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Article

Digestible and metabolizable energy values of faba beans and field peas fed to growing pigs

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Abstract

The digestible energy (DE) and metabolizable energy (ME) in faba beans (FB) and field peas (FP) fed to growing pigs were estimated by the difference procedure in two experiments using the total collection method. Twenty-four barrows with mean initial body weight (BW) of 20.0 kg (SD = 1.13) and 20.4 kg (SD = 0.56) in the first (Exp. 1) and second experiments (Exp. 2), respectively, were assigned to three dietary treatments in a randomized complete block design with BW as a blocking factor. A reference diet was prepared using corn, soybean meal, and soybean oil as the energy-contributing ingredients. Organic FB and DS Admiral FP (FPD) in Exp. 1 and Hampton FP (FPH) and 4010 FP (FP4) in Exp. 2 were included at 30% in the reference diet. In Exp. 1, the determined DE and ME were 3772 and 3606 kcal·kg^{-1} dry matter (DM) in FB and 3683 and 3589 kcal·kg^{-1} DM in FPD, respectively. In Exp. 2, the respective DE and ME were 4164 and 4014 kcal·kg^{-1} DM in FPH and 3574 and 3467 kcal·kg^{-1} DM in FP4. In conclusion, the determined ME values for FB and FP were 77% to 90% of gross energy.

Key words: digestible energy, faba beans, field peas, metabolizable energy, pigs, total collection

Introduction

Feed cost accounts for more than 60% of total production cost in the swine industry with the major proportion of this cost attributed to the energy component of the feed (Patience et al. 2015). An adequate supply of energy and nutrients is essential for the maintenance, growth, and reproductive processes in pigs (Kil et al. 2013). Therefore, pigs tend to control their feed intake based on the energy content of the feed to meet their maintenance and production requirements. Hence, it is important that diets are properly formulated, as energy-deficient diets could lead to increased feed intake, which could in turn affect feed efficiency. This could also lead to poor performance and nutrient wastage, thereby increasing the cost of production. The energy component in most swine diets is mainly supplied using corn, soybean meal (SBM), and oil. Due to an increase in feed cost and to reduce reliance on some major feed ingredients, evaluation of alternative feed ingredients is important, as this could maximize the utilization of energy in diets for pigs.

Faba beans (FB; *Vica faba*) and field peas (FP; *Pisum sativum*) are non-oil seed legume crops, also known as pulses, and a good source of starch and protein. These pulses could contain some antinutritional factors such as tannins, trypsin inhibitors, and lectins, which could impede digestion, but there are new varieties of these ingredients that contain limited amounts of antinutritional factors (Mariscal-Landín et al. 2002; Crépon et al. 2010; Amarakoon et al. 2015; Ivarsson and Neil 2018; Siegert et al. 2022). Partanen et al. (2003) reported that the inclusion of FB above 20% in a barley rapeseed diet could impair a pig's performance, but FB could be included up to 35% in other diets for growing pigs (Crépon et al. 2010). Stein et al. (2006) reported that FP could replace all SBM in diets for growing pigs without performance being negatively affected. In addition, FP could be included at 40% in the diet of weaned pigs (Landero et al. 2014; Hugman et al. 2020).

The nutritional composition of FB and FP is based on the variety, seeding time, and agronomic condition (Castella et al. 1996); therefore, variation among cultivars could lead to differences in response to FB- or FP-based diets. To the best of our knowledge, there is lack of information for energy values of these cultivars of pulses: organic FB, DS Admiral FP (FPD), Hampton FP (FPH), and 4010 FP (FP4). Therefore, the objective of this study was to determine the digestible energy (DE) and metabolizable energy (ME) in FB and three cultivars of FP fed to growing pigs. We hypothesized that the DE or ME in FB is not different from that in FPD; likewise, the DE or ME in FPH is not different from that in FP4.

Materials and methods

Purdue University Animal Care and Use Committee (West Lafayette, IN, USA) approved the protocol used for the animal experiments. These experiments were conducted in accordance with the ASASPSA Guide for Care and Use of Agricultural Animals in Research and Training. In both experiment 1 (Exp. 1) and 2 (Exp. 2), crossbred barrows (Duroc × (Yorkshire × Landrace)) were used.

