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REGULAR ARTICLE

THE QUALITY OF SORGHUM GRAIN IN ASPECT OF UTILIZATION AMINO ACIDS IN PIGS

Matej Brestenský, Soňa Nitrayová, Peter Patráš, Jaroslav Heger*

Address: Animal Production Research Centre Nitra, Institute of Nutrition, Hlohovecká 2, 951 41, Lužianky, Slovak Republic

***** Corresponding author: m_brestensky@cvzv.sk

ABSTRACT

We used 6 cannulated gilts (initial BW 34.8 ± 0.7 kg) fitted with ileal T-cannula in terminal ileum for estimation ileal digestibility (ID) of nitrogen (N) and amino acids (AA) in sorghum. Animals were fed twice a day with tested diet in daily amount 75-80 $g.kg^{-0.75}$. Water was offered *ad libitum*. The tested sorghum was only protein source in the diet. After 6 days during which the animals were fed with experimental diet followed 24 hours collection of ileal digesta. We used Cr_2O_3 as indigestible marker in amount 0.3 % of diet. We calculated apparent and true ileal digestibility of AA and N using analytic estimated values of N, Cr_2O_3, and AA. True ID of AA in sorghum ranged between 64.8 % (glycine) and 88.6 % (tyrosine) ($P<0.05$). Ileal digestibility for lysine was 72.8 % ± 2.1. True ileal digestibility for essential amino acids (80.7 % ± 2.1) was similar in comparison with true ileal digestibility of nonessential amino acids (79.7 % ± 2.4). Apparent ileal digestibility of essential and nonessential AA was 73.6 % ± 2.1 and 71.4 % ± 2.4 respectively. Sorghum is full-value nutritional source for pigs comparable with other feeds.

Keywords: ileal digestibility, nitrogen, amino acids, sorghum, pigs

INTRODUCTION

Spite of the fact that sorghum is valuable source of energy, which contains in starch, in the former time sorghum was not used in pigs´ nutrition. The content of crude protein in sorghum is in range between 6.8 – 19.6 % depending on variety. Digestibility values of crude protein ranged from 49.5 to 70 % **(Nawar et al., 1970)** and from 30 to 70% **(Silano, 1977)**. Variability of amino acids content is relatively wide and depends of variety. Similarly like other cereals also sorghum is lysine deficiency.

Higher content of tannins, which have anti- nutritional effect, declines nutritive value of sorghum **(Salunkhe et al., 1982, 1990)**. High tannin levels in sorghum were responsible for lower digestibility of crude protein in poultry which fed sorghum with high content of tannins **(Longstaff and McNab, 1991)**. Tannins have inhibitory effect on digestible enzymes, trypsine, alpha amylase and lipase. The most influenced is digestibility of amino acids, than starch and at least the lipids **(Longstaff and McNab, 1991)**. Scientific works showed that sorghum varieties with low tannins content are appropriate feeds for pigs comparable with corn **(Brand et al., 1992, Douglas et al., 1993)**. Comparisons nutritive value of sorghum and corn showed that nutritive value of sorghum is 85 - 97 % of corn **(Cousins et al., 1997)**. Pigs fed sorghum with low content of tannins reached the same performance parameters in comparison with pigs fed corn **(Brand et al., 1990)**.

The object of this study was to estimate ileal digestibility of nitrogen and amino acids in sorghum as nontraditional feed for pigs.

MATERIAL AND METHODS

Using six gilts with initial BW 34.8 ± 0.7 kg, we estimated ileal digestibility of amino acids and nitrogen in sorghum. Gilts were fitted with ileal T-cannula in terminal ileum. Animals were individually housed in balance cages. After 14 days preliminary period during which the animals fed standard diet followed 6 days experimental period during which the animals were fed with tested diet. On day 7 we collected ileal digesta for 24 hours continuously per each hour.

Component and chemical composition of tested diet is in table 1. Tested diet contained sorghum in amount 95 % as only nitrogen source. We used chromium oxide as indigestible marker in amount 0.3 % of diet. Animals were fed twice daily at 7.00 and 16.00 h in daily amount 75-80 $g.kg^{-0.75}$. Water was offered *ad libitum*.

