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Field Pea Grain for Beef Cattle

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Field pea (*Pisum sativum*) grain is a nutrient-dense source of protein and energy that is palatable for all classes of beef cattle. Field peas are highly digestible and highly fermentable in the rumen, but have a slower starch and protein fermentation rate than several other common feeds. Increased intake has been observed in some studies with the inclusion of field peas in the ration.

Processing peas has improved animal performance in some, but not all, studies. Peas apparently do not need to be processed for beef cows. In backgrounding and finishing rations, processing field peas has produced mixed results. At the least, processing will facilitate better mixing and allow for improved animal performance.

Price will dictate inclusion rates, but increasing availability of this grain legume is resulting in pricing that is competitive with other feeds. In creep feeds, 30 percent to 50 percent field peas appears to be optimum for animal performance. Commercial feed manufacturers are including peas in a number of commercial products for their nutrient density, palatability and competitive price, and to act as a binding agent for pelleted feeds. The inclusion of peas in postweaning receiving rations looks particularly attractive for starting cattle on feed.

As a protein supplement for feeder cattle, peas can be included at 15 percent to 30 percent of the ration; however, growing and finishing cattle can utilize peas as both a protein and energy source. Field peas provide a nutrient-dense beef cow supplement when fed as whole grain and work well in pelleted range cake formulations. Beef cattle producers with access to field peas at competitive feed prices should consider using this grain legume in rations for their beef cattle.

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Introduction

Field peas are an energy- and protein-dense feedstuff with energy content slightly higher than barley and similar to corn (Table 1). Peas most often are fed as a protein source. However, feeding this grain legume will increase the energy density of most diets because field peas contain more energy than many common protein supplements, such as oilseed meals or crop processing coproducts. Peas weigh 60 pounds per bushel and should be compared with other feeds on a nutrient-cost basis.

Beef cattle producers are the largest potential market for field peas in the U.S. In Europe, peas are well accepted for ruminants, especially as a protein source in silage-based diets. Peas are gaining acceptance in beef cattle diets in the U.S. due to increasing supply, which has resulted in more competitive prices. Field peas may best be utilized in scenarios where nutrient density of the diet is important, such as creep feed or supplementation of grazing livestock.

Peas also are an attractive feed ingredient where intake and palatability are critical, such as receiving diets for feedlot cattle. Substantial research data is available on field peas, as are considerable positive producer experiences with feeding this legume grain. This publication summarizes beef cattle research trials with field pea grain and gives recommendations on feeding peas to beef cattle.

Table 1. Comparison of nutrients in field peas with other feedstuffs

Item	Field Peas*	Corn**	Barley**	Wheat Midds**	Sunflower Meal**	Canola Meal**
Dry matter, %	89	88	88	89	90	92
			Dry matter basis			
TDN, %	87	90	85	80	65	69
NEg, Mcal/lb	.67	.68	.63	.62	.40	.45
Crude Protein, %	25.3	9.8	13.2	18.4	25.9	40.9
Calcium, %	.15	.03	.05	.15	.45	.70
Phosphorous, %	.44	.31	.35	1.00	1.02	1.20
Potassium, %	1.13	.33	.57	1.10	1.27	1.37

*NRC, 1984; **NRC, 1996.

Palatability

Palatability is critical to starting calves on feed during creep feeding or in feedlot receiving diets. Cattle appear to prefer field peas and generally consumed larger quantities of rations that include peas. A study by Anderson (1999a) observed a linear increase ($P < 0.05$) in feed intake with increasing levels (0 percent, 33 percent, 67 percent and 100 percent) of peas in the creep feed.

In a feedlot finishing study (Anderson, 1999b), peas were fed at 0 percent and 76 percent of the diet dry matter to determine if any palatability or anti-nutritional concerns existed. Intake was numerically greater (105 percent of control) for the pea diet. Feed intake increased linearly with peas at 0 percent, 20 percent and 40 percent of diet dry matter but decreased at 59 percent in a Nebraska finishing study (Fendrick, et al., 2005a) with no effect on gain, efficiency or carcass traits. With pea levels at 0 percent, 8.8 percent, 17.5 percent and 26.3 percent of a corn silage-based diet, intake increased linearly ($P = 0.06$), but gains and feed efficiency were not affected (Fendrick, et al., 2005b).

