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Amino Acid Supplementation of High Mungbean Meal Vermicelli By-product Diets for Growing-finishing Pigs

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ABSTRACT

Since the mungbean meal vermicelli by-product (MBMV) had very low nutrient digestibility values, this experiment was conducted to study the effect of amino acid supplementation of high MBMV rations on production performance and carcass characteristic of growing-finishing pigs. Thirty-two purebred Large White barrows averaging 30 kg were randomly assigned into four dietary treatments composed of corn-soy diet (positive control) and three treatment groups of 30 percent MBMV diet containing with and without (negative control : MBMV) amino acid balance based on NRC (1988) requirement (MBMVAA) and with high nutrient density (105 percent of corn-soy diet : hi-den MBMV). Results indicated that addition of amino acid in low protein diet with high MBMV failed to improve production performance and carcass characteristic of the animals. Amino acids supplementation at level equivalent to 105 percent NRC requirement improve the production performance and carcass characteristic in terms of average feeding period, daily gain, protein efficiency ratio, feed conversion ratio, loin eye area and lean cut yield of the high level MBMV diet in growing-finishing pigs, but was not comparable to corn-soy diet. It requires higher nutrient density in the diet especially crude protein or increase more amino acid level supplementation in high MBMV diet.

Key word : amino acid, mungbean meal vermicelli, growing-finishing pigs

INTRODUCTION

Mungbean meal vermicelli by-product (MBMV), the waste material from the production of mungbean thread (vermicelli) and mungbean starch industries, is the locally available feed ingredient. MBMV contains 11-23 % crude protein, 0.43-1.83 % ether extract, 13.07-35.55 % crude fiber, 42.87-54.01 % nitrogen free extract, 0.30-0.68 % calcium and 0.17-0.39 % phosphorus depending on the kinds of raw mungbean material. Compared to rice bran and soybean meal, MBMV is the cheapest animal feed ingredient (3.00, 4.50 and 9.50 baht/kg., respectively). In addition, when MBMV has a moderate crude protein (20 %) and low crude fiber content (15.50 %), it can be used as a protein source of growing pigs. It was noted in the report of Vijitrothai and Sitthigripong (1992) that rations containing high level of MBMV, 100 % replacing rice bran in the diet, resulted in poor product performance of growing pigs (15-30 kg). MBMV is generally high in leucine and lysine but

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deficient in methionine plus cystine and arginine. This experiment was conducted to determine the effect of amino acid supplementation of high mungbean meal vermicelli by-product rations on the production performance and carcass characteristic of growing-finishing pigs (30-90 kg).

MATERIALS AND METHODS

Animals and Feeding

Thirty-two purebred Large White bar-rows with an average weight of 30 kg were used in a randomized complete block design, replicated eight times on the basis of bodyweight. Four pigs in each block were randomly allotted to each treatment and placed in individual pens equipped with feed trough and automatic waterer. The dietary treatments are as follow:

T1: Corn-soybean diet (corn-soy : positive control)
T2: 30 % MBMV in diet (MBMV : negative control)
T3: 30 % MBMV containing amino acid balance based on NRC (1988) require-ment diet (MBMVAA)
T4: 30 % MBMV containing 105 % energy, lysine, methionine+cystine, threonine and tryptophan contents of control diet (hi-den MBMV)

The rations were divided into growing and finishing periods based on nutrient require-ments (NRC, 1988) for the different growth stages of the animals. The composition of diets are presented in Tables 1 and 2. The chemical composition of the diets given during the experiment is presented in Table 3. All animals were fed until they attained an average weight about 90 kg and were slaughtered for carcass evaluation. Drinking water was provided all the time and feed was offered twice daily at 7:00-8:00 a.m. and 3:00-4:00 p.m. throughout the study.

