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Nutrient and energy digestibility in air-classified faba bean and field pea protein and starch concentrates in 21-day old broilers

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Background

Fractionation technology has the potential to yield value-added or differentiated products from raw agricultural commodities with increased usefulness for particular feed applications. This could enhance feed competitiveness of Western Canadian which is a major pulse producing region. Protein concentrates of plant origin, could reduce reliance on recycled animal and marine protein sources, which have perceived food safety and sustainability concerns. Pulse starch concentrates have important human food applications, in particular for gluten-free products.

The objective of the present study was to compare nutrient and energy digestibility in air-classified starch (ST) and protein (PR) fractions of zero -tannin 'Snowbird' faba bean (FB) and 'Cooper' field pea (PEA) measured in 21d-old broilers.

Methods and Materials

A zero-tannin faba bean (*var.* 'Snowbird') starch concentrate was produced by grinding a sample using a cracking mill (Ferrel-Ross, Bluffton, IN) and then in an Alpine Contraplex Wide Chamber Pin Mill (Alpine Aktiengesellschaft, Augsberg, Germany) until 97.5% of the flour reached a particle size of <100 µm. The flour was air classified using an Alpine Microplex Classifier (model 132MP, Aktiengesellschaft, Augsberg, Germany) at a rotor speed of 11,000 rpm and a feed rate of 32 kg of flour/h. The air-classified field pea protein (Prestige™), starch (Probond™) and faba protein were commercial stock donated by Parrheim Foods (Saskatoon, SK). Analyzed nutrient composition of the respective starch and protein fractions are presented in Table 1.

On the day of hatch, male broiler chicks (Ross 308; n=300) were distributed among 24 test cages and fed a commercial starter diet until 14 d of age. On d 14, cages were then fed 1 of 4 test diets for 7 d in with a RCB design with 6 replicate cages per treatment. Test diets consisted of 70% of a wheat-based basal diet, containing 0.5% chromic oxide as an indigestible marker, and 30% of 1 of 4 test ingredients (ST or PR fractions of FB or PEA).

On d 21, birds were euthanized for collection of ileal digesta. Excreta was collected for 48-h prior to digesta collection. Digesta or excreta were pooled to produce a single specimen of each per test cage. Nutrient digestibility in the basal diet had previously been measured, thus permitting nutrient digestibility in the test ingredients to be calculated by the difference method.

Table 1. Analyzed composition of fractions studied in this experiment, in % as fed (unless otherwise indicated).

	Faba bean		Pea	
	Protein	Starch	Protein	Starch
Dry matter	93.32	89.64	93.53	90.47
Gross energy, Mcal/kg	4.44	3.96	4.51	3.87
Crude protein	49.75	20.69	48.78	7.11
Arginine	4.89	1.71	4.32	0.50
Isoleucine	2.21	0.86	2.22	0.27
Lysine	3.17	1.31	3.70	0.50
Methionine	0.35	0.15	0.45	0.06
Met + Cys	0.92	0.40	1.04	0.2
Threonine	1.60	0.70	1.63	0.26
Tryptophan	0.44	0.18	0.49	0.08
Valine	2.32	0.93	2.42	0.32
Total AA	44.54	18.33	45.57	6.52
Crude fiber	1.50	3.90	1.08	0.93
Ether extract	2.39	1.36	2.75	0.73
Starch	1.3	46.1	10.7	68.9
Tannins	1.2	0.6	0.75	0.2
TIA[1], mg/g	4.5	1.3	4.5	0.5

[1] *Trypsin inhibitor activity*

Nutrient digestibility coefficients were analyzed using the MIXED procedure of SAS 9.1. Statistical models included the fixed effects of pulse crop (FB or PEA), fraction type (ST or PR), and the 2-way interaction with block as the random term.

Results

For most nutrients, more differences were apparent between ST and PR than between pulses (**Table 2**). Total tract digestibility coefficients for both GE and DM were greater for PR compared to ST ($P < 0.01$), but were similar between FB and PEA ($P > 0.24$).

Pulse crop interacted with fraction type to affect AID coefficients for ARG, MET, ILE, TRP and VAL ($P < 0.02$). Coefficients for LYS, TSAA and PHE were higher in PR compared to ST ($P < 0.02$).

Table 2. Effect of air-classified fraction (protein or starch) within pulse on apparent total tract digestibility (ATTD) and ileal (AID) of energy, dry matter and selected amino acids for 21-d-old broilers.

	Faba bean		Pea			*P* - value		
	Protein	Starch	Protein	Starch	SEM	Pulse	Frac	P x F
ATTD, %								
Dry matter	66.0^{a}	51.4^{ab}	68.5^{a}	40.4^{b}	7.4	0.538	0.007	0.333
Gross energy	71.4^{a}	52.9^{ab}	69.9^{a}	38.0^{b}	7.4	0.243	0.002	0.337
AID, %								
Crude protein	114.3^{a}	83.1^{b}	111.9^{a}	71.4^{c}	3.1	0.033	0.001	0.144
Arginine	104.3^{a}	97.2^{b}	102.7^{a}	105.4^{a}	1.1	0.009	0.056	0.001
Isoleucine	97.4^{a}	92.3^{a}	92.1^{a}	98.7^{a}	2.5	0.821	0.768	0.028
Lysine	102.0^{a}	96.6^{b}	102.5^{a}	100.9^{ab}	1.5	0.131	0.035	0.220
Methionine	93.4^{a}	76.7^{b}	95.5^{a}	55.4^{c}	4.3	0.037	0.001	0.013
Met + Cys	78.4^{a}	74.3^{b}	82.3^{a}	72.6^{c}	2.5	0.683	0.014	0.291
Threonine	90.0^{a}	77.6^{ab}	78.4^{ab}	69.9^{b}	5.9	0.091	0.070	0.727
Tryptophan	78.3^{a}	71.1^{a}	75.8^{a}	42.5^{b}	2.9	0.001	0.001	0.001
Valine	111.1^{a}	91.8^{b}	98.2^{b}	96.6^{b}	2.9	0.180	0.002	0.007
Total AA	96.4	91.3	91.7	93.5	1.8	0.481	0.361	0.065

Conclusions

Nutrient digestibility is generally higher in pulse PR compared to ST fractions. Nutrient digestibility was similar between PR fractions but higher in ST from FB compare to PEA.

High dietary inclusion of pulse PR or ST fractions for broilers would require supplemental MET to achieve an adequate digestible AA profile due to low intrinsic digestible sulphur AA content.

Acknowledgements

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