Indian Journal of Animal Sciences **95** (12): 1138–1144, December 2025/Article
https://doi.org/10.56093/ijans.v95i12.173008

Effect of crude fibre levels and sources on nutrient utilization and growth performance of pigs

KANAK CHANDRA BARMAN[✉1], KESHAB BARMAN[2], ASHOK KUMAR VERMA[3], SUNIL EKANATH JADHAV[4], NARAYAN DUTTA[5], PRAMOD CHAUDHARY[6], RAJIB KUMAR DAS[7] and JAKIR HUSSAIN[8]

ICAR-Indian Veterinary Research Institute, Izatnagar-243 122, India

Received: 03 November 2025; Accepted: 13 April 2026

ABSTRACT

The study was conducted to study the effect of high fibre diets containing silages of maize (MS) and vegetable waste (VS) on the performance of growing-finishing pigs. Twenty-four castrated male piglets (Hampshire X Ghungroo; about 48 days old, 8.88 ± 0.15 kg BW) were randomly allotted into three groups as normal fibre basal diet (NF-BD), high fibre maize silage (HF-MS) and high fibre vegetable waste silage (HF-VS) where pigs in NF-BD group were fed basal diet for grower (BDG) and basal diet for finisher (BDF), HF-MS group were fed maize silage diet for grower (MSG) & maize silage diet for finisher (MSF) and HF-VS group were fed vegetable waste silage diet for grower (VSG) and vegetable waste silage diet for finisher (VSF), respectively for growing and finishing phases. The basal diets BDG (6.28% CF) and BDF (8.43% CF) were prepared without silages; whereas MSG (8.17% CF) and MSF (10.31% CF) diets contained maize silage (MS) and the VSG (8.03% CF) and VSF (10.0% CF) diets contained vegetable waste silage (VS) as additional fibre sources to increase the crude fibre (CF) level. Feeding high fibre diets (8-10% CF) containing silages to growing-finishing pigs had non-significant effect on daily intake and digestibility of nutrients (P>0.05), however higher CF levels showed significant reduction in the CP intake (P<0.05) per kg $W^{0.75}$ during the growing period. The N-balance was comparable (P>0.05) across the groups except for the excretion of faecal and urinary N in HF-MS and HF-VS groups, respectively during the finisher phase. Net gain and ADG were significantly higher (P<0.05) in basal and VS diet-fed groups. FCR values differed significantly (P<0.001) across the treatment groups, where HF-MS showed higher values followed by HF-VS and NF-BD groups. The cost (Rs/kg weight gain) was significantly lower in the NF-BD and HF-VS groups than in the HF-MS group. This study revealed that the pigs fed vegetable waste silage-based diet (8-10% CF) performed better than the maize silage-based diet at similar CF level and the overall production performance of crossbred pigs fed vegetable waste silage-based diet is at par with low fibre basal diet (6-8% CF).

Keywords: Fibre level, Growth performance, Maize silage, Pig, Vegetable waste silage

Dietary fibre (soluble fibre or insoluble fibre) have a significant impact on nutrient digestibility (Hogberg and Lindberg 2004). Crude fibre is composed of cellulose, hemicellulose and lignin in the plant cell wall and is fermented by a large number of microorganisms in the caecum and colon predominantly to short-chain fatty acids (SCFA) which are then absorbed in the intestine (Ngoc *et al*. 2012). Among the SCFA, butyric acid improves gut mucosal health and immune system of pigs besides its role in energy supply to the gut ecosystem. Furthermore, high-fibre diet increases cellulolytic bacteria in the large intestines of pigs (Anugwa *et al*. 1989) and dietary fibre has prebiotic effects in pigs and improves the gut-associated immune system (Lindberg 2014). On the other hand, diets having higher fibre content may have adverse effects on voluntary feed intake (due to more gut fill) and nutrient digestibility in young pigs (Kyriazakis and Emmans 1995, Zhang *et al*. 2013). Similarly, higher non-starch polysaccharides (NSP) encapsulate nutrients and hamper their accessibility to digestive enzymes for hydrolysis (Wenk 2001).