Traits and Measurements

The pigs were individually weighed at the beginning of the experiment. The animals were weighed more often as they approach the desired weight of 60 kg and 90 kg. Weighing was done before feeding in the morning. Complete records of weights, feed consumption, initial and final date of different growth stage of the animals were kept to determine the average daily gain, length of feeding days, daily feed intake, and feed conversion ratio. The computation of feed cost per kilogram gain of pigs was based on the prevailing prices of different feed ingredients during the conduct of the experiment.

When all animals reached 90 kg, they were fasted 18 hours with free access to drinking water prior to slaughter. The pigs were slaughtered following the standard procedures and the carcass measurements were done following the procedure by Sethakul (1991).

Chemical Analysis

The nutrient contents of various rations were analyzed by proximate analysis including calcium and phosphorus following the standard AOAC (1990) procedure. Gross energy were determined using the ballistic bomb calorimeter.

Statistical Analysis

All data were subjected to analysis of variance following a randomized complete block design using the General Linear Model procedure by statistical analysis system (SAS, 1985). Duncan's multiple range test was used to determine the significant difference among treatment means (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Growth Performance Study

Body weight and weight gain. Table 4

showed that no significant differences on the average initial age, initial weight, final weight at the growing and finishing stages and weight gain among pigs fed various rations.

Average daily feed intake. No significant differences were observed on the daily feed intake of pigs fed the different rations in the growing, finishing and the whole feeding periods (Table 4). However, pigs fed corn-soy diet had slightly lower daily feed intake than those fed MBMV containing rations. This result probably because the higher crude fiber content of all MBMV containing rations (Table 3) increased feed intake of the animals. This finding agrees with the report of Graham and Aman (1991) that hind-gut fermenters generally attempt to increase intake when challenged with a higher

Table 1 Composition of experimental diets which were fed to growing pigs.

Ingredients (%)	Diets			
	Corn-soy	MBMV	MBMVAA	hi-den MBMV
Yellow corn	48.57	49.45	55.50	45.41
Rice bran	30.00	0.00	0.00	0.00
Soybean meal (44%)	18.34	13.40	7.71	14.16
Mungbean meal vermicelli	0.00	30.00	30.00	30.00
Tallow	0.20	4.60	4.10	7.80
Oyster shell	1.30	0.75	0.75	0.70
Dicalcium phosphate	0.25	0.70	0.75	0.75
Salt	0.35	0.35	0.35	0.35
L-Lysine	0.13	0.00	0.05	0.03
DL-Methionine	0.02	0.00	0.04	0.01
L-Tryptophan	0.04	0.00	0.00	0.01
L-Threonine	0.05	0.00	0.00	0.03
Agrifac-plus	0.25	0.25	0.25	0.25
Vitamin mineral premix	0.50	0.50	0.50	0.50
Total	100.00	100.00	100.00	100.00
Cost, baht/kg [a]	6.69	5.89	5.79	6.16
Calculated Composition				
Crude protein, %	16.00	16.00	14.00	16.00
ME, kcal/kg	3100.53	3103.20	3100.59	3256.94
Calcium, %	0.64	0.64	0.64	0.64
Phosphorus, avail. %	0.25	0.25	0.25	0.25
Lysine, %	0.84	0.84	0.75	0.88
Methionine+Cystine, %	0.43	0.43	0.41	0.45
Tryptophan, %	0.22	0.22	0.19	0.23
Threonine, %	0.65	0.65	0.57	0.68

[a] Computation based on the prices (baht/kg) when the experiment was conducted during October, 1995 to February, 1996

fiber diet. Among the MBMV containing rations, pigs fed hi-den MBMV diet was the lowest daily feed intake followed by those fed MBMVAA and MBMV rations during the whole growing-finishing period. This result is likely affected by the higher ether extract and energy content in hi-den MBMV, MBMVAA and MBMV rations, respectively.

Average daily metabolizable energy (ME) intake. The growing pigs fed corn-soy diet had lower ($P<0.05$) daily ME intake than those fed hi-den MBMV diet but was not significantly different with those on MBMV and MBMVAA rations (Table 4). While, the feed intake in this stage was not significantly different. This result is probably due to the higher ME content in hi-den MBMV diet

Table 2 Composition of experimental diets which were fed to finishing pigs.