Twenty-four barrows with initial body weight (BW) of 20.0 kg (SD = 1.13) and 20.4 kg (SD = 0.56) in Exp. 1 and Exp. 2, respectively, were individually housed in metabolism crates equipped with a feeder and a nipple drinker. Pigs were assigned to three dietary treatments in a randomized complete block design with BW as a blocking factor. The reference diet (RD) was prepared to contain corn, SBM, and soybean oil as the sources of energy (Table 1). The RD was also formulated to meet or exceed the estimated vitamin and mineral requirements suggested in NRC (2012). The test diets were prepared by adding FB, FPD, FPH, or FP4 at 30% at the expense of corn, SBM, and soybean oil into the RD. The ratio among corn, SBM, and soybean oil was kept consistent in all diets.

Daily feed allowance was calculated at 4.5% of the mean BW of pigs in each block, and pigs were fed an equal amount of feed twice daily at 08:00 and 17:00. Pigs were fed experimental diets during the five-day adaptation period, whereas on days 6 and 11 the first meal fed to the pigs contained approximately 3 g chromic oxide as a marker. The collection of feces started at the appearance of the first marker in feces and stopped at the appearance of the second marker. During this period, urine was also quantitatively collected using plastic buckets containing 10 mL of 10% formic acid. Urine collected from each pig daily was weighed and subsampled. Feces and urine collected were immediately stored at −20 °C. The collected feces and urine samples were dried at 55 °C in a forced-air drying oven until constant weight (Precision Scientific Co., Chicago, IL, USA). Dried feces were finely ground (<1 mm) using a hammer mill, and subsampled. Samples of experimental diets were finely ground (<0.75 mm) using a centrifugal grinder (ZM 200; Retsch GmbH, Haan, Germany). Ingredient and diet samples were analyzed for dry matter (DM) by drying at 105 °C for 24 h in a forced-air drying oven (method 934.01; AOAC 2006). The concentration of gross energy (GE) in ingredient, diet, feces and urine samples was analyzed by an isoperibol bomb calorimeter (Parr 6200; Parr Instrument Co., Moline, IL, USA). Test ingredients and diets were analyzed for ether extract (method 920.39 (A); AOAC 2006). The Megazyme (Megazyme Ltd., Bray, Ireland) total starch determination kit using the RTS-NaOH procedure was used to analyze the test ingredients for starch concentrations. Neutral detergent fiber (NDF; Van Soest et al. 1991) and acid detergent fiber (ADF; method 973.18 (AD); AOAC 2006) were analyzed in test ingredients using a fiber analyzer (Ankom 2000 Fiber Analyzer; Ankom Technology, Macedon, NY, USA). Nitrogen (N) was also analyzed by a combustion method (model FP2000; LECO Corp., St. Joseph, MI, USA; method 990.03; AOAC 2000), whereas the concentration of crude protein (CP) was calculated as the product of N concentration and 6.25.

The apparent total tract digestibility (ATTD) and metabolizability of GE in experimental diets were calculated as suggested by Kong and Adeola (2014). The concentrations of DE and ME in the experimental diets were calculated by the difference between the GE intake and fecal and urinary GE output using the following equations described by Kong and Adeola (2014):

$$\text{DE in diet}\left(\text{kcal}\cdot\text{kg}^{-1}\text{DM}\right) = \left(\text{GE}_\text{i} - \text{GE}_\text{f}\right)/\text{DMI}$$
$$\text{ME in diet}\left(\text{kcal}\cdot\text{kg}^{-1}\text{DM}\right) = \left(\text{GE}_\text{i} - \text{GE}_\text{f} - \text{GE}_\text{u}\right)/\text{DMI}$$

where GE_i, GE_f, and GE_u represent the GE intake, fecal GE output, and urinary GE output (kcal·day^{-1}), respectively, and DMI represents DM intake (kg DM.day^{-1}). Based on the concentration of DE in diets, the DE values (kcal·kg^{-1} DM) in FB and FP were calculated using the difference procedure as follows:

$$(\text{DE}_\text{ti}\times \text{C}_\text{ti}) + (\text{DE}_\text{rd}\times \text{C}_\text{rd}) = \text{DE}_\text{td}$$
$$\text{DE}_\text{ti} = [\text{DE}_\text{td} - (\text{DE}_\text{rd}\times \text{C}_\text{rd})]/\text{C}_\text{ti}$$

where DE_{ti} and DE_{td} represent the digestible energy in the test ingredient and test diet (i.e., experimental diet containing test ingredient), respectively; DE_{rd} represents the digestible energy of the RD corrected for the energy-contributing ingredients (i.e., DE ÷ 0.96); and C_{rd} and C_{ti} represent the concentrations of RD and test ingredient in the test diet, respectively. The ME contributed from the FB or FP was estimated using the same calculation but replacing DE with ME.

