commercial method for RSM production. The main steps include

- seed drying
- cooking at 80-90°C to increase oil extraction efficiency
- mechanical crushing of the seed with the addition of heat
- solvent extraction/percolation of the pressed cake in food grade hexane
- the residual hexane is flashed from the meal under pressure in a desolventising and toasting unit using heat and sparge steam with temperatures ranging from 95-115°C for between 60-80 minutes

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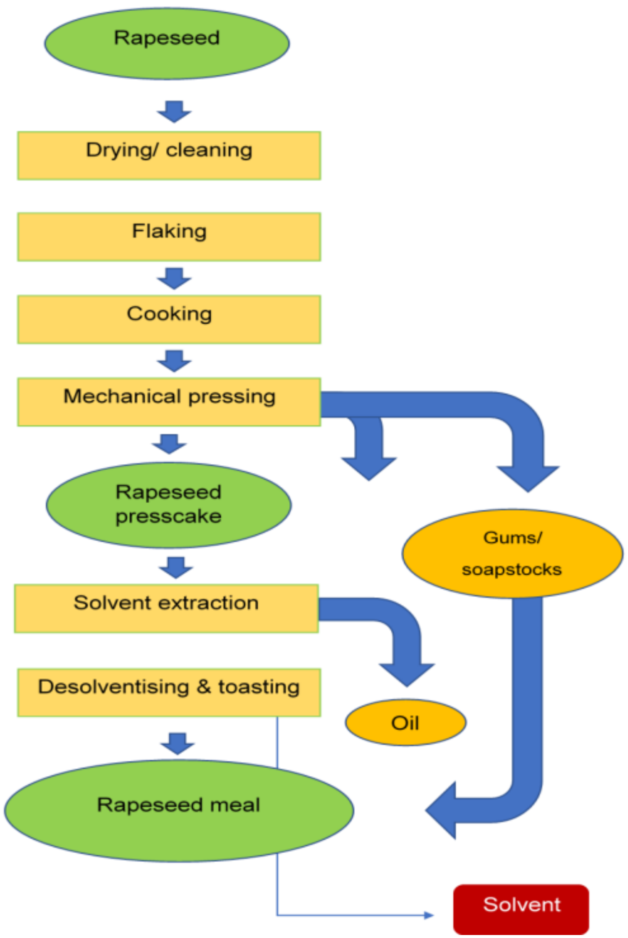
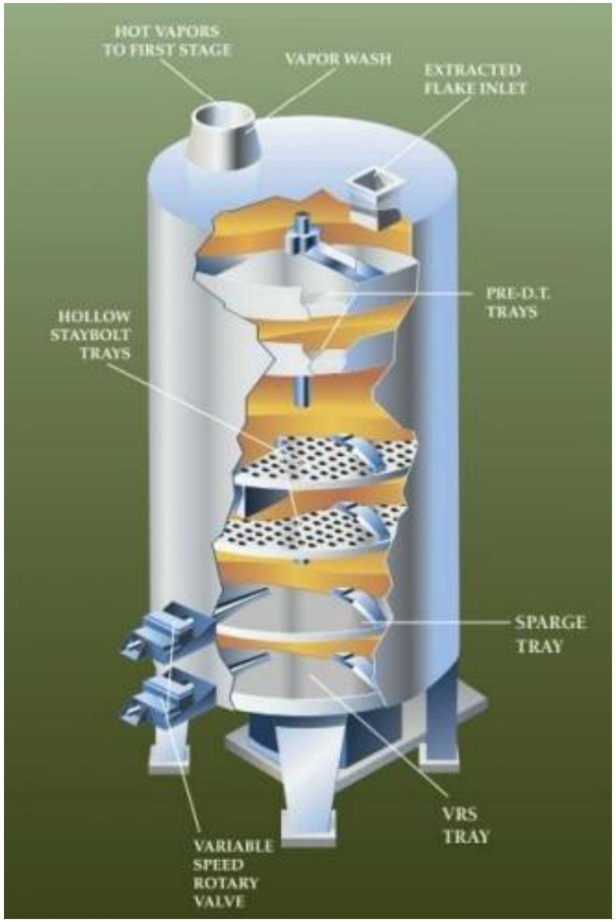
Pre-press solvent extraction





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Background

Desolventising and toasting effectively remove residual hexane to non-harmful levels (< 5% residual oil)

Prolonged exposure to high temperatures can substantially reduce the feeding value of RSM primarily by damaging the protein fraction of the meal and increasing the levels of indigestible fibre

Eklund et al. (2015) reported greater quantities of indigestible fibre and lower amino acid digestibilities in RSM subjected to a longer residence time in the desolventising and toasting unit

Background

Newkirk et al., (2003) report that removal of the desolventising and toasting step resulted in greater metabolisable energy and protein digestibility in broilers

Recommended 5 - 15% in finals feeding phases for turkeys!!!