A diverse range of natural fibre-rich ingredients are included in pig ration. Fibrous crop by-products, forages and roots including cassava, citrus pulp, konjac flour and sweet potato are frequently used for pigs feeding in sub-tropical and tropical countries (Jarrett and Ashworth, 2018). Crude fibre-rich feed resources are relatively economical

Present address: [1]Assistant Professor, Department of Animal Nutrition, CVSc, AVFU, Khanapara, Guwahati-781022. [2]Principal Scientist, Animal Science Division, ICAR HQ New Delhi. [3]Retired Principal Scientist and Head, Animal Nutrition Division, ICAR-Indian Veterinary Research Institute, Izatnagar-243 122. [4]Principal Scientist, Animal Nutrition Division, ICAR-Indian Veterinary Research Institute, Izatnagar-243122. [5]Principal Scientist Animal Nutrition Division, ICAR-Indian Veterinary Research Institute, Izatnagar-243122. [6]Government Veterinary Officer, Vinakkhal, Tehri Gahrwal, Uttarakhand-248001. [7]Technical Officer, ICAR-NRC on Pig, Rani, Guwahati. [8]Professor, Department of Livestock Production and Management, CVSc, AAU, Khanapara, Guwahati-781022.[✉]Corresponding author; email: kcbarman74@gmail.com

and have a special role in the nutrition and health of pigs. Although high-fibre diets do not always improve pig performance, they provide an effective and economical use of locally grown feedstuffs and hence contribute to sustainable swine production. Corn silage at the rate of 20–40% dry matter in the diet of finishing heavy pigs had little or no adverse effects on growth and carcass traits (Galassi *et al*. 2007, Capraro *et al*. 2014, Zanfi *et al*. 2014). Edwards (2002) reported that forage like lucerne, maize, wheat, barley and vegetable waste can be fed to pigs either fresh, dried or as silage. Studies have been conducted to reduce the production cost of finishing pigs by incorporating vegetable waste (Potshangham *et al*. 2018), corn silage (Rajic 1988) and green berseem (Kumar and Patel 2016) in pigs diets. The relative benefits and drawbacks of fibre-rich feed in pig diets depend on the stage of the production and type of dietary fibre present. The nutritive value of high-fibre feed, their potential inclusion level in the diet and consequences for growth performance of pigs are essential criteria to study.

Hence, the present experiment was conducted to evaluate the effect of diets containing higher crude fibre levels sourced from maize and vegetable waste silages on nutrient utilization and growth performance of growing and finishing pigs.

MATERIALS AND METHODS

Location of study and management of animal welfare: The study was carried out at ICAR-National Research Centre on Pig, Rani, Guwahati, Assam, India located at an altitude of 467m above MSL and latitude 25° 48' 30" N and longitude 91° 17' 49" E. The experiment was carried out with prior approval of the Institutional Animal Ethics Committee (approval number NRCP/CPCSEA/1658/IAEC-76). Experimental pigs were housed in a well-ventilated sty with the provision of hygienic and uniform management conditions. Drinking water was made available round the clock and feeding was done twice daily at 9:00 AM and 3:00 PM. They were also treated against endo- and ectoparasites and vaccinated against swine fever before starting the experiment.

Preparation of silage from vegetable waste and maize fodder: Silages were prepared using maize fodder (*Zea mays*, variety-hybrid maize 4750) and vegetable waste separately, in silage bags (50kg capacity) following standard procedure at regular intervals. Vegetable wastes, mainly the old mature discarded leaves and stems of cabbage (*Brassica oleracea var. capitata*) and cauliflower (*B. oleracea var. botrytis*), were collected (approximately cabbage: cauliflower: 60:40 on raw basis) from vegetable markets and left over from the farmers' field. The vegetable wastes were chaffed and kept in open-air sunshine for one day to reduce the moisture content to 65-70 per cent. The maize fodder was harvested at 3 months after sowing (cut 30 cm above ground) and wilted to reduce the moisture content to 65-70 per cent before chopping. Fodder and vegetable waste were chaffed at 2-3cm size with a chaff cutter machine. Jaggery (gur) was added as fermentative accelerator @ 3kg per 100kg of raw chaffed vegetable wastes and maize fodder following the same silage preparation protocol. Common salt was mixed at the rate of 250g per 100kg of raw chaffed item to improve the palatability of silages. The material was then packed tightly into a 50 kg capacity silage bag (thickness 100-120 microns; size 23x55 inches) separately and properly tied to maintain anaerobic conditions. The bags were then stored in a room and opened for sampling and feeding pigs after 4 weeks. Silages were examined for DM content; colour, pH and presence of fungus before incorporation in the ration. Unsuitable silages were simply avoided for feeding pigs.