Weiss and Raymond (1989) conducted a series of studies using silage-based diets in Europe and reported diets with peas were consumed at 102 percent of the level of diets containing soybean meal.

In a Colorado State University study, Flatt and Stanton (2000) fed increasing levels of peas (0 percent, 5 percent, 10 percent and 20 percent of ration dry matter) in finishing diets. They observed a linear decrease ($P < 0.05$) in intake, but gains were similar and feed efficiency improved with increasing proportions of peas.

Rumen Degradability

Pea protein is highly rumen degradable. Estimates of rumen degradability of the protein range from 78 percent to 94 percent (NRC, 1989; Aufrere, et al., 1994; Encinias, et al., 2005), leaving modest amounts as rumen-undegradable protein (also referred to as by-pass or escape protein). However, the disappearance rate for peas was slower during the first six hours (1.6 percent per hour; Lindberg, 1981) than for soybean meal (4.5 percent per hour), but increased thereafter. The more slowly degraded or sustained-release nitrogen fraction found in peas may be beneficial for growth of rumen microbes and have a positive influence on rumen pH and feed efficiency.

Processing peas by dry or temper roasting did not change the proportion of rumen degradability of protein until peas were roasted for 12 minutes at 300 F (Gilbery, et al., 2005). Maximum reduction in ruminal protein degradation was observed when peas were toasted at 302 F for 30 minutes (Ljøkjel, et al., 2003). However, Aguilera, et al. (1992) achieved significant reduction in ruminal degradation at 148 F for 30 minutes. Extrusion of peas also can decrease ruminal degradation at 284 F (Walhain, et al., 1992; Focant, et al., 1990), however, Goelema, et al. (1999) observed ruminal protein degradation increased with pelleting. Processing peas at high temperatures for long periods of time may not be practical.

Starch in peas degrades much more slowly in the rumen than wheat or barley and at about the same rate as corn (Walhain, et al., 1992; Robinson and McQueen, 1989). However, total tract starch digestibility was similar when field peas replaced dry-rolled corn in medium-concentrate growing diets for beef steers (Reed, et al., 2004b)

Pelleting Field Peas

In addition to adding nutrient density to commercial feeds that use high proportions of fiber-based ingredients, field peas are an excellent binding agent for pelleting mixed feeds. However, peas are difficult to pellet alone because the binding properties reduce throughput. Both pellet quality and processing rate are satisfactory when peas are included at 20 percent to 50 percent of a feed formulation (K. Koch, personal communication, 2005).

Effect of Variety and Color

Protein content varies because of varieties, field fertility, yield and other factors. A trial comparing Profi to Integra (24 percent vs. 17 percent crude protein; Bock and Anderson, 2001) suggested that animal performance differs because of varieties, even though the control diet contained protein levels that NRC recommended (1996). No data is available that compares green and yellow varieties.

Encinias, et al. (2005) reported data on the effect of variety on *in situ* crude protein disappearance (Table 2). Differences exist between varieties for many nutritional characteristics, including rate and extent of ruminal degradation. This may be more important in situations where nutrient requirements are high (i.e., high-producing dairy cows). In particular, variety Trapper had slower rates of ruminal degradation and lower degradability estimates than v. Profi, Arvika and Carneval. More research is needed on the nutritional characteristics of field pea varieties and their effects on animal performance.

