THE DIFFERENT PROTEIN SOURCES FEEDING IMPACT ON THE QUALITY OF PORK

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Abstract

The study was conducted to determine the quality of pork after feeding soybean meal and peas as protein sources to fattening pigs. The research was done in two pig farms in Latvia and four fattening pig groups were conducted (two in each holding). In holdings one pig group was soybean meal and the other peas group with 10 animals each. The pig groups received different amount of the protein feeds (soybean meal 15%, peas 15% and 28%) blended into a mixture of concentrated feed. The results showed that 15 and 28% inclusion of pea in finisher pig diets about 3–5% increase LWG. The higher pig ADG resulted on the increasing of fat in the body at the similar FC per 1 kg LWG. The IF about 0.68 and 0.48 kg were more in peas pig groups with significant differences ($p<0.001$) between soybean pig groups. For pigs, which fed peas, average backfat were of 14.3 mm, 2 and 1.3 mm more than the one of pigs in soybean groups. There were no differences of ash content and pH in *Longissimus dorsi* muscle, but moisture, fat, CP and cholesterol content were significantly different ($p<0.05$; $p<0.01$; $p<0.001$) between soybean and peas groups. Fat content in *Longissimus dorsi* muscle was 2.5 till 2.8% higher ($p<0.01$) for peas group pigs. The fatty acid content were not high, but were significantly ($p<0.001$, $p<0.01$, $p<0.05$) different with pigs of soybean groups. The highest values of nonessential amino acids were measured in glutamic (3.09–3.54 g). The lowest value were found out in tryptophane (0.245 g) and proline (0.37 g) in soybean group, but in peas groups the content of proline were (0.772–0.779 g) and was more twice times higher than tryptophan.

Keywords: pig, peas, nutrition, amino acid, pork.

Introduction

The main feed for pigs are cereal grains which commonly used as feed in industrial pig production. The cereal grains contain insufficient quantities of several of the indispensable amino acids such as lysine, threonine and sulfur containing amino acids (Sauer et al., 1977). Therefore, it is essential that the pigs' diet contain a supplementary source of these limiting amino acids. Soybean meal is often used as the main supplement of amino acids in pig feed (Jezierny et al., 2010). In temperate environments, soybeans are difficult to cultivate and the pig industry relies heavily on imported soybean meal. However, as the transportation cost for feed increases, pig producers will have to maximize the use of locally produced feedstuffs. Therefore, it is important that alternative sources of supplementary protein be developed. In temperate environments, the one crop which is potential for use in pig diets is the peas. Field peas (*Pisum sativum* L.) have been grown for centuries in many parts of the world. Historically, field peas have been produced mainly for human consumption, but during the last years, the industry has also found markets for field peas in pig feeding.

Because the goal of this study was to evaluate the effect of including different levels of pea in pig diets on performance of finisher pigs, carcass and meat quality.

Materials and Methods

Animals and housing. The research was done in two pig farms in Latvia. The four fattening pig groups were conducted (two in each holding), according of pig origin, age and liveweight. In holdings one pig group was (1 and 2) soybean meal and the other (1 and 2) peas group, with 10 animals each. The selected pigs were crossbreed – Large White×Landrace in both farms. Finisher pigs were housed on concrete floors with shavings and access to drinking water at all times. Each pig was allowed access to its individual feeder for 30 min twice daily. The trial was run for 50–54 days (FD) and concluded when the pigs reached an average weight of 94–113 kg.

Diets and Performance Measures. Commercial sources of pea (variety 'Respect') and soybean meal were obtained for the experiment. The soybean meal groups in both holdings received soybean meal 15% as alone protein feed in diet, but peas' groups pigs received 28% peas in first holding and 15% peas in second holding, for check out the peas amount influencing to pork quality. The protein feeds were blended into a mixture of concentrated feed. The other ingredients in diets were kept constant for all groups and included barley, wheat, triticale and trace element-vitamin premix. The pig feed mixture was prepared without crystalline amino acids. The diets were formulated to be isoenergetic for metabolize energy (ME), with the same crude protein (CP), Lysine (Lys) content (calculated for Feed Catalog), and to meet the minimum requirements of Ca and P by modifying the inclusion macroelements and vitamins (Table 1). Analysis of feed samples for dry matter, crude protein, crude fiber, fat, ash, Ca and P were determined in scientific laboratory of agronomik analysis of Latvia using such methods: for dry matter (DM) – forage analyses, USA, met. 2.2.1.1:1993, crude protein (CP) LVS EN ISO 5983-2:2009, crude fiber (CF) ISO5498:1981, fat ISO6492:1989, ash ISO 5984:2002/Cor1:2005, Ca LVS EN ISO 6869:2002, P ISO 6491:1998.