The proximate composition of all the feed ingredients, residues, faecal and urine samples were analysed as per the methods described by AOAC (2012) while NDF and ADF were analysed as per Van Soest *et al.* (1991). The energy content of feed ingredients was calculated from the proximate composition referring to the formula mentioned by NRC (2012).

Experimental animals and design: Twenty-four castrated male crossbred piglets (Hampshire x Ghungroo) of 48 ± 5d old with an average BW of 8.88 ± 0.15kg were selected for the study. The piglets were randomly distributed into three treatment groups *viz.,* diets containing normal fibre level without silages (NF-BD), high fibre diets with maize silage (HF-MS) and high fibre diets with vegetable waste silage (HF-VS) comprising eight piglets in each in an experiment based on Completely Randomized Design. Two basal diets without silage (BDG and BDF), two diets with maize silage (MSG and MSF) and two diets with vegetable waste silage (VSG and VSF) were prepared as per nutrient requirements of swine ICAR (2013) with varying levels of crude fibre. The CF level in basal diets BDG (6%) and BDF (8%) were as per BIS (1986) standard for grower and finisher pigs, respectively, whereas MSG and VSG contained two-point higher CF (8%) than BDG and similarly, MSF and VSF contained two-point higher CF (10%) than BDF diets. Diets BDG and BDF were assigned for NF-BD; MSG and MSF for HF-MS; and VSG and VSF for HF-VS groups, respectively for the growing and finishing phase. The animals were fed till they attained 70 kg live weight.

Two digestions cum metabolic trials (7 days duration) were conducted, one at the attainment of 35kg body weight and another at the end of the feeding trial to estimate the nutrient digestibility and plan of nutrition. Total feed intake, live weight gain and FCR of experimental pigs were recorded and feed cost per kg weight gain was calculated.

Statistical analysis: The data obtained were subjected to one-way ANOVA (Snedecor and Cochran 1989). Paired comparisons were performed using Tukey's test and were considered significant at $P<0.05$.

RESULTS AND DISCUSSION

Chemical composition of experimental diets: The chemical composition and nutrient content of different diets fed to growing-finishing pigs is presented in Table

Table 1. Ingredients composition and nutrient content of experimental diets (% DM basis) for feeding growing and finishing pigs

Parameters	Growing period (Weaning to 35 kg BW)			Finishing period (35-70 kg BW)		
	BDG	MSG	VSG	BDF	MSF	VSF
Maize (crushed)	58	53.50	51.50	45.5	44.50	42.00
Soybean meal	12	6.50	4.50	8.5	7.00	3.50
GNC (expeller)	12.5	3.50	7.00	8	8.00	7.00
Wheat bran	15.5	20.00	16.00	36	15.00	11.00
VWS	0	0.00	18.50	0	0.00	34.00
MWS	0	14.00	0.00	0	23.00	0.00
Oil	0	0.50	0.50	0	0.50	0.50
Mineral and vitamin mixture*	1.5	1.50	1.50	1.5	1.50	1.50
Common salt	0.5	0.50	0.50	0.5	0.50	0.50
Nutrient composition (% DM basis)						
Organic matter	93.06	92.90	92.20	92.35	92.42	91.20
Crude protein	19.05	18.72	18.53	17.04	17.23	17.73
Ether extract	2.63	2.63	2.71	2.55	2.57	2.72
Crude fibre	6.28	8.17	8.03	8.43	10.31	10.00
Total ash	6.94	7.10	7.80	7.65	7.58	8.80
Nitrogen free extract	65.10	62.88	62.43	64.33	61.81	60.26
NDF	20.99	22.26	20.69	27.41	26.00	21.85
ADF	6.23	8.37	8.81	7.68	10.57	11.53
ME (Mcal/kg)**	3.22	3.17	3.16	2.89	2.97	3.02
Calorie:Protein	169.10	169.29	170.71	169.65	172.38	170.38

