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Original article

EFFECT OF PARTIAL MAIZE SUBSTITUTION IN FATTENING PIG RATIONS WITH BY-PRODUCTS FROM VEGETABLE AND FRUIT PROCESSING ON SOME CARCASS TRAITS

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Summary

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The aim of this experiment was to examine the possibilities of maize's partial substitution as an energetic nutrient with by-products obtained by manufacturing tomatoes, peppers and grapes in the nutrition of pigs on meat yield, meatiness and the share of certain tissues in part of the carcass. The experiment was carried out on growing and fattening pigs about 60 days old and with average weight of 27.00±0.64 to 27.69±0.71 kg. Forty-eight growing and fattening pigs were divided into 3 groups, each group consisting of 8 pigs of each sex. The experiment lasted 100 days in 2 phases, 50 days each. The experimental pigs from the control group (C) were fed rations not containing any of the above mentioned by-products, whereas the two experimental groups (O-I and O-II) were fed rations where maize was substituted with 6% (O-I) and 9% (O-II) from the examined by-products. Average body weight (ABW), mass of warm carcasses (MWC) and dressing percentage (DP) of fattening pigs were 96.20 kg, 78.93 kg, 80.38% in group C, 98.10 kg, 81.68 kg, 81.60% in group O-I and 99.50 kg, 81.59 kg, 82.00% in group O-II, respectively. No significant differences were observed between the three groups ($P>0.05$). The values for meatiness of warm carcasses (MWC), both absolute and relative were 31.80 kg and 40.17% in group C, 33.15 kg and 40.93% in group O-I and 33.99 kg and 41.96% in group O-II, respectively. Significant difference was observed between groups C and O-II ($P<0.05$) for both levels (absolute and relative). The average relative proportions of bone, muscle and fat tissue in the carcass of fattening pigs were 7.45%; 42.00%; 21.62% (group C), 7.92%; 44.78%; 18.51% (group O-I) and 7.55%; 46.20%; 16.81% (group O-II). Significant difference was observed between groups C, O-I and O-II ($P<0.05$) were established for muscle and fat tissue contents.

Key words: meatiness, meat yield, nutrition, pigs, relative proportion of bone, muscle, fat

INTRODUCTION

Performance of fattening pigs is expressed not only by parameters used to define gain and food consumption (per animal and per unit of gain), but also by estimating meat yield, meatiness and the share of certain

carcass parts and the tissues in major carcass parts.

Maricic (1981), in two experiments in fattening pigs, with a mixture of standard raw material and chemical composition, determined the mass of warm carcass between 71.03 and 75.19; 73.53 kg on the average. Based on the data the average yield was around 78.45%. In similar studies (Maricic, 1984) warm carcass weight ranged from 78.47–80.23 kg, or an average of 79.35 kg, and the yield between 79.65–80.59%, or an average of 80.12%.

Arsenijevic (1982) studied the effect of diet on body weight in fattening pigs with a final body weight of 95–100 kg. A standard mixture of raw material and fish meal was used. The results showed mass of warm carcass 80.33 kg (80.23%) and meat in warm carcass – 32 kg or 39.66%. Manojlovic (1985) reported the results of two experiments on Swedish Landrace and Large White in which, among other things, dressing percentage was evaluated. The mass of warm carcass ranged from 78.63–81.20 kg, the yield of 79.90–79.82%. Namely, the quantity of meat in the warm carcass was 31.88 and 31.91 kg or 38.78 and 39.28%, respectively.

Zivkovic (1986) performed a series of five experiments on Swedish Landrace and Large White crosses. The results demonstrated mass of warm carcass ranging from 70.4–77.5 kg depending on live body weight of pigs, and the yield – from 73.6 to 77.5%. Lean meat ranged between 29.1–1.8 kg and 38.8–41.0%.

Djurica (1987) performed two feeding experiments in Swedish Landrace pigs using a mixture of standard raw material and chemical composition. The mass of warm carcass at slaughter ranged from 70.68 to 76.58, or an average of 73.57 kg, and dressing percentage – from 80.32 to 80.36, average 80.34%. Warm carcass lean meat at slaughter was 30.55–30.85 kg (average 30.72 kg) and 40.27–40.19 kg (average 40.24%).