Data were analyzed by ANOVA using the GLM procedure of SAS (SAS Institute Inc., Cary, NC, USA). The model included experimental diets and block as independent variables. The differences between least square means were separated by pairwise comparison with Tukey's adjustment. The experimental unit was pig, and significance was declared at $P < 0.05$.

Results

The GE in FB and FP ranged from 3935 to 3986 kcal·kg^{-1}, whereas starch concentration ranged from 351 to 391 g·kg^{-1} (Table 2). The CP concentrations in the three cultivars of FP were close to each other at 211 to 214 g·kg^{-1} and that of FB was 252 g·kg^{-1}. The ADF concentration among test ingredients was close, whereas FPH and FPD had the highest and lowest NDF values, respectively.

The GE intake of pigs fed FB or FPD in Exp. 1 was lower ($P < 0.05$) compared with pigs fed the RD (Table 3). A similar effect was also observed in DE and ME intake. In addition, the GE in feces was lower ($P < 0.05$) with the inclusion of FB or FPD in the diet, but no effect was observed for GE in the urine. The ATTD of GE in the FB diet was not different from those of RD and FPD diets, whereas that of the FPD diet was lower than ($P < 0.05$) that of the RD, but a decrease in metabolizability of GE was observed with the inclusion of FB or FPD in the diet. The substitution of RD with FB or FPD decreased ($P < 0.05$) the DE and ME in the diets, but diets containing FB or FPD had DE and ME values that were not different. The estimated DE values in FB and FPD were 3772 and 3683 kcal·kg^{-1} DM, respectively, whereas the ME estimated in FB was 3606 kcal·kg^{-1} DM, and in FPD the ME was 3589 kcal·kg^{-1} DM (Table 4). There was no difference observed in the estimated DE and ME values between FB and FPD.

In Exp. 2, the substitution of energy-containing ingredients in the RD with FPH or FP4 in the test diets lowered ($P < 0.05$) the GE intake, whereas pigs fed the FPH diet had higher ($P < 0.05$) GE intake compared with pigs fed the FP4 diet (Table 5). The fecal output for pigs fed the reference or FPH diet was not different, but this was lower ($P < 0.05$) compared with pigs fed the FP4 diet. The same effect was seen for

Table 1. Ingredient and analyzed chemical composition in experimental diets used in Exp. 1 and Exp. 2, as-fed basis.

	Diet					
	Exp. 1			Exp. 2		
Item	RD	FB	FPD	RD	FPH	FP4
Ingredient ($g \cdot kg^{-1}$)						
Ground corn	672.90	462.92	462.92	672.90	462.92	462.92
Soybean meal	245.00	168.55	168.55	245.00	168.55	168.55
Faba beans	0.00	300.00	0.00	0.00	0.00	0.00
Field peas	0.00	0.00	300.00	0.00	300.00	300.00
Soybean oil	43.50	29.93	29.93	43.50	29.93	29.93
Ground limestone	12.00	12.00	12.00	12.00	12.00	12.00
Monocalcium phosphate	13.00	13.00	13.00	13.00	13.00	13.00
Salt	4.00	4.00	4.00	4.00	4.00	4.00
L-Lysine HCl	4.20	4.20	4.20	4.20	4.20	4.20
DL-Methionine	0.80	0.80	0.80	0.80	0.80	0.80
L-Threonine	1.20	1.20	1.20	1.20	1.20	1.20
L-Tryptophan	0.10	0.10	0.10	0.10	0.10	0.10
Vitamin premix[a]	2.00	2.00	2.00	2.00	2.00	2.00
Mineral premix[b]	0.80	0.80	0.80	0.80	0.80	0.80
Selenium premix[c]	0.50	0.50	0.50	0.50	0.50	0.50
Total	1000	1000	1000	1000	1000	1000
Analyzed chemical						
DM	868	867	869	868	867	869
GE ($kcal \cdot kg^{-1}$)	4076	3964	3957	4076	3996	3991
Crude protein ($g \cdot kg^{-1}$)	166	194	184	166	188	186
Ether extract ($g \cdot kg^{-1}$)	379	296	265	379	294	254

Note: RD, reference diet; FB, faba beans; FPD, DS Admiral field peas; FPH, Hampton field peas; FP4, 4010 field peas.
[a]Provided the following quantities per kg of complete diet: vitamin A, 5280 IU; vitamin D_3, 528 IU; vitamin E, 35.2 IU; menadione, 1.8 mg; riboflavin, 7.0 mg; D-pantothenic acid, 17.6 mg; niacin, 26.4 mg; vitamin B_{12}, 0.03 mg.
[b]Provided the following quantities per kg of complete diet: I, 0.29 mg; Mn, 13.7 mg; Cu, 7.23 mg; Fe, 155 mg; Zn, 119 mg.
[c]Provided 0.3 mg $Se \cdot kg^{-1}$ of complete diet.