BDG: Basal diet for grower; MSG: Grower diet with maize silage; VSG: Grower diet with vegetable waste silage; BDF: Basal diet for finisher; MSF: Finisher diet with maize silage; VSF: Finisher diet with vegetable waste silage; *Each 1 kg contains: vitamin A 750,000 IU; vitamin D3 150,000 IU; vitamin C 0.75g; vitamin E 0.25g; Niacin 0.5g; Biotin 0.005g; calcium 300g; phosphorus 60g; magnesium 7.2g; manganese 1.5g; iodine 0.15g; sodium 4g; sulphur 7.2g iron 3 g; zinc 3.7 g; copper 1.2 g; cobalt 0.10 g; selenium 0.02 g; L-lysine mono HCl 2g; DL- methionine 1g; protein hydrolysate 1.2g; BHT 0.25g; Betaine 0.75g; **Calculated values.

1. The CP (%) and ME (kcal/kg) content in grower diets were comparable and were 19.05 and 3221; 18.72 and 3169 and 18.53 and 3163, respectively for BDG, MSG and VSG diets with corresponding Calorie-Protein ratio (C:P) as 169, 169 and 170. The CF (%) content in the grower diets was assessed as 6.28, 8.17, 8.03, respectively in BDG, MSG and VSG diets. Diets fed in finisher phase contained CP (%) 17.04, 17.23 and 17.73 with C:P ratio of 170, 172 and 170, respectively in BDF, MSF and VSF diets. The content of CF (%) in finisher diets were 8.43, 10.31 and 10.0, respectively for BDF, MSF and VSF diets. The other proximate compositions were comparable among the diets. The ADF contents were higher in diets containing silages than basal diets. While the total ash content was higher in diets containing vegetable silage as a fibre source.

Nutrient intake and apparent nutrient digestibility: The mean body weight (kg) and $W^{0.75}$ (kg) of pigs were similar in both the metabolic trials across the treatment groups. The intake of DM and OM (g/d or g/kg $W^{0.75}$) was numerically higher in the NF-BD group during the grower phase and in HF-VS during the finisher phase. The CP intake (g/d) followed a similar trend as the DM and OM, whereas CP intake (g/kg $W^{0.75}$) was significantly higher in NF-BD group than in the other groups. Feeding high-fibre diets (8 -10% CF) containing maize silage and vegetable waste silage to growing-finishing pigs had no significant effect on DM, OM and CP intake (g/d or g/kg $W^{0.75}$), but higher CF levels significantly reduced the CP intake per kg metabolic body weight during grower phase (Table 2). Likewise, the dietary group (HF-VS) that received vegetable waste silage as a fibre source (8% and 10% CF levels) was found to be better than the maize silage-supplemented dietary groups (8% and 10% CF levels) in terms of digestibility of different nutrients. The trivial variation in digestibility of different nutrients might be due to the varying CF levels in the experimental diets in the grower and finisher phase and fibre source or level of lignification. Very limited literature is available related to the use of vegetable and maize silage for feeding pigs to compare data generated in the present studies. Jorgensen *et al.* (2012) reported a significantly lower apparent total tract digestibility (ATTD) of DM and energy ($p<0.05$) of ration containing clover-grass (NSP 38.5%), clover-grass silage (NSP 4.10%) and pea-barley silage (NSP 39.7%) than the basal diet (NSP 16.50%). Similarly, ATTD of DM, OM, CP and GE were significantly reduced when the level of wheat bran was increased in the diet (Wilfart *et al*. 2007). Le Gall *et al.* (2009) found that the digestibility of nutrients including energy and organic

Table 2. Effect of crude fibre level and sources on nutrient intake and apparent nutrient digestibility in different treatment groups in growers and finisher pigs