Ingredients (%)	Diets			
	Corn-soy	MBMV	MBMVAA	hi-den MBMV
Yellow corn	54.90	57.43	63.53	53.40
Rice bran	30.00	0.00	0.00	0.00
Soybean meal (44%)	12.60	6.67	0.97	7.43
Mungbean meal vermicelli	0.00	30.00	30.00	30.00
Tallow	0.00	3.60	3.10	6.80
Oyster shell	1.20	0.70	0.60	0.60
Dicalcium phosphate	0.00	0.50	0.60	0.60
Salt	0.35	0.35	0.35	0.35
L-Lysine	0.11	0.00	0.06	0.02
DL-Methionine	0.01	0.00	0.04	0.01
L-Tryptophan	0.04	0.00	0.00	0.01
L-Threonine	0.04	0.00	0.00	0.03
Agrifac-plus	0.25	0.25	0.25	0.25
Vitamin mineral premix	0.50	0.50	0.50	0.50
Total	100.00	100.00	100.00	100.00
Cost, baht/kg [a]	6.37	5.56	5.46	5.82
Calculated Composition				
Crude protein, %	14.00	14.00	12.00	14.00
ME, kcal/kg	3130.66	3132.44	3131.19	3286.52
Calcium, %	0.52	0.54	0.52	0.53
Phosphorus, avail. %	0.20	0.20	0.21	0.21
Lysine, %	0.68	0.68	0.60	0.71
Methionine+Cystine, %	0.36	0.36	0.34	0.38
Tryptophan, %	0.19	0.19	0.16	0.20
Threonine, %	0.56	0.56	0.48	0.59

[a] Computation based on the prices (baht/kg) when the experiment was conducted during October, 1995 to February, 1996

(Table 1). During the finishing and the whole growing-finishing periods, no significant differences were noted on the daily ME intake of pigs fed various rations. However, pigs on corn-soy diet had slightly lower daily ME intake than those on the MBMV containing rations probably due to the higher crude fiber content in MBMV containing rations (Table 3).

Average daily crude protein (CP) intake. Pigs on MBMVAA diet had lower (P<0.01) daily CP intake than those fed the other rations during every feeding periods except that those fed corn-soy diet (Table 4). No significant differences were observed on daily CP intake of pigs fed corn-soy,

Table 3 Chemical analysis of experimental diets fed to growing and finishing stages.

Composition (%)	Diets			
	Corn-soy	MBMV	MBMVAA	hi-den. MBMV
Dry matter				
growing stage	90.18	91.25	91.05	91.84
finishing stage	91.21	91.64	91.65	92.45
Crude protein				
growing stage	15.99	15.98	14.17	16.08
finishing stage	13.64	13.96	12.15	14.01
Ether extract				
growing stage	8.59	7.83	8.07	11.71
finishing stage	7.21	6.48	6.73	9.40
Crude fiber				
growing stage	2.67	6.86	6.31	5.86
finishing stage	4.00	6.26	6.17	5.87
Ash				
growing stage	5.75	5.42	5.45	5.44
finishing stage	5.74	4.40	4.15	4.81
Nitrogen free extract				
growing stage	57.18	55.16	57.05	52.75
finishing stage	60.62	60.54	62.45	58.36
Calcium				
growing stage	0.70	0.78	0.88	0.89
finishing stage	0.69	0.75	0.67	0.77
Total phosphorus				
growing stage	0.72	0.47	0.51	0.40
finishing stage	0.61	0.34	0.33	0.36
Gross energy, kcal/kg				
growing stage	4986.00	5048.30	5061.50	5264.80
finishing stage	4966.30	4856.50	4911.70	5195.70

MBMV and hi-den MBMV rations. This result is probably due to the lower crude protein content in MBMVAA diet than those in the other rations (Table 3).