Table 1 Component and chemical composition of tested diet (g.kg^{-1} air dry basis)

Component		Analyzed content of nutrients	
Sorghum	958.00		
Sunflower oil	9.00	Dry matter	885.90
MCP	11.00	Crude protein	16.87
Calcium	13.00	Lysine	2.49
Salt	3.00	Threonine	4.68
Premix[1]	3.00	Methionine	1.45
Chromic oxide	3.00	Cysteine	1.68

[1] Supplied per kg of diet: vit. A 9 000 IU, vit. D3 1 500 IU, α– tocopherol 35.0 mg, vit. B1 1.7 mg, vit. B2 6.0 mg, vit. B6 2.5 mg, Ca-panthothenate 15.0 mg, niacin 38.0 mg, vit. K3 2.0 mg, biotin 0.12 mg, cyanocobalamin 0.03 mg, choline 156 mg, Fe 103.0 mg, Zn 116.5 mg, Mn 49.0 mg, Cu 40.0 mg, I 1.2 mg, Co 0.4 mg, Se 0.3 mg, lysine 3.82 g, methionine 0.8 g, threonine 1.72 g.

The samples of ileal digesta were collected in to polyethylene bags fitted to the cannulas. Ileal digesta after collection was acidified using 6M H_2SO_4 so that the pH reached 3.5 to minimalized microbial activity. Consequently the ileal digesta was frozen at –20°C and stored for following analyses.

In samples of diet and lyophilized samples of ileal digesta we estimated content of nitrogen using **AOAC (1990)** and content of chromic oxide according to the **Williams et al., (1962)**. The content of amino acids after acid hydrolyses with 6M-HCl and methionine with cysteine after oxidative hydrolyzes we estimated using automatic analyzer of amino acids AAA 400 (fy Ingos Praha).

Coefficients of apparent ileal digestibility of amino acids and nitrogen we calculated according to following pattern:

$$\text{Apparent ID (\%)} = 100 \times [1-(N_i \times C_d)/(N_d \times C_i)]$$

Where N_d a C_d is content of nutrient and chromic oxide in diet (g.kg^{-1} DM) a N_i a C_i is content of nutrient and chromic oxide in ileal digesta (g.kg^{-1} DM).

Coefficients of true ileal digestibility of amino acids and nitrogen we calculated according to following pattern:

$$\text{True ID (\%)} = \text{AID}+100*\text{IFL}/\text{AAd}$$

Where IFL is ileal endogenous flow of AA ($g.kg^{-1}$ DM) and AAd is content of amino acids in ileal digesta ($g.kg^{-1}$ DM).

The experimental data were subjected to ANOVA using Statgraphic Plus 3.1. package (version 3.1., Statistical Graphics Corp. Rockville, MD, USA). When significant value for treatment effect ($P<0.05$) was observed, the differences between means were assessed using Fisher's LSD procedure.

RESULTS AND DISCUSSION

True ileal digestibility of amino acids (Table 2) ranged between 64.8% (glycine) and 88.6 % (tyrosine) ($P<0.05$). There were no differences between true ileal digestibility of nonessential amino acids and digestibility of essential amino acids in tested sorghum. When we compared digestibility for lysine and methionine, digestibility for lysine was lower by 13 % ($P<0.05$). We observed no significant differences between lysine and threonine, threonine and methionine. We found different digestibility between sulphur amino acids. Ileal digestibility for cysteine was lower by 11 % ($P<0.05$) in comparison with methionine.

Table 2 Apparent and true ileal digestibility of amino acids and nitrogen in sorghum (%)

	Sorghum	
	Apparent ileal digestibility	**True ileal digestibility**
n	6	6
	mean SE	mean SE
N	66.0 ± 1.5	76.0 ± 1.5
Arginine	68.1 ± 1.4 ^{cd}	75.8 ± 1.4 ^{bc}
Histidine	71.5 ± 2.0 ^{cdef}	76.7 ± 2.0 ^{bc}
Isoleucine	78.5 ± 2.0 ^{gh}	84.5 ± 2.0 ^{def}
Leucine	83.0 ± 2.0 ^{h}	86.3 ± 2.0 ^{ef}
Lysine	58.7 ± 2.1 ^{b}	72.8 ± 2.1 ^{b}
Methionine	77.4 ± 2.4 ^{fgh}	84.5 ± 2.4 ^{def}
Phenylalanine	80.1 ± 3.7 ^{gh}	85.0 ± 3.7 ^{def}
Threonine	69.9 ± 2.1 ^{cde}	79.1 ± 2.1 ^{bcd}
Valine	75.0 ± 2.2 ^{efg}	81.7 ± 2.2 ^{cde}
Alanine	80.1 ± 1.8 ^{gh}	84.4 ± 1.8 ^{def}
Asp.acid	76.7 ± 1.2 ^{efgh}	83.7 ± 1.2 ^{def}
Cysteine	65.1 ± 2.5 ^{bc}	74.5 ± 2.5 ^{b}
Glu.acid	83.0 ± 1.8 ^{h}	86.4 ± 1.8 ^{ef}