Parameters	Grower phase					Finisher phase				
	NF-BD	HF-MS	HF-VS	SEM	P value	NF-BD	HF-MS	HF-VS	SEM	P value
					Nutrient intake					
DMI (g/d)	1360	1295	1350	37.06	NS	2327	2320	2365	14.80	NS
DMI (g/kgW$^{0.75}$)	93.02	89.31	89.06	0.88	NS	92.60	95.58	96.74	1.19	NS
OMI (g/d)	1265.62	1203.06	1244.70	38.08	NS	2148.83	2144.14	2156.88	11.19	NS
OMI (g/kg W$^{0.75}$)	86.57	83.03	81.99	0.79	NS	85.51	88.16	88.23	1.02	NS
CPI (g/d)	259.08	242.42	250.16	8.34	NS	396.49	389.74	419.31	4.95	NS
CPI (g/kg W$^{0.75}$)	17.72^{a}	16.72^{b}	16.48^{b}	0.25	*	15.78	16.47	17.15	0.29	NS
					Apparent nutrient digestibility (%)					
DM	84.44	77.24	80.03	1.48	NS	77.70	66.47	69.90	2.35	NS
OM	84.86	79.77	81.56	1.25	NS	78.79	67.66	71.78	2.29	NS
CP	80.34	71.21	74.86	1.93	NS	78.47	68.60	74.88	1.98	NS
EE	61.11	49.37	50.08	5.10	NS	63.52	52.72	59.74	2.76	NS
CF	44.19	38.45	43.26	3.32	NS	58.98	49.06	54.37	2.97	NS
NFE	90.59	89.60	90.15	0.59	NS	82.07	70.86	74.07	2.31	NS
NDF	69.24	47.98	57.06	4.29	NS	47.93	43.03	45.18	2.33	NS
ADF	16.85	21.21	17.30	3.12	NS	22.21	23.85	29.46	2.66	NS

NF-BD: Basal diet (6% CF for grower and 8% CF for finisher pigs); HF-MS: Diet with maize silage (8% CF for grower and 10% CF for finisher pigs); HF-VS: Diet with vegetable waste silage (8% CF for grower and 10% CF for finisher pigs); NS: Not significant (P>0.05); [a, b, c] Means bearing different superscripts within a row in particular phase differ significantly (*p<0.05)

matter decreased significantly as the dietary fibre increased in the diets. Hogberg and Lindberg (2004) had reported that the impact of fibre level on nutrient digestibility may vary with the properties and composition of fibre, whether it contains more soluble or insoluble fibre. It has also been reported that high-fibre diets may have adverse effects on voluntary feed intake and digestibility of nutrients in young pigs (Kyriazakis and Emmans 1995, Zhang *et al*. 2013).

Energy metabolism and nitrogen balance: The GE intake (kcal/d) was found to be non-significant (P>0.05) in the NF-BD group at the grower phase while the intake was lower in the finisher phase as compared to other groups. However, DE and ME intake (kcal/day) in both the digestion trial were numerically highest (P>0.05) for NF-BD group and lowest in HF-MS group. The daily intake (kcal) of GE, DE and ME were statistically comparable (P>0.05) among the treatment groups (Table 3). The N intake (g/day), N absorbed (g/day), total N excreted (g/day), N retained in body (g/day), N retained (%) were comparable (p>0.05) among the treatment groups in both the trial; whereas, faecal-N excretion (g/d) was significantly higher (P<0.05) in HF-MS (18.91) than NF-BD group and urinary-N excretion (g/d) was significantly higher (P<0.05) in HF-VS group than other groups. Considering the intake and digestibility of nutrients, the NF-BD group with 6 and 8% CF levels respectively for the grower and finisher phase revealed a better plane of nutrition followed by the HF-VS group (8 and 10% CF). The average daily feed intake in the growing period (22-35kg BW) by the experimental pigs was comparable to the recommended level of ICAR (2013) for pigs of 22-38kg BW (1350g/d) while the daily average feed intake in finisher phase (36-70kg BW) was higher than the levels mentioned by ICAR (2013) for pigs 39-56kg BW.

Growth performance and feed efficiency: Dry matter intake (g/d) was significanly lower (P<0.001) in NF-DB group in comparison to other groups although it was comparable (P>0.05) in HF-MS and HF-VS groups (Table 4). The net gain (kg) and ADG (g/d) were significantly higher (P<0.05) in the NF-BD and HF-VS groups than HF-MS dietary group, while NF-BD and HF-VS were statistically similar (P>0.05). FCR was significantly lower (P<0.001) in pigs of the basal diet group (NF-BD) followed by the HF-VS group. The pigs that were fed a diet containing maize silage (HF-MS) recorded significantly higher (P<0.001) FCR. Body weight gain and ADG in the overall experimental period (8-70kg BW) were found to be higher (P<0.05) in pigs fed basal diet (normal CF level, 6 and 8%) or high fibre VS diet (8 and 10% CF) and comparatively lower in pigs fed high fibre MS diet (8 and 10% CF). However, FCR was found higher (P<0.001) in the high-fibre maize silage-fed group. The effect of high-fibre diets on pig performance might be due to the chemical and physical properties of the fibre sources and their degree of lignification besides their level of inclusion in the diet (Wenk, 2001). Numerous reports revealed that increased dietary fibre levels in the diets drastically reduced ADG and FCE (Agyekum *et al*. 2014, Yu *et al.* 2016, Bixia *et al.* 2018). Contrary to the present findings, Shin *et al.* (2007) observed no significant differences in