Compared to solvent-extracted RSM, rape expeller, the end product of the expeller-extraction method where oil is extracted only mechanically resulted greater ME and amino acid digestibility for pigs (Woyengo et al. 2010a; Maison and Stein 2014) and for poultry (Woyengo et al. 2010b; Kong and Adeola 2016; Olukosi et al. 2017)

Metabolisable energy in rapeseed meals processed in different methods

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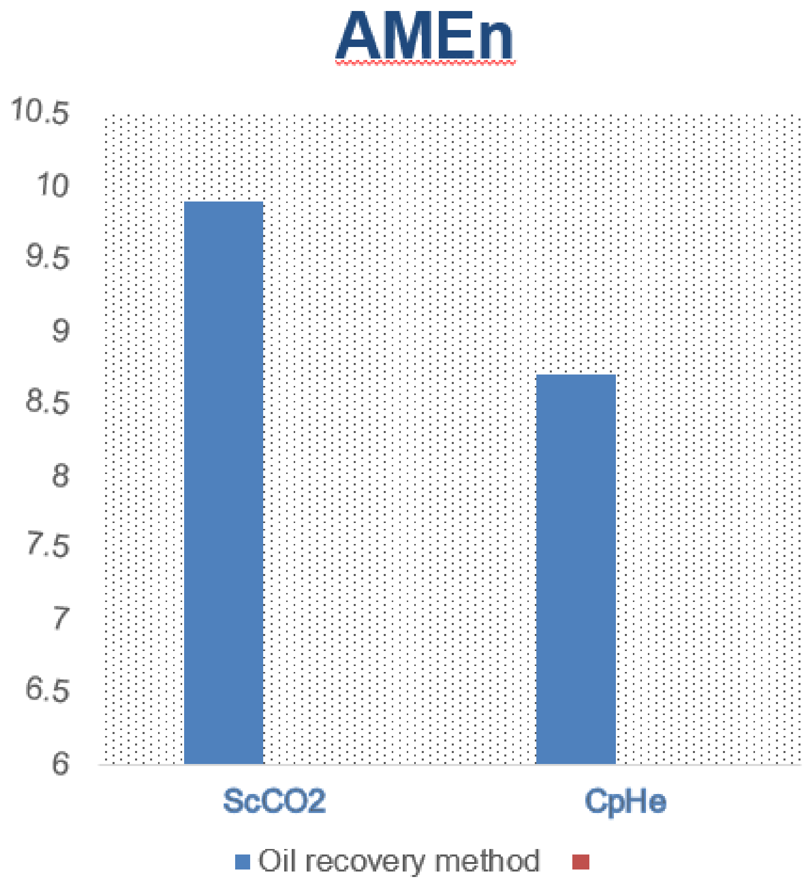

Supercritical carbon dioxide extraction ($ScCO_2$) *vs* cold press hexane extraction (CpHe) values of RSM AMEn and protein digestibility for broilers

