

EXAMINING THE EFFICIENCY OF THE SUBSTITUTION OF MAIZE WITH BY-PRODUCTS OBTAINED BY MANUFACTURING VEGETABLES AND FRUITS IN MIXTURES FOR WEANED PIGLETS

ISTRAZIVANJE UCINKOVITOSTI ZAMJENE KUKURUZA NUSPROIZVODIMA DOBIVENIM U OBRADI POVRĆA I VOĆA U SMJESAMA ZA ODBIJENU PRASAD

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ABSTRACT

To examine the possibilities of maize substitution as an energetic nutrient with by-products obtained by manufacturing tomatoes, peppers and grapes in the nutrition of different categories of swine on the production results and health condition an experiment was carried out in the nutrition of weaned piglets. The researches were conducted in the producing conditions at pigs farm ZZ “Edinstvo” in the village of Chelopek near the town of Tetovo, R. Macedonia where experiments were organized in a group controlled system. The experiment was carried out on piglets after weaning in a period of 28-30 days with an average body weight of 8.66–8.84 kg. For the experiment were used mongrels of Swedish and Dutch races with equalized genetical potential were each group in experiment consist of equal number of males and females. The experiment piglets was carried out on 72 weaned piglets divided into 3 groups, each group having 12 piglets of different sex. The experiment lasted for 42 days in 2 phases with 21 days each phase. In the experiment 2 mixtures were used for weaned piglets from 1 to 21 days and the whole mixture for piglets in breeding in a period of 21–42 days of the experiment. The experimental piglets from the control group were fed mixture without a share by the examined by-products, whereas the experimental groups were fed with mixture substitution of maize with different quality of the above mentioned by-products. The mixture contained – 3% i.e.6% from the examined by-products. Maize’s semisubstitution with by-products obtained by manufacturing tomatoes, peppers and grapes especially in the amount of 3% did not have any negative effects on the production results of weaned piglets. In general, the applied treatments did not have negative effect on the production results and health condition of different categories of swine which real possibilities for maize’s semisubstitution with by-products obtained by manufacturing offers tomatoes, peppers and grapes.

Key words: nutrition, weaned piglets, by-products obtained by manufacturing tomatoes, peppers and grapes, production results

INTRODUCTION

The intensive animal production is very demanding as regards the organism of the domestic animal, as well as the animal food industry. The goal of the intensive pig production is high growth with

minimal food consumption in the shortest time giving animal products without harmful substances at the same time taking care of the animal health. Because of the differences in nutrition, husbandry, accomodation and pig breeds in our conditions of production we only review the literature that is a re-

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sult of extensive research done on weaned piglets production (Kovčín and Pejić, 1988; Waaijenberg, 1987; Puača, 1970; Collier and Hardy, 1986; Rotar and Salobir, 1987; Inbarr, 1989; 1990; Inbarr, 1989a; Officer, 1992; Cowan, 1995; Easter, 1995; Graham, 1996; Partridge, 1997; Grujić, 1998; Dabetić, 1999).

Breeding animals has developed as means of providing enough food of animal origin that is biologically valuable. Achieving it, there are two main problems that need to be solved: producing large quantities of industrial feeds for animals and dealing with the shortage of certain feeds. One of the prerequisites for producing industrial feeds for animals is providing feed high in energy which constitutes above 40% of the total mixture. In Macedonia 80% of the energetic feeds can be obtained from the production by domestic industry, the other 20% are imported. Unfavorable climatic conditions complicate further the situation in energetic feed production, especially maize. The difficulties apply to the export of feeds too. So beside the hampered foreign trade, the production of feeds for animals and the animal breeding in general depends on imported feeds. That justifies the striving for solutions for rational user of the energetic feeds of domestic origin, and substituting them, e.g. with by-products from the food industry. The non-hazardous disposal of by-products obtained from the food industry during processing food from plant origin for human consumption actualizes further the situation.

The research to date has noted and established in practice a great number of by-products. Especially those obtained from wheat industry (wheat flour, wheat bran), cooking oil industry (pellets), sugar industry (dry slices of sugar beet). In Macedonia there are other by-products that can be obtained from the agrocomplexes. The unconventional by-products that receive most attention are those obtained from tomatoes, peppers and grapes. The waste from the manufacturing of the tomatoes, peppers and grapes is 5-10, 25-30 and 20-25% respectively. Most of the published work on the nutritional value of the above mentioned by-products bring out the energy value and relatively good protein value (Sinovec and Ševković, 1995; Radovanović and Rajić, 1990; Stojanović et al., 1989; Todorov, 1995; Šokarovski and Cilev, 1999). Biological experiments proved their nutritive value and efficiency in nutrition of ruminants (Smilevski et al., 1973, 1975; Damjanovs-

ka et al., 1988; Šokarovski et al., 1981; Bogdanov, 1980). Since the demand for pork and poultry is increasing, it is necessary to examine the effect of this by-products in the nutrition in non-ruminants, especially as they compete for food with humans.