Table 2. Effect of field pea cultivar on *in situ* protein degradation characteristics

	Cultivar				
Item	Profi	Arvika	Carneval	Trapper	SEM[a]
CP, % DM	22.6	26.1	22.6	19.4	-
0 h N disappearance, %	54.3[c]	53.0[c]	47.4[c]	32.0[b]	5.65
Slowly degradable, %	45.7[b]	47.0[b]	52.6[b]	68.0[c]	6.00
Rate of CP digestion, %/h	14.6[d]	8.6[c]	10.5[d]	7.3[b]	0.26
Estimated RDP, % of CP					
$k^f = 0.02$	93.4[c]	91.5[c]	92.7[c]	87.4[b]	2.05
k = 0.04	88.2[c]	85.4[c]	86.6[c]	77.7[b]	3.29
k = 0.06	84.3[c]	81.0[c]	82.0[c]	71.0[b]	4.02

[a]n = 4.[b, c, d, e]Row means with different superscripts are different (P < 0.02).
[f]k = ruminal outflow rate (h^{-1}). Adapted from Encinias et al. (2004).

Creep Feed Research

In a two-year study with 128 cow/calf pairs (Anderson, 1999a), wheat midds and field peas were offered in four reciprocal creep feed combinations to determine the optimum level of peas. Treatments were reciprocal amounts of dry-rolled peas and pelleted wheat midds at 0 percent to 100 percent, 33 percent to 67 percent, 67 percent to 33 percent and 100 percent to 0 percent, respectively. Peas were coarsely rolled and wheat midds were fed as one-quarter inch diameter pellets. Feed intake increased linearly ($P < 0.05$) with an increasing level of field peas in the diet during the 56-day study. Calf gains increased from 2.82 pounds per day at 100 percent midds to 3.11 at 33 percent peas to 3.17 pounds at both 67 percent and 100 percent peas. Feed efficiency decreased with increasing pea levels. These data suggest that the ideal inclusion rate for peas is between 33 percent and 67 percent.

Landblom, et al. (2000) limited intake of creep feeds containing three levels of peas with the addition of 16 percent salt. Eighty cow/calf pairs were used to compare four treatments: 1) no creep feed, 2) 33 percent peas, 3) 67 percent peas, and 4) 100 percent peas. Peas replaced wheat middlings in these creep feed formulations. Daily intake was approximately 3 pounds per head for all creep rations. Gains tended to be greater ($P = 0.11$) for creep feed vs. no creep feed. No differences ($P > 0.10$) were observed due to the level of peas, but the 67 percent pea diet provided numerically superior gain and feed efficiency.

Creep feeds formulated with 18 percent or 50 percent field peas produced equal calf gains when intake was limited to 4.09 pounds with 16 percent salt in the feed in a season-long grazing study (Gelvin, et al., 2004). Salt added at only 8 percent of a 55 percent field pea creep feed resulted in greater feed intake ($P < 0.05$), but no differences ($P > 0.10$) in gain or feed efficiency were observed.

Gelvin, et al. (2004) also utilized ruminally cannulated nursing steer calves to investigate the effects of a field pea-based creep feed in ruminal fermentation characteristics, forage intake and digestibility while calves grazed native rangelands. No differences in forage intake were noted; however, supplemented calves had greater total intake than control calves. In addition, supplementation decreased ruminal pH, but increased ruminal concentrations of volatile fatty acids and ammonia.

Nursing beef calves were fed creep diets formulated with 40 percent ground, rolled or whole peas in a 56-day trial at the NDSU Carrington Research Extension Center (Anderson and Schoonmaker, 2005c). Intake was not affected ($P > 0.05$) by processing treatment, but calf gains were greatest ($P < 0.05$) with rolled peas (3.31 pounds/day), compared with ground (3.11) or whole (3.13) peas.

Field Peas in Feedlot Diets

The greatest potential market for the use of field peas in the northern Plains states and Prairie Provinces of Canada is in feeder calf diets. However, field peas will have to compete with feeds such as barley, corn, wheat midds and other commodities based on nutrient costs.