Glycine	46.3 ± 3.1 [a]	64.8 ± 3.1 [a]
Proline	64.8 ± 4.6 [bc]	72.8 ± 4.6 [b]
Serine	74.2 ± 1.4 [defg]	82.2 ± 1.4 [cdef]
Tyrosine	80.8 ± 2.4 [gh]	88.6 ± 2.4 [f]
EAA	73.6 ± 2.1 [i]	80.7 ± 2.1 [i]
NEAA	71.4 ± 2.4 [i]	79.7 ± 2.4 [i]

[abcdefgh], Means in column followed by different letters were significantly different (P< 0.05)

[ij], Means in column followed by different letters were significantly different (P< 0.05)

N – nitrogen, EAA – essential amino acids, NEAA – non-essential amino acids

Values of ileal digestibility estimated in our study are lower in comparison with results of **Jondroville et al., (2001)**. Opposite our results **Nawar et al., (1970)** and **Silano et al., (1977)** reported lower values for digestibility of crude protein in sorghum, in ranged from 49.5 to 70 % and from 30 to 70 % respectively.

Digestibility of amino acids in sorghum is comparable with corn **(Taverner et al., 1981, Lin et al., 1987)**. **Bellaver and Easter (1998)** estimated in corn true ileal digestibility for nitrogen 78.9 %. This value is higher by 3 % in comparison with digestibility estimated in our study for sorghum. **Stein et al., (2001)** estimated in corn true ileal digestibility for nitrogen higher by 1 % in comparison with our results. True ileal digestibility for lysine in corn was 59.92 % **(Bellaver and Easter 1998)** and 77.3 % **(Stein et al. 2001)**. True ileal digestibility found in our study for lysine was 72.8 %. **Fan and Sauer (2002)** reported true ileal digestibility of lysine 77.1 % for barley.

The lowest digestibility estimated in sorghum was for glycine (P<0.05). Similarly like in our study **Belaver and Easter, (1998)** and **Stein et al., (2001)** reported the lowest ileal digestibility for glycine in corn. In comparison with sorghum true ileal digestibility of amino acids in corn was in range from 67.76 % (glycine) to 94.33 % (arginine) **(Belaver and Easter, 1998)** and from 73.2 % for glycine to 93.2 % for proline **(Stein et al. 2001)**.

The results of ileal digestibility in sorghum are comparable with other feeds which are common used in pig nutrition. **Stein et al., (2001)** reported ileal digestibility for essential amino acids 88.8 % in wheat and 84.0 % in barley and ileal digestibility for nonessential amino acids 91.01 % in wheat and 83.6 % in barley. Ileal digestibility for nitrogen reported in corn was 78.9 % **(Belaver and Easter, 1998)** in barley 78.3 % **(Fan and Sauer, 2002)** and 75.2 % **(Stein et al., 2001)** , but in wheat was higher by 13 % **(Stein et al., 2001)** in comparison with digestibility estimated in our study for sorghum.

Sorghum is full-value source of energy. Sorghum contains also other native compounds like phytate, tannins and cyanogen glycosides. Tannins have major anti nutritive effect which negative influence the nutrient digestibility of amino acids, starch and lipids **(Longstaff and McNab, 1991)**. The results of ileal digestibility for amino acids estimated in our study indicate that sorghum varieties with low content of tannins are appropriate source of energy and amino acids for animals. Sorghum varieties with low tannin content have the same nutritional value than corn **(Brand et al., 1990, 1992, Douglas et al., 1993, Shelton et al., 2004)**, wheat **(Stein et al., 2001)** and barley **(Stein et al., 2001, Fan and Sauer, 2002).**

CONCLUSION

The digestibility values of amino acids estimated in our study are comparable with values of other feeds which are common used in swine nutrition. Based on our results estimated in our study we conclude that sorghum is appropriate component to the feed stuffs for pigs. Regarding that digestibility of nutrients is affected with anti-nutritional factors it is important using sorghum varieties with low tannin content. Therefore, sorghum is possible to supply to the feed stuffs as full-value nutritional source.

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