That is why it is scientifically justified and practically useful to examine the effects of maize substitution with by-products obtained from the manufacture of tomatoes, peppers and grapes, on the production results and health of weaned piglets.

MATERIAL AND METHODS

The objective was to examine the possibility of maize substitution with by-products obtained by manufacturing tomatoes, peppers and grapes in the nutrition of weaned piglets. The chemical composition of by-products obtained during processing tomatoes, peppers and grapes used in the experiment is shown in Table 1.

The table shows that tested products contain significantly higher amounts of protein and fat compared to corn, with slightly less favorable amino acid composition. On the other hand, due to the extremely high fiber content and very low carbohydrate content, they are much poorer source of energy than corn. An experiment in group control system was carried out on the pig farm ZZ "Edinstvo", Chelopek, Tetovo region, R. Macedonia. The experiment was carried out on weaning piglets about 28-30 days old and average weight of 8.66-8.84 kg. Mongrels were used for the experiment from Swedish and Dutch races with equal genetic potential. Each group consisted of equal number of males and females.

The experiment of the weaning piglets was carried out on 72 piglets divided into 3 groups, each group consisting of 12 piglets of equal sex proportion. The experiment lasted for 42 days in 2 phases each lasting for 21 days. The weight of the piglets and the amount of consumed feed were measured on a regular basis during the experiment. The weaned piglets were fed suitable mixture of standard raw and chemical composition (Table 2). Two mixtures were used during the experiment that completely satisfied the needs of the piglets (AEC, 1993; NRC, 1998; Regulation 2000), the mixture for weaning piglets for 1-21 days, and the mixture for breeding piglets for 21-42 days experimental period.

Table 1. The chemical composition of the tested by-products and corn, (%)

Tablica 1. Kemijski sastav testiranih nusproizvoda i kukuruza, (%)

Chemical composition – Kemijski sastav	By-products – Nusproizvodi			Corn – Kukuruz
	Grapes – Grožđe	Peppers – Paprika	Tomatoes – Rajčica	
Moisture – Vлага	8.40	8.61	8.18	13.00
Ash – Pepeo	4.36	6.15	3.38	1.20
Protein – Bjelančevine	12.66	18.77	21.15	8.00
Fat – Mast	10.60	8.18	13.20	4.00
Fibre – Vlakna	39.16	37.78	39.31	2.10
NEF – NET	24.82	20.51	14.78	71.70
Calcium – Lalcij	0.64	0.56	0.41	0.02
Phosphorus – Fosfor	0.41	0.82	0.36	0.30
ME, MJ/kg	8.99	8.50	8.61	13.97
Lysine – Lizin	0.33	0.29	0.31	0.20
Methionine+cystine – Metionin + cistin	0.13	0.15	0.11	0.26
Threonine – Treonin	0.18	0.10	0.02	0.10
Tryptophane – Triptofan	0.35	0.25	0.22	0.40

Table 2. Composition of mixture for the nutrition of weaned piglets, (%)

Tablica 2. Sastav smjese za hranidbu odbijene prasadi

Feeds – Krmiva	To – od 15 kg			From – od 15-25 kg		
	K	O-I	O-II	K	O-I	O-II
Maize – Kukuruz	61.70	58.70	55.70	65.30	62.30	59.30
By product of tomatoes – Nusproizvod rajčice	-	1.00	2.00	-	1.00	2.00
By product of peppers – Nusproizvod paprike	-	1.00	2.00	-	1.00	2.00
By product of grapes – Nusproizvod grožđa	-	1.00	2.00	-	1.00	2.00
Soya bean meal – Sojina sačma	22.00	22.00	22.00	21.00	21.00	21.00
Sunflower meal – Suncokretova sačma	5.00	5.00	5.00	5.00	5.00	5.00
Fish meal – Riblje brašno	6.00	6.00	6.00	3.00	3.00	3.00
Soya oil – Sojino ulje	3.00	3.00	3.00	3.00	3.00	3.00
Limestone – Vapnenac	0.50	0.50	0.50	0.50	0.50	0.50
DcaP	1.00	1.00	1.00	1.30	1.30	1.30
Salt – Sol	0.20	0.20	0.20	0.30	0.30	0.30
Methionine – Metionin	0.05	0.05	0.05	0.05	0.05	0.05
Lysine – Lizin	0.05	0.05	0.05	0.05	0.05	0.05
Premix – Premiks	0.50	0.50	0.50	0.50	0.50	0.50