Length of feeding days. Pigs fed MBMVAA diet took longer ($P<0.01$ and $P<0.05$) feeding period than those fed the other rations during the growing and finishing stages, respectively except that pigs fed MBMV diet in the growing stage. For the whole growing-finishing stage, pigs fed MBMVAA also took longer ($P<0.01$) feeding period than those fed the other rations (Table 5). This result is probably due to the lower ADG of pigs on MBMVAA diet (Table 5) than those fed the other rations. No significant differences were observed on feeding period of pigs fed corn-soy, MBMV and hi-den MBMV rations in every feeding stages. However, the result indicated that the high nutrient density should be increased to improve the feeding period of high level MBMV ration in the growing-finishing stage.

Average daily gain (ADG). Table 5 showed that pigs on MBMVAA diet had lower ($P<0.01$) ADG during the growing and the whole growing-

Table 4 Average age, weight, daily feed intake, metabolizable energy intake and crude protein intake of pigs fed experimental diets.

Criteria	Diets					
	Corn-soy	MBMV	MBMVAA	hi-den. MBMV	MEAN	SE
No. of animals	8	8	8	8		
Initial age, days	79.75	79.88	77.00	78.38	78.75	1.04
Initial wt., kg	30.45	30.38	30.31	30.43	30.39	0.29
Final wt. at growing stage, kg	60.39	60.43	60.30	60.41	60.38	0.05
Final wt. at finishing stage, kg	90.45	90.39	90.25	90.49	90.39	0.06
Weight gain, kg						
30-60 kg	29.94	30.05	29.99	29.99	29.99	0.30
60-90 kg	30.06	29.96	29.95	30.08	30.01	0.07
30-90 kg	60.00	60.01	59.94	60.07	60.00	0.29
Average daily feed intake, g						
30-60 kg	2164.22	2278.33	2291.79	2307.93	2260.57	29.69
60-90 kg	2771.05	2923.11	2857.96	2760.14	2828.06	40.75
30-90 kg	2451.17	2581.87	2562.51	2527.87	2530.85	29.57
Average daily metabolizable energy intake, kcal						
30-60 kg [1]	6710.23^{b}	7070.10^{ab}	7105.89^{ab}	7516.79^{a}	7100.75	102.49
60-90 kg	8675.20	9156.45	8948.82	9071.24	8962.93	128.32
30-90 kg	7639.81	8048.89	8001.72	8273.17	7990.90	98.03
Average daily crude protein intake, g						
30-60 kg [2]	346.06^{ab}	364.08^{a}	324.75^{b}	371.12^{a}	351.50	5.48
60-90 kg [2]	377.97^{ab}	408.07^{a}	347.24^{b}	386.70^{a}	379.99	6.55
30-90 kg [2]	360.82^{ab}	384.52^{a}	335.40^{b}	378.46^{a}	364.80	5.39

[1] Means within rows showing different superscripts are different ($P<0.05$).

[2] Means within rows showing different superscripts are different ($P<0.01$).

finishing stages and lower (P<0.05) ADG in the finishing stage than those fed the other rations. No significant differences were observed on ADG in pigs fed corn-soy, MBMV and hi-den MBMV rations in every feeding stages. This result is probably due to the high level of crude fiber and low crude protein and amino acid contents as well as the low net protein utilization (NPU) value of MBMV (47.23 %) in MBMVAA ration. Also, the low crude protein intake (Table 4) of pigs fed MBMVAA diet has been suggested as possible reason. Among the MBMV containing rations, the pigs fed hi-den MBMV diet had the highest ADG followed by those on MBMV and MBMVAA diets, respectively. This finding agrees with the reports of Lawrence (1977); Cromwell *et al.* (1993) that the growth rates of pigs were improved progressively when fed with diet containing high

Table 5 Average feeding days, daily gain, protein efficiency ratio, feed conversion ratio and feed cost per gain of pigs fed experimental diets.

