Journal of Animal and Feed Sciences, 7, 1998, 213 – 217

A note on the use of Jerusalem artichokes (*Helianthus tuberosus* L.) in diets for growing pigs

J.L. Piloto, Vilda Figueroa, M. Macias, Maria Rosabal and J. Ly

Swine Research Institute
P.O. Box 1, Punta Brava
La Habana, Cuba

(Received 24 February 1998; accepted 25 March 1998)

ABSTRACT

Thirty-two Yorkshire Landrace x Duroc castrated male and female pigs with a live weight of approximately 14.6 kg were used to study the effect of maize meal substitution by Jerusalem artichokes 0, 33, 66 and 100% (on dry matter basis) in the ration for pigs aged from 61 to 96 days. The pigs were individually allocated to cages and distributed in a random block design with 4 treatments and 8 replications. Fresh Jerusalem artichokes were offered to the animals. Daily feed intake (kg DM/day), weight gain (g/day) and feed conversion (kg DM/kg gain) in increased maize substitution order were: 1.26, 1.22, 1.18 and 1.05; 483, 480, 403 and 283; 2.61, 2.54, 2.93 and 3.71. There were significant differences ($P<0.01$) between diets containing the highest maize substitution levels (66 and 100%) and the others, probably due to the bulking characteristics and digestion pattern of the tubers.

KEY WORDS: pigs, Jerusalem artichokes, performance

INTRODUCTION

Jerusalem artichoke (*Helianthus tuberosus* L.) tubers are frequently available in the field for pigs (Ruszczyc and Glapś, 1958; Cañas, 1990; Jost, 1992). Most of the experimental work done with the feeding of fresh (raw) Jerusalem artichokes to pigs has been with diets very low in tubers (Farnworth, 1994; Farnworth et al., 1995). In this connection Farnworth (1994) has suggested that young pigs consuming fresh tubers increased body weight gains, but decreased feed efficiency. Lynch (1991) observed a reduction in the growth rate in fattening pigs consuming 16% fresh tubers in the diet.

The purpose of this investigation was to determine whether large amounts of raw Jerusalem artichokes could be safely incorporated into diets of young pigs, and the effects of such diets on pig performance.

MATERIAL AND METHODS

Thirty-two Yorkshire Landrace x Duroc, 61 day-old castrated male and female pigs with a liveweight of approximately 14.6 kg were used. The animals were allocated in individual cages (0.75 x 0.50 m) provided with appropriate feeding troughs in an open house. The pigs were divided in a random block design with 4 treatments, each on 8 pigs to study the effect of the substitution of maize meal for 35 days by raw Jerusalem artichokes (0, 33, 66 and 100% on dry matter basis in the ration) on pigs performance.

After harvesting, the Jerusalem artichokes were placed in air-tight plastic bags and stored chilled (2-4°C). Raw tubers were supplied to the pigs after the other ingredients of the ration were offered at 9:00 am, and were available throughout the day. The animals had water *ad libitum* from automatic water nipples.

TABLE 1

Composition of the diets

Indices	Diets			
	JA0	JA33	JA66	JA100
Ingredients, g/kg dry matter				
maize meal	733.6	491.5	249.4	–
soyabean oilmeal	232.4	232.4	232.4	232.4
Jerusalem artichoke tubers	–	242.1	484.2	733.6
$CaHPO_4 \cdot 2H_2O$	25.0	25.0	25.0	25.0
NaCl	4.5	4.5	4.5	4.5
vitamins and trace elements[1]	4.5	4.5	4.5	4.5
Chemical composition, g/kg				
Dry matter	914.4	549.5	384.5	303.6
In dry matter:				
ash	60.2	70.5	81.7	91.4
organic matter	939.8	929.5	998.3	908.6
crude protein	170.3	168.7	167.1	165.3
crude fibre	32.1	41.4	50.7	70.2
NDF	107.1	112.1	122.1	132.2
Gross energy, kJ/10 g DM	161.3	161.4	161.6	161.6