The main aim of the research was to determine how the maize substitution with by-products obtained by manufacturing tomatoes, peppers and grapes, in the nutrition of weaning piglets, affects the production results and the piglets health condition and to determine when it is practical to use mixtures with by-products in the nutrition of piglets. Minimal corrections were made in the mixtures. The experimental piglets from the experimental control group were fed mixtures not containing any of the above mentioned by-products, whereas the pigs in the experimental groups were fed with mixtures where maize was substituted with different quantities of the specified by-products. The mixtures included 3 and 6% of the examined by-products in the mixtures for piglets nutrition.

Samples of the feed for analysis were taken at equal time intervals of 30 days during the experiment. Regulation (1987) for the methods of sampling and methods of physical, chemical and microbiological analysis of animal feeds was used.

Control weighing of the experimental animals was done using technical scale that was 10⁻²kg accurate. Based on those results, the mean weight of animals was calculated. From the difference in the measurements the total weight gain was calculated, while the daily weight gain was calculated based on individual phases of the experiment, as well as the total experiment.

During the experiment the total mixture that was given to particular group of animals was weighed. In the end, based on the sum of the daily mixtures that were used, the total expenditure of food was calculated for each phase and the whole experiment. The results on consumed feed and the weight gain of the pigs, the conversion of food was calculated for each phase and the whole experiment.

Besides taking preventive measures, all of the piglets were under veterinary control and every change in medical condition was examined and noted. Daily examination comprised group and individual observations.

RESULTS AND DISCUSSION

The chemical content of the mixtures for the weaned piglets in the experiment is shown in Table 3. It can be seen that substituting the maize with by-

products from the manufacture of tomatoes, peppers and grapes insignificantly increases the protein content, fat and fiber and energy, while the amino acids content remains the same.

The rations and amounts of feed mixture for the experimental piglets were composed using conventional methods applied in practice. The results on the chemical content of the feeds used for the growing piglets in the control group showed that the food was meeting the technological standards and regulations (Regulation, 2000), and so content all the nutrients in the mixtures corresponded to the needs of the different categories of pigs in the different phases of the experiment (NRC, 1998; AEC, 1993). The chemical analysis confirmed the balance in the different amino acids content (lysine, methionine, treonine and tryptophane) in the mixture for the animals in the control group. The chemical content, including the amino acids, in the mixtures for piglets in the experimental groups that had semisubstitution of maize with by-products obtained from the manufacture of tomatoes, peppers, grapes, did not differ significantly from the mixtures for the control groups.

Based on the above, it can be concluded that the chemical content of all mixtures for all the groups of experimental piglets was meeting the needs and corresponded to the demands that were made when the experiment was established.

The piglets in every group had uniform body structure, well formed bone and muscle tissue, vivid temper and were in good condition. The hair, skin and visible mucous membranes had no changes. Appetite was good, and the stool was normal. The ability to move and coordinate movement were well-balanced and the muscle tone was normal. During the experiment the health of the piglets was not affected and no disease or mortality was noted.

At the beginning, the piglets in all of the experimental groups had uniform body weight, and the differences between groups were not statistically significant (Table 4). At the middle of the experiment the experimental groups had slightly lower body weight compared to the control group, and the piglets in the group O-II had the lowest body weight. In the end of the experiment the piglets in all of the groups had almost the same body weight, and the piglets in group O-I had slightly higher body wei-

Table 3. Chemical composition of mixtures for the nutrition of weaned piglets, (%)

Tablica 3. Kemijski sastav krmnih smjesa za hranidbu odbijene prasadi, (%)