Table 2. Analyzed chemical composition of faba beans and field peas used in Exp. 1 and Exp. 2 ($g \cdot kg^{-1}$), as-is basis.

Item	FB	FPD	FPH	FP4
Dry matter	876	875	881	883
Gross energy ($kcal \cdot kg^{-1}$)	3977	3979	3935	3986
Starch	354	365	391	351
Crude protein[a]	252	211	212	214
Ether extract	19	15	14	11
Calcium	1.3	0.9	0.9	0.9
Phosphorus	2.9	3.9	3.1	2.7
Crude fiber	58	54	53	59
Neutral detergent fiber	100	82	139	106
Acid detergent fiber	56	50	55	46

Note: RD, reference diet; FB, faba beans; FPD, DS Admiral field peas; FPH, Hampton field peas; FP4, 4010 field peas [a]Analyzed nitrogen concentration multiplied by 6.25.

fecal GE output. The DE intake for pigs fed the RD or FPH diet was not different, which was also higher ($P < 0.05$) than the DE intake of pigs fed the FP4 diet; this was also true for ME intake. There was a decrease ($P < 0.05$) in the ATTD and metabolizability of GE with the inclusion of FP4 into the diet, but the urinary GE output for pigs fed the FP4 diet was not different compared with pigs fed the RD or FPH diet. The DE and ME in the FP4 diet were lower ($P < 0.05$) compared with values in the reference and FPH diets. The DE values estimated for FPH and FP4 were 4164 and 3574 $kcal \cdot kg^{-1}$ DM, respectively, whereas the ME values estimated were 4014 and 3467 $kcal \cdot kg^{-1}$ DM, respectively (Table 4). The energy values estimated in the current study for FPH were higher ($P < 0.05$) compared with FP4.

Table 3. Apparent total tract digestibility (ATTD) and metabolizability of gross energy in experimental diets fed to growing pigs in Exp. 1.

Item	Diet			SEM	*P* value
	RD	FB	FPD		
Feed intake (g·day^{-1})	899	898	899	1.0	0.527
GE intake (kcal·day^{-1})	3663a	3558b	3558b	4.6	<0.001
Feces output (g·day^{-1})	84.1b	94.6ab	96.7a	3.41	0.045
GE in feces (kcal·kg^{-1})	4735a	4614b	4602b	19.5	<0.001
Fecal GE output (kcal·day^{-1})	398	436	445	15.9	0.121
DE intake (kcal·day^{-1})	3265a	3121b	3113b	15.6	<0.001
ATTD of GE (%)	89.1a	87.7ab	87.5b	0.43	0.037
DE (kcal·kg^{-1} DM)	4185a	4011b	3984b	19.8	<0.001
Urine output (g·day^{-1})	840	1333	1281	201	0.199
GE in urine (kcal·kg^{-1})	93.4	74.0	73.9	9.60	0.284
Urinary GE output (kcal·day^{-1})	65.7b	83.9a	67.1b	2.42	<0.001
ME intake (kcal·day^{-1})	3199a	3037b	3046b	15.6	<0.001
Metabolizability of GE (%)	87.3a	85.4b	85.6b	0.43	0.012
ME (kcal·kg^{-1} DM)	4101a	3903b	3898b	19.9	<0.001

Note: Least square means within rows with a common lowercase letter are not different at $P > 0.05$. Data are least square means of eight replicate crates with one pig per crate. RD, reference diet; FB, faba beans; FPD, DS Admiral field peas; GE, gross energy; DE, digestible energy; ME, metabolizable energy.

Table 4. Energy values (kcal·kg^{-1} DM) in faba beans and field peas fed to growing pigs in Exp. 1 and Exp. 2.

Item	Digestible energy	Metabolizable energy
Exp. 1		
FB	3772	3606
FP (DS Admiral)	3683	3589
SEM	68.0	63.4
P value	0.386	0.861
Exp. 2		
FP (Hampton)	4164	4014
FP (4010)	3574	3467
SEM	87.2	84.2
P value	0.002	0.003

Note: FB, faba beans; FP, field peas. Analysis for each of the digestible and metabolizable energy was conducted with 16 observations in each experiment.