Table 3. Effect of crude fibre level and sources on energy kinetics and nitrogen balance in different treatment groups in growers and finisher pigs

Parameters	Grower phase					Finisher phase				
	NF-BD	HF-MS	HF-VS	SEM	P value	NF-BD	HF-MS	HF-VS	SEM	P value
Energy kinetics (Kcal/kg)										
GE intake	5826.91	5552.83	5749.53	175.84	NS	9795.04	9839.58	9941.04	57.14	NS
FE voided	1162.47	1271.04	1238.45	54.20	NS	2102.34	3143.95	2777.80	214.29	NS
DE intake	4664.44	4281.79	4511.08	158.48	NS	7692.70	6695.63	7163.24	217.93	NS
ME intake	4337.93	3896.43	4150.20	313.62	NS	7128.67	6041.45	6527.51	233.80	NS
Nitrogen balance										
N intake (g/d)	41.45	38.79	40.02	1.34	NS	63.44	63.96	67.09	0.79	NS
N voided in faeces (g/d)	8.43	11.17	10.34	0.62	NS	12.84[b]	18.19[a]	15.70[ab]	1.04	*
N absorbed (g/d)	33.02	27.62	29.68	1.63	NS	50.61	45.77	51.39	1.24	NS
N excreted in urine (g/d)	14.29	14.42	13.52	0.31	NS	16.23[b]	16.46[b]	18.29[a]	0.43	*
Total N excreted (g/d)	22.72	25.59	23.86	0.75	NS	29.07	34.65	34.00	1.20	NS
Total N retained (g/d)	18.73	13.20	16.16	1.56	NS	34.38	29.31	33.10	1.15	NS
N retained on total N intake (%)	45.19	34.00	40.39	2.73	NS	54.20	45.80	49.31	1.74	NS
N retained on N absorbed (%)	56.72	47.75	54.45	2.32	NS	67.93	64.01	64.34	0.97	NS

NF-BD: Basal diet (6% CF for grower and 8% CF for finisher pigs); HF-MS: Diet with maize silage (8% CF for grower and 10% CF for finisher pigs); HF-VS: Diet with vegetable waste silage (8% CF for grower and 10% CF for finisher pigs); NS: Not significant ($P>0.05$); [a, b, c] Means bearing different superscripts within a row in a particular phase differ significantly (* $p<0.05$)

average daily gain (ADG) and FCR among the crossbred finishing pigs (Landrace x Yorkshire x Duroc) fed with 3% ryegrass silage. The results obtained from the present study indicated that appropriate levels of dietary CF from selected sources could improve the growth performance of growing-finishing pigs.

Total feed intake and feed cost per kg weight gain: Total feed intake (kg) was significantly higher ($P<0.001$) in HF-MS and HF-VS groups, whereas total feed cost (INR) per pig was significantly lower ($P<0.001$) in HF-VS group (Table 4). Feed cost (INR) per kg weight gain was significantly lower ($P<0.05$) in the NF-BD and HF-VS groups than in the HF-MS group. Feeding vegetable waste silage was to be economical and comparable to conventional feeding in growing-finishing pigs with the feed cost per kg gain was 6.32% more in pigs fed maize silage than the conventional feeding. Reese (1998) had earlier remarked that feeding corn-soybean-based diets containing high-fibre feed resources at different levels increased total feed cost from 0 to $3.30 per sow during the gestational period. While Kumar and Patel (2016) revealed that the cost of total feed intake and cost per kg live weight gain was lowest in LWY finisher pigs when green berseem (*Trifolium alexandrinum*) replaced 50% concentrate in a kitchen waste-based diet. Similarly, Potshangham *et al.* (2018) had also reported that supplementation of cauliflower leaves to a basal diet reduced the cost of swine production. Rajic (1988) also reported that the cost per kg gain in fattening pigs fed with