Criteria	Diets					
	Corn - soy	MBMV	MBMVAA	hi-den MBMV	MEAN	SE
No. of animals	8	8	8	8		
No. of feeding day, days						
30-60 kg [2]	37.38 [b]	38.88 [ab]	42.38 [a]	37.13 [b]	38.94	0.68
60-90 kg [1]	34.50 [b]	35.13 [b]	41.25 [a]	35.88 [b]	36.69	0.92
30-90 kg [2]	71.88 [b]	74.00 [b]	83.63 [a]	73.00 [b]	75.63	1.48
Average daily gain, g						
30-60 kg [2]	805.12 [a]	774.66 [a]	709.66 [b]	812.02 [a]	775.36	11.69
60-90 kg [1]	886.24 [a]	864.85 [a]	737.98 [b]	847.19 [a]	834.07	20.73
30-90 kg [2]	842.50 [a]	815.55 [a]	721.28 [b]	828.25 [a]	801.90	14.36
Average protein efficiency ratio, gain/protein intake						
30-60 kg [2]	2.33[a]	2.13[b]	2.19[ab]	2.19[ab]	2.21	0.02
60-90 kg [1]	2.34[a]	2.12[b]	2.12[b]	2.19[ab]	2.19	0.03
30-90 kg [2]	2.33[a]	2.12[b]	2.15[ab]	2.19[ab]	2.20	0.02
Feed conversion ratio						
30-60 kg [2]	2.69 [c]	2.94 [b]	3.24 [a]	2.84 [bc]	2.93	0.04
60-90 kg [2]	3.15 [b]	3.40 [b]	3.91 [a]	3.28 [b]	3.43	0.07
30-90 kg [2]	2.92 [b]	3.17 [b]	3.57 [a]	3.06 [b]	3.18	0.05
Feed cost per gain, baht/kg [3]						
30-60 kg [1]	18.00 [ab]	17.32 [b]	18.75 [a]	17.50 [b]	17.89	0.17
60-90 kg [1]	20.07 [ab]	18.91 [b]	21.33 [a]	19.07 [b]	19.84	0.31
30-90 kg[2]	19.02 [ab]	18.10 [b]	20.04 [a]	18.28 [b]	18.86	0.22

[1] Means within rows showing different superscripts are different (P<0.05)

[2] Means within rows showing different superscripts are different (P<0.01)

[3] Composition base on the price (baht/kg) of feedstuffs when the experiment was conducted during October, 1995 to February, 1996.

protein, digestible energy and lysine to meet the required daily nutrient intakes. Moreover, Castell *et al*. (1994) stated that an increase in dietary crude protein or lysine:energy ratio, led to significant improvements in growth rate, gain:feed and lean content of the pigs. However, the result indicated that just only 5 % amino acid supplementation of the MBMV to balance the diet will not improve the growth rate of the pigs. Bulk feed due to high fiber content still limit the utilization of MBMV. To correct this it requires the increase in nutrient density especially crude protein or more amino acid supplementation in the diet.

Protein efficiency ratio (PER). Pigs fed corn-soy ration had higher ($P<0.01$) PER than those on MBMV diet but was not significantly different with the pigs fed MBMVAA and hi-den MBMV rations (Table 5) during the growing and the whole growing-finishing stages. In the finishing stage, pigs fed corn-soy diet had better ($P<0.05$) PER than those on MBMV and MBMVAA rations but was not significantly different with the pigs fed hi-den MBMV ration. There were no significant differences on PER value of pigs fed all MBMV containing rations. The pigs on MBMV diet gave the poorest PER value probably due to the higher crude fiber content in this diet than the other rations (Table 3). Cunningham *et al.* (1962) ; Baird *et al.* (1974) reported that a decrease of approximately 1.1-1.6 % in crude protein digestion for each 1 % increase in crude fiber of the pigs diet. However, the result showed that in all feeding periods, the high nutrient density should be increased to improve the PER value of the high level MBMV ration.