Discussion

The GE in FB analyzed in the current study was within the range of values reported by Babatunde et al. (2021). In addition, the GE in FB was higher compared with that reported by Tan et al. (2021) but lower compared with that reported by Siegert et al. (2022). The GE in FP used in the current study was close to that reported by NRC (2012) and higher than that reported by Tan et al. (2021). Variations in the chemical composition of FB and FP have been reported and these tend to occur based on the variety and growing conditions (Castella et al. 1996; Igbasan et al. 1997; Abdulla et al. 2021).

In Exp. 1, the low GE intake for pigs fed the FB or FPD diets perhaps resulted in the low DE intake as no difference was observed for fecal GE output among treatments. Despite the higher GE in the feces of pigs fed the RD compared with pigs fed the FB or FPD diet, the DE in the RD was higher compared with the FB and FPD diets. This is because of the higher GE intake and somewhat lower numerical fecal GE output, which resulted in a higher DE intake for pigs fed the RD. In addition, the lower DE and ME in FB and FPD diets compared with RD could be due to the concentration of hulls from the test ingredient, as the main constituent of hulls is fiber. The concentration of non-starch polysaccharides and antinutritional factors in the hulls can also affect the energy digestibility of these ingredients. Pulse starch from FB and FP has higher amylose and amylase resistance compared with starch from corn (Li et al. 2019; Dong and Vasanthan 2020; Tan et al. 2021). This could contribute to lower energy digestibility in pulse-based diets compared with corn-based diets. NRC (2012) reported DE of 3245 kcal·kg^{-1} and ME of 3060 kcal·kg^{-1} in FB (approximately 3682 and 3473 kcal·kg^{-1} DM, respectively), despite a higher GE value (4473 vs. 3977 kcal·kg^{-1} in the current study). The lower ADF (5.6% vs. 10.3%) concentration in FB used in the current study may have contributed to the DE and ME values estimated. The GE in FPD was close to the value (3979 vs. 4035 kcal·kg^{-1}) reported by NRC (2012), whereas the DE and ME were lower. The DE and ME for FP estimated in the current study were higher than those reported by Fan et al. (1994); this could be due to the lower GE in FP used by Fan et al. (1994). The DE and ME for FP reported by Stein et al. (2004) were 3864 and 3741 kcal·kg^{-1} DM, respectively, which are greater than the DE and ME estimated for FPD in this experiment. The difference observed could be a result of the direct procedure of estimation used in their study or simply due to the variation among different cultivars of FP. Fan et al. (2017) reported higher DE and ME values for wheat when the direct procedure was used compared with the indirect procedure, although similar energy values for wheat have been reported when the difference procedure in combination with regression was compared with the direct procedure (Bolarinwa and Adeola 2012, 2016). Also, the concentration of starch in vari-

Table 5. Apparent total tract digestibility (ATTD) and metabolizability of gross energy in experimental diets fed to growing pigs in Exp. 2.

Item	Diet			SEM	*P* value
	RD	FPH	FP4		
Feed intake (g·day^{-1})	917	917	917	0.0	—
GE intake (kcal·day^{-1})	3737a	3664b	3659c	0.4	<0.001
Feces output (g·day^{-1})	92.9b	85.9b	114.4a	4.30	0.001
GE in feces (kcal·kg^{-1})	4669	4672	4621	23.3	0.262
Fecal GE output (kcal·day^{-1})	434b	401b	529a	19.9	0.001
DE intake (kcal·day^{-1})	3304a	3263a	3131b	19.9	<0.001
ATTD of GE (%)	88.4a	89.1a	85.5b	0.55	0.001
DE (kcal·kg^{-1} DM)	4151a	4105a	3928b	25.4	<0.001
Urine output (g·day^{-1})	1455	1274	1158	200.1	0.585
GE in urine (kcal·kg^{-1})	54.8	74.2	73.8	12.25	0.460
Urinary GE output (kcal·day^{-1})	66.7b	81.5a	71.4ab	3.60	0.032
ME intake (kcal·day^{-1})	3237a	3181a	3059b	20.5	<0.001
Metabolizability of GE (%)	86.6a	86.8a	83.6b	0.56	0.002
ME (kcal·kg^{-1} DM)	4067a	4002a	3838b	26.1	<0.001