Individual body weight, feed consumption (FC) was recorded on a weekly basis.

Slaughter and carcass Quality Measurements. Pigs were slaugtered at a commercial slaughterhouse via

electrical stunning, followed by exsanguinations, and carcases were dehaired via scalding, eviscerated, and split vertically down the midline. Hot carcass weights were obtained and backfat depth was measured at a specific site [i.e., the head of the last rib, 6 cm from the mid back line, using a probe (Introscope Optimal Probe)]. The length of carcass (CL) was measured in a straight line from the forward edge of the first rib to the forward edge of the aitch bone and muscle-eye (LM) area with the planimeter. The internal fat (IF) was removed from carcass and weighed, the loin muscle (LMW) also was removed without fat from the left side of each group 3 pig carcases and weighed. Left side of carcass was devided into fractions for determination ham (HW), bone (BW) and meat weight (MW). The samples of meat were taken from the musculus *longissimus lumborum et thoracis* 24 hours post mortem and subsequently subjected to the chemical analysis. Chemical content of pork analyzed for such indices: fat content (LVS ISO 1443:1973), moisture (LVS ISO 1442:1997), crude protein content (CP) (LVS ISO937:1978), ash (ISO 936:1998), pH (LVS ISO 2917:2004), cholesterol (BIOR-T-012-132-2011), unsaturated fatty acids–alfa – linolenic (C18:3), arachidonic (C20:4), eicosapentaenoic (C20:5), linoleic (C18:2), oleic (C18:1) and palmitoleic (C16:1) (BIOR-T-012-131-2011). Amino acid composition of the muscle was analyzed with methods ISO13903:2005, but tryptophan content by method EN ISO 13904, HPLC. The content of each individual amino acid was calculated on g 100 g of wet matter basis.

Statistical Analysis. The data were processed with MS Excel mathematical program. The results were compared using t-test. t-test was carried out on the data for growth performance and meat quality.

Results and Discussion

Concentrated feed mixtures of chemical analyzes showed that the pigs received a full and balanced feed (Table 1). Based on fattening pig nutrition standards (NRC, 2012) the necessary crude protein is 14–16% with the lysine content 0.5–0.8% of the dry matter, depending on the liveweight (LW).

Table 1

The chemical content of feed in dry matter

Indices	First holding		Second holding	
	1 soybean group	1 peas group	2 soybean group	2 peas group
DM, %	88.89	88.00	88.02	87.47
ME MJ, kg	13.30	13.40	13.50	13.20
CP ,%	15.27	14.62	15.38	15.00
Lys, %	0.77	0.73	0.78	0.68
CF, %	4.36	4.67	3.46	3.71
Fat, %	1.74	1.67	2.43	1.95
Ash, %	5.57	4.89	4.32	2.76
Ca, %	0.90	0.79	0.63	0.62
P, %	0.59	0.56	0.49	0.46

Pig fattening results showed that pigs growth intensity was high in all study groups of pigs (Table 2).

The average daily liveweight gain (ADG) for the pigs were from 850±7.48 till 915±10.4 g, slightly higher in peas groups.

Although soybean meal protein digestibility is higher (87%) than pea protein (only 79%) (Jezierny et al., 2011), but about 5% higher and significantly different ($p<0.05$) live weight gain (LWG) showed the pig group in the second holding, which fed in the feed 15% peas, and in the first holding pig daily weight gain (28% peas in feed) was 3% higher compared to the soybean group (Table 2).

Table 2

Pig fattening results (n=40)

Results	First holding		Second holding	
	1 soybean group	1 peas group	2 second soybean group	2 peas group
Start LW, kg	46.6±0.43	46.3±0.42	68.0±0.76	68.4±0.45
End LW, kg	94.5±0.36	95.7±0.67	110.5±0.9[a]	113±0.74[a]
LWG, kg	47.9±0.77	49.4±0.95	42.5±0.64	44.6±0.71
% LWG	100	103	100	105
FD	54	54	50	50
ADG, g	887±21.8	915±10.4	850±7.48[b]	892±8.42[b]
FC per 1 kg LWG, kg	2.88	2.98	2.85	2.9