Feed efficiency. Table 5 showed that in every feeding periods, pigs fed MBMVAA diet had poorer ($P<0.01$) feed efficiency than those fed corn-soy, MBMV and hi-den MBMV rations. In the growing stage, pigs fed corn-soy diet showed better ($P<0.01$) feed efficiency than those fed MBMV and MBMVAA rations but was not significantly different with the pigs fed hi-den MBMV diet. The animals on corn-soy diet had higher feed efficiency than those fed all MBMV containing rations probably due to the higher ADG, PER value and lower daily feed intake of pigs fed corn-soy diet. Among the MBMV containing rations, the pigs fed hi-den MBMV diet had the highest feed efficiency followed by MBMV and MBMVAA rations, respectively. This result is probably due to the higher ADG, PER value and lower daily feed intake of pigs fed hi-den MBMV diet. This is supported by the reports of Lawrence (1977) and Castell *et al.* (1994). However, the result indicated that the nutrient density should be increased to improve 3.6 % feed efficiency of high level MBMV diet but simultaneous decrease 4.8% feed efficiency when compared to corn-soy diet. Therefore, just only 5 % amino acid supplementation of the MBMV to balance the diet will not improve the feed efficiency of the pigs . Bulk feed due to high fiber content still limit the utilization of MBMV. To correct this it requires the increase in nutrient density of the diet such as crude protein or more essential amino acid supplementation in the diet.

Feed cost per gain of pigs. In the growing and finishing periods, pigs on MBMVAA diet had higher ($P<0.05$) feed cost per gain than those fed MBMV and hi-den MBMV rations but was not significantly different with those fed corn-soy diet (Table 5). For the whole growing-finishing stage, pigs fed MBMVAA also was more expensive ($P<0.01$) than those fed MBMV and hi-den MBMV rations but showed no significantly different with those fed corn-soy diet. There were no significant differences between the feed cost per gain of pigs fed corn-soy, MBMV and hi-den MBMV rations in every feeding periods. However, the result indicated that the MBMVAA diet is the most expensive feed for growing-finishing pigs. The feed cost per gain of pigs on corn-soy diet was slightly more expensive

than those fed MBMV and hi-den MBMV rations.

Carcass evaluation

The slaughter and carcass characteristic of the pigs fed various dietary treatments are summarized in Table 6. Carcass characteristic in terms of slaughter weight and age, hot and chilled carcass yields, carcass backfat thick-ness, carcass length, leaf fat weight, trimmed ham, trimmed picnic shoulder and trimmed boston butt, were not significantly different between the pigs fed various rations. The pigs on MBMVAA diet had larger ($P<0.05$) leaf fat yield than those fed MBMV and hi-den MBMV rations but was not significantly different with those fed corn-soy diet. The thinnest leaf fat yield was noted on pigs fed hi-den MBMV diet probably because this diet has a more balance amino acid than the other rations. For lean cut weight and percentage lean cut of slaughter weight, pigs on MBMVAA diet had lower ($P<0.05$) than those fed corn-soy diet but was not significantly different with those fed MBMV and hi-den MBMV rations.

The loin eye area, trimmed loin yields and percentage lean cut of chilled carcass weight of pigs fed corn-soy diet showed higher ($P<0.01$) than those fed MBMV and MBMVAA rations but were not significantly different with the pigs fed hi-den MBMV diet. This result is probably due to the higher PER value and lower crude fiber content in corn-soy diet as well as the lower crude protein and amino acid contents of MBMVAA diet. However, the result indicated that carcass characteristics such as carcass backfat thickness, leaf fat yield, trimmed ham, trimmed picnic shoulder, trimmed boston butt, trimmed loin and lean cut yields of pigs fed hi-den MBMV diet were slightly better than those fed MBMV and MBMVAA rations and closely similar to corn-soy diet-fed pigs. Therefore, when MBMV is supplemented with essential amino acid it improves the protein utilization of the diet and shows similar carcass characteristic to the corn-soy diet-fed pigs.