Table 4. Body weight changes, feed efficiency and production economy among the treatment groups

Parameters	Dietary treatments†			SEM	P value
	NF-BD	HF-MS	HF-VS		
Initial body weight (kg)	8.90	8.91	8.81	0.07	NS
Final body weight (kg)	73.08	69.83	73.02	0.66	NS
Net gain (kg)	64.18[a]	60.91[b]	64.21[a]	0.63	*
ADG (g/d)	305.60[a]	290.06[b]	305.48[a]	2.99	*
DMI (g/d)	1275.36[b]	1358.81[a]	1367.44[a]	9.22	**
FCR	4.18[c]	4.69[a]	4.48[b]	0.05	**
Total feed intake (kg)	267.83[b]	285.35[a]	287.16[a]	1.94	**
Total feed cost (INR)	8522.52[a]	8586.60[a]	8349.96[b]	28.66	**
Feed cost per kg weight gain (INR)	132.84[b]	141.23[a]	130.29[b]	1.37	*

†NF-BD: Basal diet (6% CF for grower and 8% CF for finisher pigs); HF-MS: Diet with maize silage (8% CF for grower and 10% CF for finisher pigs); HF-VS: Diet with vegetable waste silage (8% CF for grower and 10% CF for finisher pigs); NS: Not significant; [a, b, c] Means bearing different superscripts within a row differ significantly (*$p<0.05$, **$p<0.001$); INR: Indian Rupee

corn silage was 25.59% less in comparison to the pigs fed with complete feed.

It may be concluded that crude fibre levels and sources in *in-vivo* studies had little effect on the intake and digestibility of nutrients as well as the plan of nutrition of growing-finishing pigs. VS and MS can be incorporated in the diet of pigs to increase CF levels up to 8% at the grower phase and 10% at the finisher phase without any deleterious effect on health. Feeding vegetable waste silage-containing diets to growing-finishing pigs was found to be more economical as compared to feeding maize silage diets at similar level of crude fibre.

ACKNOWLEDGEMENT

The authors are grateful to the Director, ICAR-NRC on Pig, Rani, Guwahati for providing unreserved access to experimental units and laboratory facilities. The authors also acknowledge the financial support of ICAR-Indian Institute of Maize Research, Ludhiana to do the experiment successfully.

REFERENCES

Agyekum A K, Woyengo T A, Slominski B A, Yin Y L and Nyachoti 2014. Effects of formulating growing pig diet with increasing levels of wheat-corn distillers dried grains with solubles on digestible nutrient basis on growth performance and nutrient digestibility. *Journal of Animal Physiology and Animal Nutrition* **98**(4): 651–658.

Anugwa F O, Varel V H, Dickson J S, Pond, W G and Krook L P. 1989. Effects of dietary fibre and protein concentration on growth, feed efficiency, visceral organ weights and large intestine microbial populations of swine. *The Journal of Nutrition* **119**: 879–886.

AOAC. 2012. *Official method of analysis*, 19th ed. Association of Official Analytical Chemists, Washington DC, USA.

Bixia L, Shouwen R, Yanfeng F, Feng T, Fang X and Wang X. 2018. Effects of different dietary crude fibre levels on the growth performance of finishing Su-Shan pigs. *International Journal of Animal and Veterinary Science* **12**(6): 165–168

Capraro D, Zanfi C, Bassi M, Pascotto E, Bovolenta S and Spanghero M. 2014. Effect of physical form of whole ear corn silage (coarse vs wet milled) included at high dietary levels (30 vs 40% dry matter) on performance of heavy finishing pigs. *Animal Feed Science and Technology* **198**: 271–278.

Edwards S. 2002. *Feeding Organic Pigs: a handbook of raw materials and recommendations for feeding practice*. Published by University of Newcastle, Newcastle upon Tyne, UK.

Galassi G, Malagutti L and Crovetto G M. 2007. Growth and slaughter performance, nitrogen balance and ammonia emission from slurry in pigs fed high fibre diets. *Italian Journal of Animal Science* **6**: 227–239.

Hogberg A and Lindberg J E. 2004. Influence of cereal non-starch polysaccharides and enzyme supplementation on digestion site and gut environment in weaned piglets. *Animal Feed Science and Technology* **116**: 113–128.