Chemical composition – Kemijski sastav	To – do 15 kg			From – od 15-25 kg		
	K	O-I	O-II	K	O-I	O-II
Moisture – Vлага	11.32	11.17	11.04	11.45	11.31	11.18
Ash – Pepeo	5.06	5.17	5.27	4.90	5.00	5.11
Protein – Bjelančevine	20.18	20.47	20.75	18.17	18.45	18.74
Fat – Mast	6.15	6.35	6.55	6.09	6.29	6.49
Fibre – Vlakna	3.80	4.90	6.00	3.80	4.90	6.00
NEF – NET	53.49	51.94	50.39	55.59	54.05	52.48
Calcium – Kalcij	0.98	0.99	1.01	0.85	0.86	0.88
Phosphorus – Fosfor	0.74	0.75	0.75	0.70	0.70	0.71
ME, MJ/kg	14.39	14.43	14.48	14.32	14.37	14.42
Lysine – Lizin	1.18	1.18	1.19	1.00	1.01	1.01
Methionine+cystine – Metionin + cistin	0.69	0.69	0.69	0.62	0.61	0.61
Threonine – Treonin	0.28	0.28	0.28	0.26	0.26	0.26
Tryptophane – Triptofan	0.45	0.44	0.44	0.43	0.43	0.43

Table 4. Body weights of weaned piglets, (kg)

Tablica 4. Tjelesne mase odbijene prasadi, (kg)

Groups - Skupine	Statistical parameters – Statistički pokazatelji				
	x	Sx	Sd	Cv	Iv
	1. day – 1. dan				
K	8.66	0.21	1.05	12.16	7.00 -11.00
O-I	8.79	0.20	0.99	11.36	7.00 -10.60
O-II	8.84	0.19	0.94	10.58	7.20 -10.50
	21. day – 21. dan				
K	15.04	0.86	2.74	19.38	10.30 -17.80
O-I	14.80	0.79	2.51	17.96	8.70 -16.70
O-II	14.01	0.80	2.52	19.14	9.30 -16.30
	42. day – 42. dan				
K	26.98	0.80	3.92	14.53	17.00 -34.00
O-I	27.37	0.72	3.51	12.83	18.50 -34.00
O-II	26.02	0.87	4.26	16.39	13.00 -31.00

ght compared to the control group. The differences between the groups were not statistically significant ($p>0.05$). Based on this results it can be already concluded that the used treatments did not affect the body weight.

There were differences between the groups in the average daily gain in mass in each group (Table 5). The highest daily gain in weight in the first phase of the experiment was achieved by the control group, the lowest by the O-II group, the results be-

Table 5. Gain of weaning piglets in the experiment, (kg/day)

Tablica 5. Prirast odbijene prasadi u pokusu, (kg/dan)

Groups - Skupine	Statistical parameters – Statistički pokazatelji				
	x	Sx	Sd	Cv	Iv
1. - 21.day – 1. - 21. dan					
K	0.304 ^a	0.01	0.01	11.41	0.205-0.422
O-I	0.286	0.02	0.05	12.28	0.185-0.410
O-II	0.246 ^b	0.03	0.08	15.35	0.185-0.380
21. - 42. day – 21. - 42. dan					
K	0.568	0.02	0.07	15.03	0.411-0.713
O-I	0.598	0.02	0.06	12.80	0.393-0.711
O-II	0.572	0.02	0.09	16.71	0.456-0.723
1. - 42. day – 1. - 42. dan					
K	0.436	0.01	0.06	13.32	0.337-0.504
O-I	0.445	0.02	0.06	14.71	0.309-0.564
O-II	0.409	0.03	0.07	15.33	0.382-0.521

^{a, b} $p < 0.05$

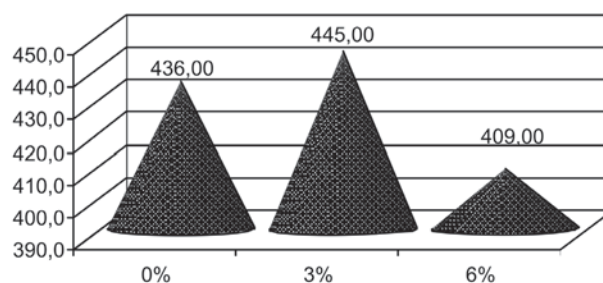
ing statistically significant ($p < 0.05$). In the second phase of the experiment, the piglets of the two experimental groups increased their weight gain, but the results were not statistically significant ($p > 0.05$). The weight gain in the whole experiment was slightly higher for the O-I group, and slightly lower for the O-II group, when compared to the control group. Although the numbers show differences, the statistical analysis shows that the differences between groups in weight gain were not statistically significant ($p > 0.05$).