CONCLUSION

Addition of amino acid in low protein diet with high MBMV failed to improve the production performance and carcass characteristic of the animals. Supplementation of amino acids and energy at 5 percent level together with 30 percent MBMV diet improved the production performance and carcass characteristic in terms of average feeding period, daily gain, protein efficiency ratio, feed conversion ratio, loin eye area and lean cut yield of the high level MBMV diet in growing-finishing pigs, but was not comparable to corn-soy diet. Bulk feed due to high fiber content still limit the utilization of MBMV. To correct this it requires more nutrient density in the diet particularly crude protein or increase more amino acid level supplementation in high MBMV diet.

When MBMV is used in pigs ration, the feed formulation can not be based on NRC requirement. It requires more nutrient density than corn-soy diet.

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Table 6. The slaughter and selected carcass characteristics of pigs fed various diets.

Traits	Diets					
	Corn-soy	MBMV	MBMVAA	hi-den MBMV	MEAN	SE
No. of animals	8	8	8	8		
Slaughter wt., kg	93.50	93.53	92.68	93.46	93.29	0.39
Slaughter age, days	157.50	161.13	166.38	157.50	160.63	2.05
Hot carcass wt., kg	71.85	71.60	71.16	71.35	71.49	0.42
Hot carcass yield, %	76.84	76.54	76.79	76.34	76.63	0.30
Chilled carcass wt., kg	69.96	69.71	69.35	69.37	69.59	0.44
Chilled carcass yield, %	74.82	74.52	74.83	74.21	74.59	0.31
Carcass backfat thickness, cm	3.01	2.99	3.23	3.01	3.06	0.07
Carcass length, cm	79.13	79.13	79.38	76.75	78.59	0.53
Loin eye area[2], sq.cm	45.88[a]	40.38[b]	40.19[b]	43.44[ab]	42.47	0.77
Leaf fat wt., kg	1.27	1.10	1.38	1.07	1.21	0.05
Leaf fat yield[1], %	1.36[ab]	1.18[b]	1.49[a]	1.14[b]	1.29	0.05
Trimmed ham						
weight, kg	15.50	15.26	15.13	15.33	15.30	0.15
of slaughter wt., %	16.58	16.31	16.32	16.40	16.40	0.15
of chilled wt., %	22.15	21.88	21.81	22.11	21.99	0.18
Trimmed picnic shoulder						
weight[1], kg	7.93	7.68	7.43	7.72	7.69	0.08
of slaughter wt., %	8.48	8.21	8.01	8.27	8.24	0.09
of chilled wt., %	11.33	11.02	10.72	11.15	11.05	0.11
Trimmed boston butt						
weight, kg	5.53	5.25	5.18	5.42	5.34	0.07
of slaughter wt., %	5.92	5.61	5.60	5.79	5.73	0.07
of chilled wt., %	7.92	7.52	7.49	7.80	7.68	0.09
Trimmed loin						
weight[2], kg	10.76[a]	9.57[b]	9.33[b]	10.27[ab]	9.98	0.16
of slaughter wt.[2], %	11.51[a]	10.22[b]	10.08[b]	10.99[ab]	10.70	0.17
of chilled wt.[2], %	15.39[a]	13.71[b]	13.47[b]	14.81[ab]	14.34	0.22
Lean cut						
weight[1], kg	39.72[a]	37.76[ab]	37.06[b]	38.78[ab]	38.33	0.35
of slaughter wt.[1], %	42.49[a]	40.35[b]	40.00[b]	41.50[ab]	41.08	0.33
of chilled wt.[2], %	56.79[a]	54.13[ab]	53.48[b]	55.93[ab]	55.08	0.41

[1] Means within rows showing different superscripts are different ($P<0.05$)

[2] Means within rows showing different superscripts are different ($P<0.01$)

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