Research in Receiving Rations

Dry-rolled field peas were fed at 28 percent and 56 percent of receiving diets to 294 head of freshly weaned calves from 34 different ranches during two years (Anderson and Stoltenow, 2004). Dry-rolled barley and canola meal were the reciprocal ingredients in the 60 percent concentrate diets that included corn silage and mixed hay. Daily intake increased linearly ($P < 0.05$) with increasing pea levels (14.6, 15.5 and 16.5 pounds per head respectively, for 0 percent, 28 percent and 56 percent field peas) during the 42-day receiving study, and gains were greater for the 56 percent pea diet ($P < 0.05$) at 3.53 pounds vs. 3.31 pounds for the control.

Dry-rolled pulse grains (field peas, chickpeas or lentils) were fed as the protein sources at 17 percent of dry matter intake, compared with canola meal in four isonitrogenous receiving diets (Anderson and Schoonmaker, 2004). Freshly weaned calves (n=172) from 39 North Dakota ranches were allotted randomly by ranch to 16 pens for the 42-day trial. The 60 percent concentrate rations included dry-rolled corn, corn silage, chopped mixed hay and Rumensin® supple-

ment at 240 mg per head daily. Dry matter intake increased ($P < 0.05$) from 15 pounds per day for the control to 16.3 pounds for each of the three pulse treatments. Daily gains were greater ($P < 0.05$) for the three pulse treatments at 4.08 pounds, compared with 3.68 for the control diet.

At the end of the receiving study, calves were placed on a common corn-based finishing diet and fed to market weight. Calves previously fed pulse grains continued to gain faster (4.04 pounds per head per day for the three pulse diets vs. 3.46 for the control) for at least seven weeks following the removal of the pulse grains from the diet. This advantage for pulse grains is very interesting and needs further study.

Growing Experiments

Cattlemen widely use field peas as a protein supplement for wintering ranch-raised calves. Reed, et al. (2004a) investigated the optimum level of peas in a forage-based diet. Field peas were offered at 0, 2, 4, and 6 pounds to steers in a 4-by-4 Latin Square trial consuming medium-quality grass hay. Total dry matter and organic matter intake increased ($P < 0.05$) with increasing field pea supplement levels while intake of forage dry matter decreased ($P < 0.05$), as expected. Rumen volatile fatty acids, total tract crude protein digestibility and apparent ruminal dry matter digestibility tended to increase linearly ($P = 0.09$) with increasing field pea level. Peas had no effect ($P > 0.11$) on total tract dry matter or organic matter digestibility. Field peas acted like other cereal grains in supplementing forage diets in this study.

Weaned crossbred steer calves were fed three 60 percent concentrate diets consisting of: 1) barley with canola meal at crude protein levels that NRC recommended (control) (1996); 2) barley with canola meal added to equalize the crude protein level of the field pea diet; and 3) rolled field peas as the concentrate source (Anderson, 1999b). The protein level in the field pea diet exceeded NRC-recommended (1996) nutrient requirements. Dry matter intake of the field pea diet was 112.3 percent of the control and 109.3 percent of the barley plus canola meal treatments. Gains from the pea diet were numerically greater than the barley treatment (116.8 percent) and barley plus canola meal (107 percent). Feed efficiency improved with peas in the diet over the control (105.8 percent) and barley-canola (103.4 percent) treatments. In this trial, the break-even price for a bushel of peas was approximately 170 percent of the price of a bushel of barley for growing calf diets.

Calves were fed 69 percent corn silage-based diets with rolled peas at 0 percent, 8.8 percent, 17.5 percent and 26.3 percent of intake replacing corn grain in a Nebraska study (Fendrick, et al., 2005b). Dry matter intake increased linearly ($P = 0.06$) with pea level but no differences in gain or feed efficiency were observed, although gains were 105 percent of control for the 26.3 percent treatment.

Field peas at 0 percent, 15 percent, 30 percent and 45 percent of dry-matter (DM) intake were substituted for fibrous coproducts (soyhulls, barley malt and wheat midds) in a 4-by-4 Latin Square study (Soto-Navarro, et al., 2004) utilizing four cannulated steers. Dry matter intake decreased with increasing pea levels in the 45 percent grass hay-55 percent coproduct diets. Digestion of starch decreased with increasing pea levels, but digestibility of organic matter (OM), acid detergent fiber (ADF) and neutral detergent fiber (NDF) were not affected.