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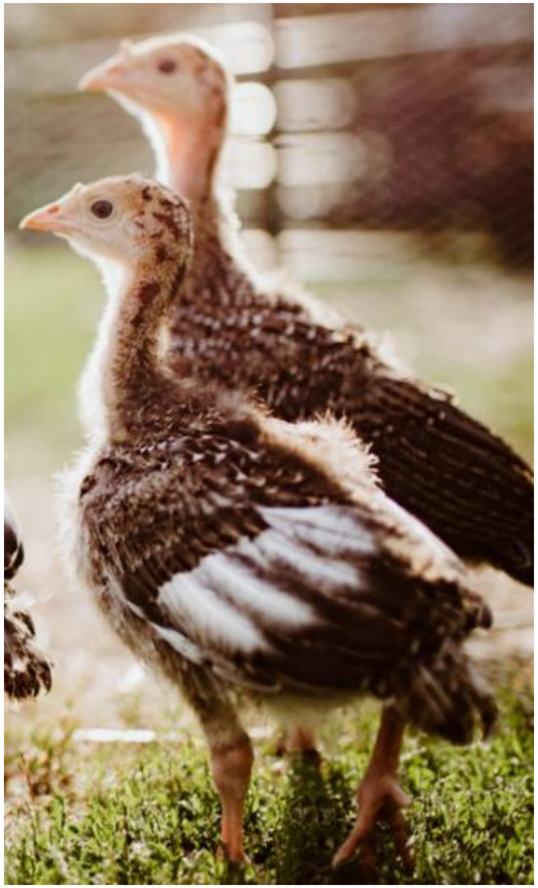
Watts et al. 2021. *Archives of Animal Nutrition*, *75*(3), pp.209-221.

Aim



This experiment was designed to investigate the influence of oil extraction method and the use of exogenous xylanase enzyme on the range of variation in the apparent metabolisable energy (AME) for young turkeys

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Experimental design (RSM)

Three RSM **cold press hexane extraction** samples obtained from three different rapeseed cultivars were obtained from a pilot scale extraction plant (OLEAD, Pessac, France; Watts et al., 2020)

Energy and nutrient availability of the meals were examined in turkey poults experiment from 55 to 63 d age

Each of the three RSM samples were incorporated into a nutritionally complete basal feed (BF; Table 1) in meal form at 200 g/kg (800 g of the BF + 200 g of each RSM sample; test feed TF)

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Experimental design (basal feed)

Main ingredients (g/kg)	Control
Wheat	525.1
Prairie meal	25.0
Soybean meal	295.0
Rape Seed Meal	50.0
Rye	20.0
Amino acids, Minerals …	…
Calculated provision	
ME (MJ/kg)	12.16
CP (g/kg)	241.2
Ether extract (g/kg)	45.6
Ca (g/kg)	12.8
Available P (g/kg)	6.8

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Experimental design (RSM diets)

The four diets, including the BF, were then split in two parts and one of the parts was supplemented with 16 000 BXU/ kg xylanase (Econase XT 25P; AB Vista, UK) resulting in eight experimental diets in total

The nutrient specification of the diets met the breeder's recommendation

Ninety-six BUT Premium female turkeys (Faccenda Foods Ltd., Dalton, UK) were used in the study. All birds were reared in a single floor pen until the start of the study. Three weeks before the start of the study all birds were fed the BF

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Experimental design (housing)

At 55 d age two birds were randomly allocated to one of 48 cages with 0.36 m^2 floor area and each diet was fed to 6 cages following randomisation

At 60 d of age, after 5 d given to adjust to the diets, the droppings were collected for 4 d until the end of the study at 63 d age

Feed intake for the same period was recorded

Experimental design (calculation)

Metabolisable energy in RSM was obtained using substitution technique

$$AME\ (MJ/kg)\ of\ RSM = \frac{AME\ of\ T\ - AME\ BF\ x\ 0.800}{0.200}$$

(where T is the test diet, BF is the basal diet)

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Watts et al. 2021. *Archives of Animal Nutrition*, *75*(3), pp.209-221.

Statistical analysis

Experimental data were analysed using Genstat (23rd edition) statistical software (IACR Rothamstead, Hertfordshire, UK)

Studied variables were statistically compared using two-way analysis of variance (diets X xylanase)

In all instances, differences were reported significant at $P < 0.05$

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Proximate analysis of the experimental rape seed meal samples

	GE MJ/kg	DM g/kg	EE g/kg	CP g/kg	NDF g/kg	GLS (umol/g)
Cabernet	17.18	883	23	322	247	7.7
Elgar	17.59	883	18	314	247	2.4
Quartz	17.62	881	13	342	276	1.6

GE, gross energy; DM, dry matter; EE, ether extract; CP, crude protein; NDF, neutral detergent fibre; GLS, total glucosinolates.