Damjanovic (1987) reported a mass of warm carcass around 74.38 kg, and a yield of about 80.21%. The amount of meat in hot carcass was 29.52 kg and the lean meat – 39.44%. In similar studies (Damjanovic, 1991) nearly the same results were reported with mass of warm carcass 74.37 kg and 79.04% and slightly lower amount of meat in the hot carcass (30.20 kg and 40.45%). It is considered (Desmolin *et al.,* 1972) that backfat thickness is used for categorisation of fattening pigs into classes I–III, whereas the length of carcass sides – a criterion enabling the classification of meaty pigs into classes IV–VI.

The Republic of Macedonia have considerable amounts of fruit and vegetable by-products (tomatoes 5–10%; grapes 20–25% and peppers 25–30%). Therefore, a study of the effect of partial substitution of maize with by-products on the performance, health condition of growing and fattening pigs on meat yield, meatiness and share of certain tissues in part of the carcass is scientifically justifiable and of great interest for practice.

The main objective of the study was to establish the effect of maize substitution with different levels of by-products obtained in processing of tomatoes, peppers and grape, in the nutrition of growing and fattening pigs on their performance and health in order to the justification for the use of fore mentioned by-products in pig nutrition.

MATERIALS AND METHODS

The chemical composition of by-products obtained during processing of tomatoes, peppers and grapes used in the experiment is shown in Table 1. The tested products

Table 1. Chemical composition of the tested by-products and maize, %

Chemical composition	By-products			Maize
	Grapes	Peppers	Tomatoes	
Moisture	8.40	8.61	8.18	13.00
Ash	4.36	6.15	3.38	1.20
Protein	12.66	18.77	21.15	8.00
Fat	10.60	8.18	13.20	4.00
Fibre	39.16	37.78	39.31	2.10
NEM	24.82	20.51	14.78	71.70
Calcium	0.64	0.56	0.41	0.02
Phosphorus	0.41	0.82	0.36	0.30
ME, MJ/kg	8.99	8.50	8.61	13.97
Lysine	0.33	0.29	0.31	0.20
Methionine+cysteine	0.13	0.15	0.11	0.26
Threonine	0.18	0.10	0.02	0.10
Tryptophan	0.35	0.25	0.22	0.40

Table 2. Composition of rations for nutrition of different groups of growing and fattening pigs, %

Feedstuffs	from 25–60 kg			from 60–100 kg		
	C	O-I	O-II	C	O-I	O-II
Maize	61.20	55.20	52.20	63.90	57.90	54.90
By-product of tomatoes	–	2.00	3.00	–	2.00	3.00
By-product of peppers	–	2.00	3.00	–	2.00	3.00
By-product of grapes	–	2.00	3.00	–	2.00	3.00
Wheat bran	12.00	12.00	12.00	15.00	15.00	15.00
Soya bean meal	16.00	16.00	16.00	10.00	10.00	10.00
Sunflower meal	5.00	5.00	5.00	7.00	7.00	7.00
Fish meal	1.00	1.00	1.00	-	-	-
Soya oil	2.00	2.00	2.00	1.00	1.00	1.00
Limestone	1.20	1.20	1.20	1.40	1.40	1.40
Dicalcium phosphate	0.70	0.70	0.70	0.70	0.70	0.70
Salt	0.40	0.40	0.40	0.50	0.50	0.50
Premix	0.50	0.50	0.50	0.50	0.50	0.50

contained significantly higher amounts of protein and fat compared to maize, with slightly less favourable amino acid composition. On the other hand, due to the extremely high content of fibre and very low carbohydrate content, they were a much poorer source of energy than maize.

A trial was organized according to the group-control system under production conditions at ZZ Edinstvo pig farm, Čelopek village, town Tetovo, Republic of Macedonia. The trial was realised in pigs during the growing and fattening period, at the age of approximately 60 days and average body mass from 27.00±0.64 to 27.69±0.71 kg. Crosses of Swedish and Dutch Landrace of uniform genetic potential were used. Every group consisted of equal number of male and female animals.