Reed, et al. (2004b) replaced corn (50 percent of diet formulation with corn silage and alfalfa hay) with field peas at 0 percent, 33 percent, 67 percent and 100 percent in a 4-by-4 Latin Square study with four head of cannulated steers. Intake was not affected, but ruminal fill and ruminal pH decreased with increasing pea levels. Ruminal ammonia, total tract volatile fatty acid (VFA) concentrations, and total OM, NDF and ADF disappearance all increased with pea level ($P < 0.05$). Starch digestion was not affected.

Growing heifer calves were fed field peas as an isonitrogenous replacement for barley and soybean meal with no effect ($P > 0.10$) on intake, gain or feed efficiency (Poland and Landblom, 1998). In another study, performance was similar but intake decreased ($P < 0.10$) in the pea diet, tending to improve feed efficiency.

Peas were used as a protein source, compared with soybean

meal, in silage-based diets with several European trials that Weiss and Raymond (1989) reported. In five trials, intake and gain from pea-supplemented diets averaged 102 percent of control; feed conversion was equal.

A growing trial included 40 percent ground, rolled or whole field peas in the 60 percent forage ration (Bock, et al., 2000). Seven steers were assigned to each of the three treatments and individually fed in Calan® headgates. No differences ($P < 0.05$) were observed for dry matter intake but gains were greater for the ground (3.61 pounds/day) and whole (3.74 pounds/day) peas, compared with the rolled (3.37 pounds/day) pea treatment during the 84-day study.

Finishing Experiments

Steer calves (n=83) were fed totally mixed finishing diets with dry-rolled barley and canola meal or field peas as the grain source. Feed intake tended to be greater for peas (104.7 percent) than barley in the finishing diets. Daily gains were 105.5 percent of control with equal feed efficiency. Marbling scores and the percent Choice carcasses were greater ($P < 0.05$) for steers fed field peas. Peas were worth 135 percent the price of a bushel of barley in this study when used as the primary concentrate in finishing diets (Anderson, 1999b).

Whole peas were fed at 0 percent, 20 percent, 40 percent and 59 percent of finishing diets to 129 yearling steers in a Nebraska finishing study (Fendrick, et al., 2005a). Dry matter intake increased ($P < 0.01$) with increasing pea levels up to 40 percent and decreased at 59 percent. Gains, feed efficiency and carcass traits were not different ($P > 0.10$).

Field peas were used as a protein supplement at 10 percent of the finishing diet, replacing corn and soybean meal (Birkelo, et al., 2000). No differences were observed ($P < 0.05$) in any of the feedlot performance or carcass traits measured; however, the first 56-day period produced improved gains and feed conversion for the field pea diets.

Flatt and Stanton (2000) fed peas at 0 percent, 5 percent, 10 percent and 20 percent of finishing diets to steers and heifers, substituting field peas for soybean meal in Colorado. The variety Profi used in this trial was 20 percent crude protein. Increasing levels of peas decreased intake ($P < 0.05$) but did not affect gain, thereby improving feed efficiency linearly with increasing field pea levels ($P < 0.05$). Carcass traits were not affected. Mortality was lower ($P < 0.05$) for the calves fed field peas (0.75 percent), compared with the control diet (6.75 percent).

Three processing treatments for peas (ground, rolled or whole) were compared in an NDSU Carrington finishing trial with 112 feeder heifers fed diets with peas at 28 percent of dry matter intake (Anderson and Schoonmaker, 2005a). Particle size of ground peas was 700 microns, rolled peas averaged 3,100 microns and whole peas were 7,520 microns. Dry matter intake was greatest ($P < 0.05$) for heifers fed rolled peas (22.81 pounds), compared with whole (21.33) and ground (21.21) pea treatments. Gains were greatest ($P < 0.05$) for rolled peas (3.39 pounds/day) over whole peas (2.96 pounds), with ground peas (3.12 pounds) intermediate. Feed efficiency was similar for all treatments.