Although body weight is a good indicator of the quality of nutrition, the daily gain is considered more accurate (Graph 1). From the data analysis it can be concluded that in both phases, the piglets in the control group that were fed mixtures with standard raw material had an average daily gain of 0.436 kg. It is thought that feeding standard mixtures gives satisfying results in the production, and the pigs have a daily gain of 373 g (Kovčín and Pejić, 1988) to 383 g (Waaijenberg, 1987), and 0.340-0.387 kg Dabetić (1999), but in practice it has been obtained (Puača, 1970; Grujić, 1998) even higher daily gains (0.415-0.430 kg).

The piglets in both experimental groups had a lower weight gain compared to the control group, and the differences for the O-II group were statisti-

cally significant ($p < 0.05$). In the second phase of the experiment, the piglets in both experimental groups had slightly higher weight gain, but the differences were not statistically significant ($p > 0.05$). Talking about the whole experiment compared to the control group, the piglets from group O-I had slightly higher, and the piglets from group O-II slightly lower results in weight gain, and the analysis shows that the differences were not statistically significant ($p > 0.05$).

The average daily consumption of feed is shown in Table 6. The piglets of the control group consumed the same amount as would in practice, and the same applied to the piglets in the first ex-



Graph 1. Daily gain, (g)

Grafikon 1. Dnevni prirast, g

Table 6. Consumption of feed in the experiment, (kg/day)

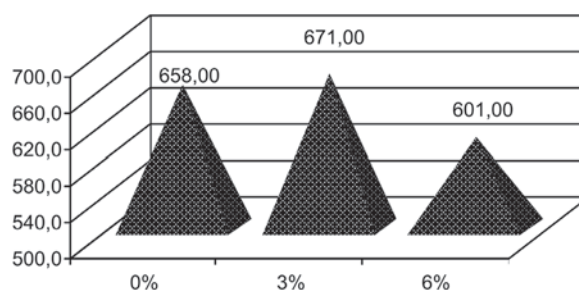
Tablica 6. Potrošnja hrane u pokusu, (kg/dan)

Phase of experiment – Faze pokusa	Groups - Skupine		
	K	O-I	O-II
	Weaned piglets – Odbijena prasad		
1. - 21. day – 1. - 21. dan	0.452	0.452	0.382
Index	100.00	99.78	84.51
21. – 42. day – 21. - 42. dan	0.865	0.890	0.820
Index	100.00	102.09	94.60
1. – 42. day – 1. – 42. dan	0.658	0.671	0.601
Index	100.00	101.98	91.34

perimental group O-I. Increasing the percentage of the by-products in the mixture had a negative effect on consumption of feed by the piglets in group O-II, both in different phases, and the whole experiment.

Apetite is the first indicator of the health of the animal and the quality of nutrition. The average daily consumption of feed varied between groups, especially between the experimental groups. The piglets in the control group that were fed mixtures of standard composition of raw materials consumed the same amount that is standard for the pigs in practice, from 0.626 kg (Waaijenberg, 1987), 0.649-0.665 kg (Dabetić, 1999) to 0.760 kg (Kovčín and Pejić, 1988), and 0.790 (Puača, 1970), but some noted (Grujić, 1998) much higher values (0.941 kg) (Graph 2).

The piglets from the experimental groups consumed different amounts of food, and the increase of the by products in the mixture decreased the



Graph 2. Consumption of feed, (kg)

Grafikon 2. Potrošnja hrane, (kg)

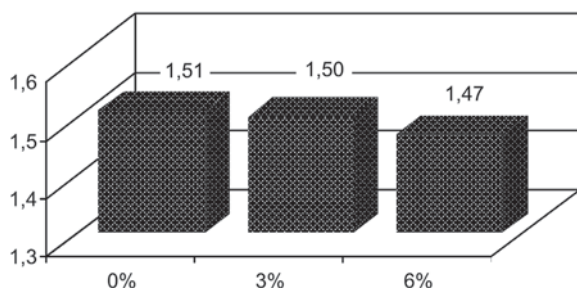
consumption of food, which applied to both phases, and the whole experiment.

Food conversion as well as the interaction of growth and consumption of food, differed between the groups and phases, and between the experiments (Table 7). The pigs in both of the experimen-

Table 7. Conversion of feed in the experiment, (kg)

Tablica 7. Konverzija hrane u pokusu, (kg)

Phase of experiment – Faze pokusa	Groups - Skupine		
	K	O-I	O-II
	Weaned piglets – Odbijena prasad		
1. - 21. day – 1. - 21. dan	1.49	1.58	1.55
Index	100.00	106.04	104.03
21. – 42. day – 21. - 42. dan	1.52	1.49	1.43
Index	100.00	98.03	94.08
1. – 42. day – 1. – 42. dan	1.51	1.50	1.47
Index	100.00	99.34	97.36



Graph 3. Conversion of feed, (kg/kg)

Grafikon 3. Konverzija hrane, (kg/kg)

tal groups had lower conversion in the first phase and higher conversion in the second phase of the experiment. For the whole experiment the experimental groups had conversion that was lower by 1.97 and 2.64 respectively.