A total of 48 animals were divided into 3 groups, and each group consisted of 8 male and 8 female pigs (16 animals per group). The experiment lasted 100 days and it was divided into two phases of 50

days. During the trial, body mass of animals was recorded as well as the feed intake. Samples of dietary mixtures were collected for analysis. Growing and fattening pigs were fed adequate complete standard mixtures with regard to ingredients and chemical composition (Table 2). The two used mixtures fully satisfied the requirements of pigs (AEC, 1993; NRC, 1998; Anonymous, 2000).

The mixtures were corrected to certain extent in order to realise set objectives. Animals in the control group (C) were fed mixtures without by-products, whereas animals in the experimental groups (O-I and O-II) received food where maize was replaced with mentioned by-products, in the amount of 6% (O-I), and 9% (O-II).

At the end of the trial, pigs were transported to slaughterhouse and meat yield and meatiness of carcass sides were determined on slaughter line. The animals were weighed individually prior to slaughtering and subsequently the mass of warm carcass sides was measured. Meatiness of warm carcass sides was calculated (Anonymous, 1986). After cooling halves at 4 ^{o}C over 24 hours and cutting of the basic parts, relative and absolute share of individual parts by weight of the halves were determined.

RESULTS

After the nutrition trial which included pigs in growing and fattening period, the animals were slaughtered and meat yield, i.e. dressing percentage were calculated (Table 3). Body masses of pigs prior to slaughtering, as previously mentioned, differed between groups, but not statistically significantly. Mass of warm carcass sides was somewhat higher compared to control animals, but differences were not statistically significant (P>0.05). Dressing percentages of pigs in experimental groups, according to the order, was by 1.52% and 2.02% higher compared to meat yield in controls. No statistically significant differences between groups were established (P>0.05).

Table 3. Body weight, mass of warm carcass and dressing percentage of fattening pigs fed rations without by-products (group C), 6% by-products (group O-I) or 9% by-products (group O-II). Values are given as mean ± SEM (range).

Body weight, kg	
C (n=16)	96.20±3.28 (90.20–115.20)
O-I (n=16)	98.10±3.63 (89.20–125.10)
O-II (n=16)	99.50±3.40 (92.00–117.00)
Mass of warm carcass, kg	
C (n=16)	78.93±3.27 (71.34–106.34)
O-I (n=16)	81.68± 3.63 (71.00–107.00)
O-II (n=16)	81.59± 3.42 (71.22–105.00)
Dressing percentage, %	
C (n=16)	80.38±0.58 (75.90–83.62)
O-I (n=16)	81.60± 0.61 (77.18–85.56)
O-II (n=16)	82.00± 0.73 (78.22–86.35)

Meatiness of warm carcass sides (absolute and relative), is presented in Table 4. It is obvious that absolute and relative meatiness increased with the applied treatment. A linear upward trend was established by statistical analysis (y=1.095x + 30.79) with high correlation coefficient (r_{xy}=0.982), whereas the same trend of increase (y=0.895x + 39.23; r_{xy}=0.992) was registered in regard to relative meatiness of warm carcass sides. In addition, absolute and relative meatiness of warm

carcass sides in pigs from the O-II group were significantly higher (P<0.05) vs those in group C.

Table 4. Meatiness of warm carcasses fattening pigs fed rations without by-products (group C), 6% by-products (group O-I) or 9% by-products (group O-II). Values are given as mean ± SEM (range).

Absolute, kg	
C (n=16)	31.80±0.26 [a] (26.50–41.43)
O-I (n=16)	33.15±0.19[a] (26.50–46.82)
O-II (n=16)	33.99±0.22 [b] (27.18–44.27)
Relative, %	
C (n=16)	40.17±0.15 [a] (40.15–41.70)
O-I (n=16)	40.93±0.19 (40.15–42.32)
O-II (n=16)	41.96±0.13 [b] (41.18–42.16)

a, b: statistically significant at P<0.05.