Values are presented as mean ±standard error. a,b $p<0.05$

For pigs the most important amino acid is lysine, which is necessary for building muscle tissue (Guoyao Wul et al., 2013). The digestibility of most amino acids in field peas is similar to that in soybean meal, but pea protein has relatively low concentration of methionine, cysteine and tryptophan. It is necessary to pay attention to the concentrations of these amino acids and often need to include crystalline sources. In our trial was not determined these amino acids in the pig diets because the higher pig daily gain may resulted on the increasing of fat in the body at the similar feed consumption per 1 kg liveweight gain. Results obtained for pigs confirm results from previous research demonstrating that there are no negative effects of including 36% field peas in diets fed to finishing pigs (Stein et al., 2004). Inclusion of 30% field peas is also was reported not to comprimise pig performance. The researchers results showed that even higher inclusion rates of peas may be used (66%) and that peas can substitute all the soybean meal in diets without negatively affecting performance and feed intake (Stein et al., 2006), in addition formulated of the digestible indispensable amino acids in pig diets is obligatory. The other research showed that including pea or faba bean in finisher pigs' diets

from 7.5–30% slightly reduced finisher daily gain, as tended to reduce over initial levels only (Smith et.al, 2013).

Carcass indicators show a tendency to accumulate more fat tissue in pigs, which fed pea in the feed. The internal fat about 0.68 and 0.48 kg were more in pea groups with significant differences ($p<0.001$) between soybean pig groups (Table 3). The significant differences was found also of meat weight in both holdings ($p<0.05$ and $p<0.001$), of muscle-eye area in first holding and of ham weight in second holding ($p<0.05$). The pigs which fed peas had a little smaller loin muscle areas (LM).

Table 3

Carcass traits (n=12)

Indices	First holding		Second holding	
	1 soybean group	1 peas group	2 soybean group	2 peas group
CW, kg	72.2±0.35	82.3±0.52	89.8±0.61	90.1±0.69
CL, cm	107±0.58	108.7±0.88	109±0.58	108.3±0.33
FT, mm	12.3±0.88	14.3±1.2	13±0.57	14.3±0.33
LM, cm^2	52.5±0.68[a]	50.5±0.21[a]	51.3±0.16	50.3±0.88
HW, kg	10.6±0.19	10.7±0.06	11.5±0.29[b]	12.5±0.19[b]
IF, kg	1.32±0.01[c]	2±0.05[c]	1.85±0.03[d]	2.33±0.04[d]
LMW, kg	2.88±0.04	2.89±0.09	3.22±0.02	3.23±0.04
BW, kg	9.9±0.06	13±0.05	13.4±0.12	10.8±0.15
MW, kg	62.3±0.23[e]	69.3±0.58[e]	76.4±1.21[f]	79.2±0.41[f]

Values are presented as mean ±standard error. a,b,f $p<0.05$ c,d,e $p<0.001$

For pigs, which fed peas, average backfat were of 14.3 mm, which is 2 and 1.3 mm more than the of soybean groups pigs. The results of the carcass traits of this experiment confirm previous studies. It has been reported from European studies that the lean meat is reduced and the backfat thickness is increased as the concentrations of dietary peas are increased (Stein et al., 2006). However, it was also demonstrated that this situation may be amelioreted by including crystalline Met and Trp in the diets. In other research showed that inclusion of 35% peas as a substitute for soybean meal had no detrimental effects on nutrient digestibility, pig performance and carcass traits (Castell et al., 1988), but in trial of researchers Gatel and Grosjan, (1990), the use of pea greater than 20% as alternative protein source in pig diets reduced performance.

There were no differences of ash content and pH in *Longissimus dorsi* muscle, but moisture, fat, crude protein and cholesterol content were significantly different between soybean and peas groups (Table 4). Fat content in *Longissimus dorsi* muscle was 2.5 till 2.8% higher ($p<0.01$) for peas group pigs than of soybean pig groups.

The similar results was found in research were peas included from 36–66% in pig groups diets, the pH and marbling of the *Longissimus dorsi* muscle and 10th rib bakcfat thickness were not influenced by treatment (Stein et al., 2006.

Interest in meat fatty acid composition stems mainly from the need to produce healthier meat, i.e., meat with higher ratio of polyunsatured (PUFA) to saturated fatty acids and a more favourable balance between n-6 and n-3 PUFA. In pigs, the drive has been to increase n-3 PUFA in meat and this can be achieved by feeding sources.