[1] supplied per kg diet: 27 mg $FeSO_4 \cdot 7H_2O$, 10 mg $MnSO_4 \cdot 4H_2O$, 15 mg $CuSO_4 \cdot 5H_2O$, 85 mg $MgSO_4 \cdot 7H_2O$, 0.3 mg $CoSO_4 \cdot 7H_2O$, 0.1 mg KI, 0.02 mg Na_2SeO_3, 1600 I.U. vitamin A, 300 I.U. vitamin D_3, 2 mg thiamine, 2 mg riboflavine, 300 mg choline, 15 mg niacin, 5 mg pantothenic acid, 15 mg pyridoxine, 0.5 mg folic acid, 25 mg cyanocobalamine

The standard analyses of the diets were performed according to AOAC (1990) whereas the NDF content was estimated by the Van Soest and Wine (1967) method. An adiabatic bomb calorimeter was used to estimate the energy value of feeds. Table 1 shows the characteristics of the experimental diets.

Data were analyzed using analysis of variance procedures according to Duncan's new multiple range test (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Table 2 shows the performance of pigs.

Feed intake significantly decreased ($P<0.05$) with increasing levels of inclusion of the tubers in the diets. This was probably due to the bulking characteristics of the Jerusalem artichokes, which in turn modify the pattern of feed intake (Ly et al., 1994) by increasing the time the animals spent eating and the rate of eating. Jost (1982) suggested that voluntary feed intake of raw tubers increases with the age of pigs. In this experiment, intake of raw tubers ranged from 1.35 to 3.46 kg/day, however, total replacement of maize by Jerusalem artichokes resulted in only a 16.7% reduction of DM intake.

TABLE 2

Performance of pigs fed diets differing in tuber content[1]

	Diets				SE±
Indices	JA0	JA33	JA66	JA100	
Initial weight, kg	14.6	14.6	14.6	14.6	0.4
Final weight, kg	31.5[a]	31.4[a]	28.7[b]	24.5[c]	1.0**
Mean daily gain, g	483[a]	480[a]	403[b]	283[c]	24***
Feed conversion, kg DM/kg gain	2.61[a]	2.54[a]	2.93[b]	3.71[c]	0.20**

* $P<0.05$; ** $P<0.01$; *** $P<0.001$

a, b, c – $P<0.05$

[1] for composition see Table 1

Weight gains of pigs were significantly affected ($P<0.001$) by lower energy intake levels in diets where maize was substituted by higher levels of Jerusalem artichokes; the introduction of 242 g of Jerusalem artichokes in the diet did not negatively influence daily gain. This result does not support the findings of Lynch (1991), who observed a growth reduction in animals fed 190 g raw tubers per kg DM.

A significant increase ($P<0.01$) in the feed conversion index with high levels of the tubers in the diet could be explained by experimental evidence of low digestion of Jerusalem artichokes in pigs (Ly et al., 1995). Accordingly, Farnworth

(1994) reported that the daily gain in young pigs given low levels of raw Jerusalem artichokes was satisfactory, but a deterioration of feed efficiency was evident.

Overall, the substitution of greater levels of the conventional energy source by Jerusalem artichokes in diets for pigs negatively affected the performance of young pigs. Nevertheless, there were no significant differences in feed intake, daily gain and feed efficiency of animals fed 242 g Jerusalem artichokes per kg of dry diet. These observations suggest that even in young pigs performance is not impaired by partial substitution of the energy source by Jerusalem artichokes rich in fructans. This could be related to the *„sui generis"* gastrointestinal activity of microorganisms, which could supply substantial amounts of lactate rather than short chain fatty acids from fructans to the host (Graham and Åman, 1986), thus decreasing energy losses from fermentation. Moreover, a moderate concentration of fructans in the diet could increase the number of Bifidobacteria, which then might result in reduced diarrhoea (Farnworth, 1993).