The relative proportion of bones, muscle and fat tissue in the carcass is shown in Table 5. The relative proportion of bones in the carcass was slightly different between groups (P>0.05). On the other hand, more pronounced numerical differences were observed in the relative proportion of muscle and fat tissue in the carcass. It is interesting to underline the increasing share of muscle tissue proportional to the reduction of the share of fat in the carcass. The difference between experimental groups and the control group was statistically significant (P<0.05). The upward trend of the relative proportion of muscle tissue in the carcass (y = 2.1x + 40.127) was linear and with a very high correlation coefficient (r_{xy}=0.966). Similarly, the negative trend of the contribution of fat in the carcass (y = –2.405 x + 23.79) was linear, with very high correlation coefficient (r_{xy} = 0.972).

Between groups O-I and O-II, the proportions of bones, muscle and fat tissue in certain parts of carcasses of slaughtered pigs (Table 5) were similar with a slight decrease in the proportion of fat and a slight increase in muscle tissue in the latter group (P>0.05).

Table 5. Relative proportion of bones, muscle and fat tissues in carcass (%) in fattening pigs fed rations without by-products (group C), 6% by-products (group O-I) or 9% by-products (group O-II). Values are given as mean ± SEM (range).

Bones	
C (n=16)	7.45±0.06 (7.10–7.85)
O-I (n=16)	7.92±0.04 (7.12–8.36)
O-II (n=16)	7.55±0.05 (6.96–8.21)
Muscle tissue	
C (n=16)	42.00±0.20 [a] (39.95–44.21)
O-I (n=16)	44.78±0.72 [b] (48.52–52.21)
O-II (n=16)	46.20±0.95 [b] (42.33–50.01)
Fat tissue	
C (n=16)	21.62±0.13 [a] (20.36–22.41)
O-I (n=16)	18.51±0.10 [b] (17.95–19.22)
O-II (n=16)	16.81±0.11 [b] (15.72–17.83)

a, b: statistically significant at P<0.05.

DISCUSSION

Mass of warm carcass sides of 78.93 kg, i.e. dressing percentage of 80.38% was established after slaughtering of animals fed mixtrations of standard composition,

which is in accordance to literature data. Maričić (1984) reported that the average mass of warm carcass sides was around 79.35 kg, and dressing percentage – around 80.12%. Similar results for warm carcass sides (80.33 kg; dressing percentage 80.23%) were reported by Arsenijević (1982). Also, similar slaughter yields (80.34 and 80.21%) were stated by Djurica (1987) and Damnjanović (1987), although reported warm carcass side masses (73.57 and 74.38 kg) were somewhat lower.

Proportional to the difference in preslaughter body masses, mass of warm carcass sides of experimental pigs was somewhat higher compared to that of control animals. Dressing percentages of by-products fed pigs, according to the order, was by 1.52% and 2.02% higher compared to meat yield established in controls ($P>0.05$).

Assessment of meatiness of carcasses on slaughter line is perhaps one of the most important indicators of meat yield. In this study, meatiness of carcass sides of fattening pigs fed a standard ration was 31.80 kg, i.e. 40.17%, which is in agreement with results obtained by other authors. Maričić (1984) established that the meatiness of pigs ranged between 40.25 and 40.80%. Similar results are stated by Manojlović (1985) from two nutrition trials on Swedish Landrace and Large Yorkshire crosses where the established quantity of meat in warm carcass sides was 31.88 and 31.91 kg, or 38.78 and 39.28%, respectively. Djurica (1987) reported that meatiness of warm carcass sides on slaughter line was between 30.55-30.85 kg (average 30.72 kg) or 40.19–40.27 (average 40.24%), and Damnjanović (1987) stated that quantity of meat in warm carcass sides was around 29.52 kg (meatiness around 39.44%).

CONCLUSIONS

Based on results from this study on the possible partial substitution of maize as energy feed with by-products obtained in processing of tomatoes, peppers and grape in pig nutrition on performance and health condition of animals, it can be concluded that partial substitution of maize with by-products obtained in processing of grapes, tomatoes and peppers, especially at a level of 6% had no negative effect on performance of pigs in growing and fattening period. Also, positive effects on certain meat parameters, especially on meatiness of carcass and amount of muscle, fat and bone tissues of the carcass have been registered. In general, applied treatments had no negative effect on performance and health of pigs, which provides objective possibility for partial substitution of maize with by-products obtained from processing of tomatoes, peppers and grapes.

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