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The impact of experimental diets and enzyme supplementation on bird growth performance

Variable	BW end (g)	FI (g/b/d)	WG (g/b/d)	FCR
Diet				
Control	2035	159	87	1.833[a]
Caberne	2035	164	84	1.955[ab]
Elgar	2070	170	82	2.085[b]
Quartz	2049	170	89	1.923[ab]
SEM	43.9	4.1	3.1	0.0604
Enzyme				
No	2052	165	83	2.006
Yes	2042	166	88	1.892
SEM	31.0	2.9	2.1	0.0427
CV %	6.8	7.9	11.3	9.8
P values				
Diet	0.938	0.201	0.390	0.049
Enzyme	0.821	0.881	0.110	0.070
Diet X Enzyme	0.843	0.445	0.912	0.222

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The impact of experimental diets and enzyme supplementation on AME and nutrient retention

Variable	AME diet (MJ/kg)	NR	FR	AME RSM* (MJ/kg)
Diet				
Control	13.85	0.635[a]	0.871	-
Caberne	13.32	0.731[b]	0.889	11.18
Elgar	13.25	0.714[b]	0.885	10.78
Quartz	13.27	0.733[b]	0.896	10.96
SEM	0.169	0.0154	0.0065	0.708
XYL				
No	13.19	0.689	0.879	9.66
Yes	13.65	0.718	0.891	12.29
SEM	0.120	0.0109	0.0046	0.578
CV %	4.0	6.9	2.3	20.4
P values				
Diet	0.054	<0.001	0.073	0.924
XYL	0.011	0.067	0.076	0.005
Diet x XYL	0.809	0.893	0.061	0.702

*Data obtained via substitution method

AME presented on DM basis

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Metabolisable energy in rapeseed meals processed in different methods

Reference	RSM process	Calculation method	AME MJ/kg DM	Improvement
Woyengo et al., 2010	pre-press solvent	substitution	8.39	
	mild		12.72	51.6 %
Kong and Adeola, 2016	pre-press solvent	regression	8.69	
	mild		11.74	35.1 %
Olukosi et al., 2017	pre-press solvent	substitution	7.74	
	mild		9.35	20.8 %
Premier guide, 2025	pre-press solvent	substitution	8.01	
Recent study	mild		9.66	20.6 %

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Impact of NSP degrading enzymes on ME in RSM containing diets

Reference	Species	RSM meal	Enzyme	ME MJ/kg DM	Change
Mushtaq et al., 2007	Broilers	B. napus (diets)	No	12.02	
		B. napus (diets)	Yes	12.03	NS
Jia et al. 2012	Broilers	B. napus black	No	7.97[bc]	
		B. napus black	Yes	8.45[abc]	NS
		B. napus yellow	No	9.16[ab]	
		B. napus yellow	Yes	9.92[a]	NS
		B. juncea yellow	No	7.26[c]	
		B. juncea yellow	Yes	9.86[ab]	35.8 %
Radfar et al., 2017	Broilers	B. napus	No	7.75[a]	
		B. napus	Yes	7.95[a]	NS
		B. juncea	No	7.87[a]	
		B. juncea	Yes	9.30[b]	18.2 %
Kozlowski et al., 2018	Turkeys	B. napus black	No	8.74	
		B. napus black	Yes	9.19	NS
		B. napus yellow	No	9.08	
		B. napus yellow	Yes	9.58	NS
		B. juncea yellow	No	9.53	
		B. juncea yellow	Yes	9.49	NS
Pirgozliev et al. 2022	Broilers	Conventional RSM (diets)	No	13.06	
		Conventional RSM (diets)	Yes	13.11	NS
Current study	Turkeys	Mild processed B. napus (diets)	No	13.19	
		Mild processed B. napus (diets)	Yes	13.65	3.5 %
		Mild processed B. napus	No	9.66	
		Mild processed B. napus	Yes	12.29	27.2 %

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Conclusions

The reported results showed that there is no significant difference in AME of different RSM batches obtained from the same processing plant

The use of mild extraction methods for the production of RSM may result in a product with a greater nutritional value to turkeys than RSM produced by traditional pre-press solvent extraction

Results also indicated that it is possible RSM obtained vial mild extraction methods to respond better to supplementary xylanase

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Conclusions

The key implications of these findings are that by adopting these techniques there is scope to increase the nutritional value of RSM for turkeys and potentially increase its utilisation in modern poultry production

Future work should focus on the long-term effects of feeding RSM produced via mild extraction methods with exogenous enzymes, e.g. xylanase, protease etc., on bird performance, as well as an in-depth evaluation of the economic implications of adopting mild extraction methods for RSM production

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