ICAR 2013. Nutrient requirement of swine, Indian Council of Agricultural Research, 2013

Jorgensen H, Carlson D and Laerke H N. 2012. Influence of forage inclusion in the diet on ileal and total tract digestibility. *Journal of Animal Science* **90**: 176–178.

Kumar R and Patel M. 2016. Studies on feeding green berseem (*Trifolium alexandrinum*) on growth performance and economics of finisher pigs raised on kitchen waste-based diet. *Journal Experimental Biology and Agricultural Science* **4**.

Kyriazakis I and Emmans G C. 1995. The voluntary feed intake of pigs given feeds based on wheat bran, dried citrus pulp and grass meal, in relation to measurements of bulk. *British Journal of Nutrition* **73**: 191–207.

Le Gall M, Warpechowski M, Jaguelin-Peyraud Y and Noblet J. 2009. Influence of dietary fibre level and pelleting on the digestibility of energy and nutrients in growing pigs and adult sows. *Animal* **3**(3): 352–359.

Lindberg J.E. 2014. Fibre effects in nutrition and gut health in pigs. *Journal of Animal Science and Biotechnology* **5**: 15.

Ngoc T T B, Hong T T T, Len N T and Lindberg J E. 2012. Effect of fibre level and fibre source on gut morphology and micro-environment in local (Mong Cai) and exotic (Landrace x Yorkshire) pigs. *Asian-Australian Journal of Animal Science* **25**(12): 1726–1733.

NRC 2012. *Nutrient Requirements of Swine*. 11th revised edition. National Research Council. Washington, DC: National Academy Press.

Potshangham C, Singh M, Sahoo S, Singh A, Gaur G, Patel B and Jadhav S. 2018. Effect of feeding cauliflower (*Brassica oleracea*) leaves on the growth performances and carcass characters of crossbred barrows (Landrace X Desi*). International Journal of Livestock Research* **8**(10): 184–196.

Rajic I, Sevkovic N, Maricic L and Manojlovic S. 1988. Maize corn silage in fattening pigs. *Acta Veterinaria (Yugoslovia)* **38** (4): 201–208

Reese D E. 1998. Dietary fibre in sow gestation diets-an economic analysis. *Nebraska Swine Report*, Lincoln, USA, p. 23. https://digitalcommons.unl.edu/coopext_swine/157

Shin S, Han Y, Cho J, Kim H, Chen Y, Yoo J, Whang K, Kim J and Kim I. 2007. Effect of silage on growth performance, blood characteristics and carcass quality in finishing pigs. *Korean Journal of Food Science of Animal Resources* **27**(4): 392–400.

Snedecor G W and Cochran W G. 1989. *Statistical methods*, 8th Ed., Iowa University Press, Ames, Iowa (USA).

Van Soest P J, Robertson J B and Lewis B A. 1991. Methods for dietary fibre, neutral detergent fibre and non-starch polysaccharides in relation to animal nutrition. *Journal of Dairy Science* **74** (10): 3583–3597.

Wenk C. 2001. The role of dietary fibre in the digestive physiology of the pig. *Animal Feed Science and Technology* **90**: 21–33.

Wilfart A, Montegne L, Simmins H, Noblet J and Van Miligan J. 2007. Effect of fibre content in the diet on the mean retention time in different segments of the digestive tract in growing pigs. *Livestock Science* **109**: 27–29.

Yu C, Zhang S, Yang Q, Peng Q, Zhu J, Zeng X and Qiao S. 2016. Effect of high fibre diets formulated with different fibrous ingredients on performance, nutrient digestibility and faecal microbiota of weaned piglets. *Archives of Animal Nutrition* **70** (4): 263–277

Zanfi C, Colombini S, Mason F, Galassi G, Rapetti L, Malagutti L, Crovetto G M and Spanghero M. 2014. Digestibility and metabolic utilization of diets containing whole-ear corn silage and their effects on growth and slaughter traits of heavy pigs. *Journal of Animal Science* **92**: 211–219.

Zhang W, Li D, Liu L, Zang J, Duan Q, Yang W and Zhang L. 2013. The effect of dietary fibre level on nutrient digestibility in growing pigs. *Journal of Animal Science and Biotechnology* **4**: 17.