In a Nebraska finishing study with 206 head, Fendrick, et al. (2005b), reported no statistical differences from the control ($P > 0.10$) with dry-rolled or whole peas fed at 15 percent or 30 percent of the diet dry matter replacing corn.

Loe, et al. (2004) utilized finishing lambs to estimate the net energy value of field peas in finishing diets. They utilized 200 crossbred lambs in two research trials where field peas replaced corn at graded levels. Based on performance and carcass data, the net energy for maintenance and net energy for gain value of field peas was estimated at 2.75 and 2.02 megacalories/kilogram (Mcal/kg). These values were 14 percent greater than corn.

Beef Cow Supplementation Research

Little research is available on feeding peas to beef cows; however, many cow-calf producers use field peas in beef cow rations. Schaefer, et al. (2000) substituted stepped levels of field peas for a barley-canola meal protein supplement in diets for gestating cows consuming grass hay. No differences ($P > 0.10$) were observed in cow gain, condition score, calving or other performance traits.

Poland, et al. (2005) fed a pelleted supplement at 7 pounds per head three times weekly (n = 45) to compare a field pea supplement to sunflower meal- or barley-based supplements for cows grazing stockpiled forage from November through January. Cows fed the three supplements performed equally ($P > 0.10$) and gained more weight than nonsupplemented cows.

Field peas were fed ground, rolled or whole to gestating mature beef cows consuming low-quality forage from November until March (Anderson and Schoonmaker, 2005b). No differences were observed in cow performance due to treatment when fed at 20 percent of the diet dry matter during the three-month winter study. The results agree with Bock, et al. (2000) who fed 40 percent ground, rolled or whole peas in 60 percent forage diets to feeder steers. Rumination or cud-chewing activity may contribute to reducing the particle size and allowing thorough digestion and utilization of whole peas in high-forage diets.

Feeding Recommendations

The major factors in considering field peas in beef cattle diets are the cost of protein and the energy from other feedstuffs available. Growing field peas as a protein source may reduce expenses and provide nutrition for improved animal performance, leading to increased net returns for the entire farm. The nutrient density of field peas is greater than most other feedstuffs, so including peas in limit-fed applications may be the best use of this feed. This use includes creep feeds, receiving diets and supplementing low-quality forage diets (i.e., range cake).

Processing studies have concluded that peas should be dry-rolled when fed in creep feeds. Creep feed diet formulations may include 25 percent to 50 percent field peas, with 35 percent to 40 percent considered optimum. Mixed results for processing have been reported in feedlot trials, but dry rolling peas did not negatively affect performance and was positive in some trials.

Field peas are used primarily as a protein source in feedlot diets. Twenty percent to 30 percent inclusion is considered optimum in most rations. Greater levels have resulted in excellent animal performance in some research studies. The ruminal protein degradation characteristics of peas complement corn-based diets particularly well.

Beef cows fed low-quality forage benefit from a rumen-degradable protein that field peas can provide. A commercial range cake that contains field peas will provide protein and energy. Peas do not need to be processed for beef cows consuming forage-based diets. Peas work well as a binder in pelleted rations and will increase nutrient density for commercial fiber-based feeds. Heating, toasting or extruding field peas may increase rumen-undegradable protein, but does not appear to be economically feasible for most classes of livestock.

Conclusions

Field peas are a useful feed for cattle and can be included in creep feeds, receiving diets, growing and finishing rations, and for supplementing beef cows. The major factor in determining whether to use field peas in cattle rations is the cost compared with other feedstuffs. Because field peas are nutrient dense, the equivalent feed value should be calculated based on respective nutrient content. Feeding homegrown peas may reduce off-farm purchases of supplemental protein and enhance the biological and economic sustainability of integrated crop/livestock farming operations.

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