Food conversion, as an interaction of weight gain and feed consumption is the best indicator of the profitability of the production, which means the quality of nutrition and its ability to meet the specific and high needs of growing young animals. The piglets in the control group that were fed mixtures of standard composition of raw materials achieved a conversion that is standard in pig industry: from 1.63-1.81 kg (Waaijenbergh, 1987; Puača, 1970), and 1.69-1.95 kg (Dabetić, 1999), as much as 2.05-2.18 kg (Kovčin and Pejić, 1988; Grujić, 1998). The growing piglets of the two experimental groups had a lower conversion in the first phase of the experiment, while the conversion in the second phase was better. Talking about the whole experiment, the experimental groups had almost identical food conversion (Graph 3).

Summing the results of the whole experiment, it can be stated that the semisubstitution of maize with by-products obtained from the manufacture of tomatoes, peppers and grapes, especially of 3%, has no negative effects on the production results of the weaning and growing piglets.

CONCLUSION

Based on the results from the examination of the possibilities of substitution of maize, as energetic feed, with by products obtained from the manufacture of tomatoes, peppers and grapes in the

nutrition of weaning and growing piglets over the production results and health it can be concluded that:

Semisubstitution of maize with by products obtained from the manufacture of tomatoes, peppers and grapes, especially of 3%, has no negative effects over the production results of the weaning and growing piglets.

As a whole, the applied treatments do not negatively affect the production results and the health condition of different categories of pigs, which advocates the semisubstitution of maize with by products obtained from the manufacture of tomatoes, peppers and grapes.

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SAŽETAK

U cilju ispitivanja mogućnosti zamjene kukuruza, kao energetskog hraniva, nus proizvodima dobivenim pri obradi rajčica, paprika i grožđa u hranidbi različitih kategorija svinja na proizvodne rezultate i zdravstveno stanje provedeno je istraživanje hranidbe odbijene prasadi. Istraživanja su izvedena u proizvodnim uvjetima na svinjogojskoj farmi ZZ "Edinstvo" s. Čelopek iz Tetovskog, R. Makedonija gdje je organiziran pokus po grupno-kontrolnom sistemu. Pokus je izveden na prasadi nakon odbića u dobi od 28. do 30. dana i prosječne tjelesne mase 8.66 ± 0.21 - 8.84 ± 0.19 kg. Za pokus su korišteni križanci švedskog i holandskog landrasa ujednačenog genetskog potencijala. Svaka grupa u pokusu sastojala se od podjednakog broja muških i ženskih životinja. Pokus na prasadi u uzgoju izveden je na ukupno 72 grla podjeljenih u 3 grupe, a svaka grupa se sastojala od 12 grla različiti-

tog spola. Pokus je trajao ukupno 42 dana i podjeljen je na dvije faze po 21 dan. U pokusu su korištene dvije smjese i to potpuna smjesa za odbijenu prasad od 1. do 21. dana i potpuna smjesa za prasad u uzgoju od 22. do 42. dana pokusa. Eksperimentalne životinje kontrolne grupe hranjene su smjesama bez udjela ispitivanih nusproizvoda, dok su pokusne grupe dobivale hranu u kojoj je izvršena zamjena kukuruza različitim količinama navedenih nusproizvoda. U smjese za hranidbu prasadi u uzgoju dodano je 3 i 6% ispitivanih nusproizvoda. Djelomična zamjena kukuruza nusproizvodima dobivenim pri obradi rajčica, paprike i grožđa, posebno u količini od 3%, nema negativne efekte na proizvodne rezultate prasadi u uzgoju. U cjelini, primijenjeni tretmani ne utječu negativno na proizvodne rezultate i zdravstveno stanje različitih kategorija svinja, što pruža realnu mogućnost djelomične zamjene kukuruza nusproizvodima dobivenim pri obradi rajčica, paprika i grožđa.

Ključne riječi: hranidba, odbijena prasad, nusproizvodi dobiveni obradom rajčica, paprika i grožđa, proizvodni rezultati