REFERENCES

A.O.A.C., 1990. Official Methods of Analysis. 15th Edition. Association of Official Analytical Chemists. Washington DC

Cañas R., 1990. Use of topinambur (*Helianthus tuberosus* L.) and fish silage in intensive pig production (in Spanish). In: Utilization of feed resources in animal production of Latin American and Caribes, Workshop FAO. Havana (Cuba), pp. 10

Farnworth E.R., 1993. Fructans in human and animal diets. In: M.Suzuki, N.J. Chatterton (Editors). Science and technology of fructans. CRC Press Inc. pp. 257 – 272

Farnworth E.R., 1994. Feeding Jerusalem artichoke (*Helianthus tuberosus* L.) to pigs. J. Sci. Food Agric. 64, 217-221

Farnworth E.R., Modler H.W., Mackie D.A., 1995. Adding Jerusalem artichoke (*Helianthus tuberosus* L.) to weanling pig diets and effect on manure composition and characteristics. Anim Feed Sci. Technol. 55, 153-160

Graham H., Åman P., 1986. Composition and digestion in the pig gastrointestinal tract of Jerusalem artichoke tubers. Food Chem. 22, 67-76

Jost M., 1982. Feeds for pigs: topinambur and artificial meadow (pasture) (in French). Rev. Suisse Agric. 24 (3), 173

Lynch P.B., 1991. Evaluation of Jerusalem artichoke tubers in the diet of fattening pigs. In: Plant Biotechnology, U.C.C. Ltd. Cork, pp. 12

Ly J., Macías M., Figueroa V., Piloto J.L., 1994. A note on the pattern of feed intake in pigs fed Jerusalem artichoke (*Helianthus tuberosus* L.). J. Anim. Feed Sci. 3, 201-205

Ly J., Macías M., Figueroa V., 1995. Ileal and faecal digestibility of Jerusalem artichokes (*Helianthus tuberosus* L.) in pigs. J. Anim. Feed Sci. 4, 195-205

Ruszczyc Z., Glapś J., 1958. The use of silage from Jerusalem artichoke tubers in fattening pigs (in Polish). Rocz. Nauk rol. B-72, 565-571

Steel R.G.D. and Torrie J.H., 1980. Principles and Procedures of Statistics. 2nd edition McGraw-Hill Book Co., New York

Van Soest P.J., Wine R.H., 1967. Use of detergents in the analysis of fibrous feeds. IV. Determination of plant cell wall constitutents. J. Assoc. Off. Agric. Chem. 50, 50-54

STRESZCZENIE

Zastosowanie bulwy (*Helianthus tuberosus* L.) w dawkach pokarmowych dla rosnących świń

Doświadczenie przeprowadzono na 32 wieprzkach i loszkach Yorkshire Landrace x Duroc, o średniej początkowej masie ciała 14,6 kg, od 61 do 96 dnia życia. W dawkach pokarmowych śrutę kukurydzianą zastępowano świeżą bulwą w ilości 0, 33, 66 i 100% (w przeliczeniu na suchą masę). Świnie trzymano w indywidualnych klatkach, tworząc 4 losowe bloki doświadczalne w 8 powtórzeniach. Dzienne pobranie paszy (kg s.m./dzień), przyrosty (g/dzień) i wykorzystanie paszy (kg s.m./kg przyrostu) w miarę zwiększania udziału bulwy w dawkach były następujące: 1,26; 1,22; 1,18 i 1,05; 483, 480, 403 i 283; 2,61; 2,54; 2,93 i 3,71. Stwierdzono istotną różnicę ($P< 0,01$) pomiędzy dawkami, w których bulwy zastąpiono kukurydzą w największej ilości (66 i 100%) a pozostałym, co prawdopodobnie spowodowane było objętością i stopniem trawienia bulwy.