Note: Least square means within rows with a common lowercase letter are not different at $P > 0.05$. Data are least square means of eight replicate crates with one pig per crate. RD, reference diet; FPH, Hampton field peas; FP4, 4010 field peas; GE, gross energy; DE, digestible energy; ME, metabolizable energy.

eties of legumes can play a role in energy digestibility because starch is the main energy source in the legume seeds. Siegert et al. (2022) reported that the starch concentration in the FB winter genotype used in their study was lower compared with the FB genotype grown in spring; therefore, the cultivar of legume seeds can affect energy digestibility. Although FB and FP contain fiber or other carbohydrate components such as resistant starch that is not digested in the small intestine, the hindgut fermentation in pigs contributes to energy digestibility, and the short-chain fatty acids produced contribute to energy utilization (Zijlstra et al. 2012) and this fermentation process could contribute to the estimated energy digestibility of FB and FP. The formulation for RD in Exp. 1 and Exp. 2 was the same and the estimated DE and ME values of RD in both experiments were in agreement with each other. This shows the reproducibility and accuracy of the data reported in the current study.

In Exp. 2, pigs fed the FP4 diet had the highest and lowest fecal GE output and GE intake, respectively, and this resulted in a low DE intake. Given that feed intake was kept consistent across treatments, the same effect observed for DE intake was seen for DE in the diets. For growing pigs, the ileal digestibility of starch in peas is lower compared with that of most cereal grains because of the greater amylose to amylopectin ratio, and some of the starch in peas is entrapped in its fibrous cell wall component making it inaccessible to digestive enzymes. However, on the ATTD level, this difference is no longer observed because as starch enters the large intestine, it is fermented resulting in the ATTD value for cereal not being different from the ATTD value for peas (Wiseman 2006; NRC 2012; Tan et al. 2021). This might explain the DE values observed in RD and FPH diets not being different because starch is a major source of energy, although starch digestibility was not measured in the current study. The lower DE in the FP4 diet might be due to a somewhat lower concentration of starch in FP4. The higher urinary GE output observed for pigs fed the FPH diet compared with RD might be due to N loss in the urine, as excreted N mainly contributes to urinary GE output. The DE and ME estimated for FPH and FP4 in this study were different, and this could be based on starch concentration or genetic variation among cultivars of FP. In addition, the nutrient concentration of ingredients does not proportionally translate into the utilization of these nutrients; hence, the composition of each nutrient is important. A high concentration of resistant starch in an ingredient could result in low energy efficiency. The concentration of starch and protein in FP may vary among varieties, which affects the DE and ME values, and the composition of protein in FP could be different (Saharan and Khetarpaul 1994; Borowska et al. 1996). The pea protein consists of albumin and globulin fraction, and the globulin fraction is more digestible (Le Gall et al. 2005). The globulin fraction is varied in its concentration and composition, and it contains vicilin. Vicilin was reported as the most abundant protein in peas; it is quite varied ranging from 26.3% to 52.0% among different cultivars (Tzitzikas et al. 2006). In addition, because not all vicilin undergoes post-translational cleavage, the amount of processed vicilin is different from the total vicilin concentration (Tzitzikas et al. 2006). This may affect N losses in the urine and therefore ME in the ingredient. The DE and ME of 3741 and 3864 kcal·kg^{-1} DM, respectively, for FP reported by Stein et al. (2004) are lower than the DE and ME for FPH but higher than those of FP4.

The ME for SBM is close to the ME for FB, whereas that of FPH is higher than the ME for corn reported by NRC (2012). The GE reported by NRC (2012) for SBM is higher than the GE for FB, whereas that of corn is close to the GE for FPH in the current study. Perhaps, this might further enhance the incorporation of FB and FP as alternative feed ingredients for growing pigs.

In conclusion, the difference in the DE and ME values of field peas observed in this study shows that there is variation in the energy values of different cultivars of field peas. Therefore, it is important that digestibility studies be conducted on different cultivars of feed ingredients for accurate feed formulation. The ME for faba beans and field peas estimated in the current study ranged from 3467 to 4014 kcal·kg^{-1} DM, which is 77% to 90% of GE.

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Data are available upon reasonable request.

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Abidemi Abosede Adekoya: conceptualization, data curation, formal analysis, investigation, methodology, project administration, software, validation, visualization, writing – original draft, writing – review & editing; Olayiwola Adeola: conceptualization, funding acquisition, methodology, project administration, resources, supervision, validation, visualization, writing – review & editing.

Competing interests

The authors declare there are no competing interests.

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