Table 4

Characteristics of *Longissimus dorsi* muscle (n=12)

Indices	Pig groups		
	1, 2 soubean groups	1 peas group	2 peas group
Moisture, %	72.3±0.47[a,e]	70.1±0.43[a]	69.2±0.55[e]
Fat, %	4.4±0.42[b,d]	6.9±0.21[b]	7.2±0.06[d]
CP, %	24.2±0.13[c,f]	22.9±0.35[c]	22.1±0.15[f]
Ash, %	1.27±0.09	1.2±0.06	1.13±0.03
pH	5.45±0.02	5.39±0.01	5.24±0.01
Cholesterol, mg 100 g	108.4±0.29[g,k]	105.0±0.54[g]	81.3±2.28[k]

Values are presented as mean ±standard error. a,e,c $p<0.05$; b,d,f,g $p<0.01$; k $p<0.001$

Only when concentration of alfa-linolenic (C18:3) approch 3% of neitral lipids or phospholipids are there any adverse effects on meat quality and flavour (Wood el al., 2003). Several papers have examined the effects of dietary oils containing a high propotion of 18:2 on the acid composition and quality of pigmeat, for example soya oil maize and sunflower, but not a peas. In present research the fatty acid content were not high, but were significantly ($p<0.001$, $p<0.01$, $p<0.05$) different with pigs of soybean groups (Table 5). High levels of PUFA are undesirable in pork, because they adversely affect consistency, storage stability and texture of the processed pork products.

The amino acids content was determined only in one sample of muscle from each pig group because the price of analyses was very high. The measured values of selected amino acids with different feeding in the groups are shown in Table 6.

Table 5

Unsaturated fatty acids content (% of total fatty acid methyl esters) in *Longissimus dorsi* muscle (n=12)

Fatty acids	Pig groups		
	1, 2 soybean group	1 peas group	2 peas group
C18:3	0.34±0.041	0.41±0.001	0.39±0.001
C20:4	0.3±0.001[a]	0.18±0.005	0.2±0.005[a]
C20:5	0.68±0.044	0.71±0.012	0.67±0.037
C18:2	4.3±0.058[c,b]	4.07±0.033[b]	3.93±0.033[c]
C18:1	46.8±0.31[d,e]	43.3±0.32[d]	40.2±0.38[e]
C16:1	3.16±0.09[f]	3.27±0.12	3.57±0.03[f]

Values are presented as mean ±standard error. b,f $p<0.05$; c,d $p<0.01$; a,e $p<0.001$

Table 6

Amino acid composition in *Longissimus dorsi* muscle (g 100 g^{-1})

Amino acids	Pig groups		
	1, 2 soybean groups	1 peas group	2 peas group
Tryptophan	0.274	0.245	0.268
Alanine	1.230	0.960	1.180
Arginine	1.320	0.870	1.270
Asparagine	1.990	1.310	1.950
Fenilalanine	0.921	0.670	0.833
Glicine	0.893	0.680	0.884
Glutamine	3.540	2.360	3.090
Histidine	0.898	0.850	0.879
Izoleicine	0.987	0.420	0.973
Leucine	1.700	1.190	1.650
Lysine	1.980	1.210	1.850
Proline	0.370	0.779	0.772
Serine	0.856	0.590	0.849
Tirozine	0.745	0.650	0.711
Treonine	0.997	0.620	0.983
Valine	1.040	0.450	1.010

The highest values in the group of nonessential amino acids were measured in glutamic (3.09–3.54 g), aspartic acid (1.31–1.99%) and leucine (1.19–1.70 g). The content of lysine was from 1.21 till 1.98 g. The lowest value were found out in the amino acids tryptophane (0.245–0.274 g) and proline (0.37 g) in soybean group, but in peas groups the content of proline were (0.772–0.779 g) and was more twice times higher than tryptophan. The biological value of meat is defined by fully valuable protein (Jukna et al., 2005). The full value of meat protein is calculating according to the relationship of irreplaceable amino acid tryptophan, which is found only in muscle tissue, and replaceable amino acid hydroxyproline, found only in connective tissue. Higher ratio shows more biologically valuable meat protein. The ratio tryptophan: hydroxyproline in pork was 7.9 (Ribikauskiene, 2003), but data in Table 6 evidently demonstrate that peas groups pork contained more proline than tryptophan.

Conclusions

The study indicates that 15 and 28% inclusion of pea in finisher pig diets about 3–5% increase liveweight gain. The higher pig daily gain resulted on the increasing of fat in the body at the similar feed consumption per 1 kg liveweight gain.

Carcass indicators show a tendency to accumulate more fat tissue in pigs, which fed pea in the feed. The internal fat about 0.68 and 0.48 kg were more with significant differences ($p<0.001$) between soybean pig groups. For pigs, which fed peas, average backfat were of 14.3 mm, 2 and 1.3 mm more than the pigs in soybean groups.

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The peas may replace soybean meal in diets fed to finishing pigs without negatively affecting pig performance that provided diets are balanced for concentrations of digestible indispensable amino acids.

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