

Research Application Summary

Effect of deep litter floor housing system on performance of pigs and pork quality

Kidega, K.,^{1*} Ndyomugenyi, E.K.² & Okello-Uma, I.¹

¹Department of Food Science and Post-harvest Technology, Gulu University, P.O. Box 166, Gulu, Uganda

²Department of Animal Production and Range Management, Gulu University, P.O. Box 166, Gulu, Uganda

*Corresponding author: kid.oliv@gmail.com

Abstract

Pork consumption is constrained by high-fat content with higher composition of saturated fatty acids. This study investigated the effect of deep litter floor housing system on performance of pigs and pork quality. Twelve three months old pigs were raised on deep litter floor (litter floor treated with Indigenous Micro-organisms (IMO) solution Vs untreated deep litter floor). Feed intake (FI), Weight gain (WG) and Feed conversion ratio (FCR) showed no significant ($P \leq 0.05$) difference for pigs raised on both litter floors. Amount of Saturated fatty acids (SFAs), Mono-unsaturated fatty acids (MUFAs), Poly-unsaturated fatty acids (PUFAs), Cis-fatty acids (CFAs), Trans-fatty acids (TFAs), and Omega-6, 7 and 9 fatty acids in pork from pigs raised on both litter floors significantly ($P \leq 0.05$) differed. Crude fat, protein, dry matter, and phosphorus content did not differ significantly ($P \geq 0.05$) in pork from pigs raised on both litter floors. IMO treatment did not affect ($P \geq 0.05$) the sensory attributes of pork. Research should be conducted on the mechanisms by which deep litter floor modifies fatty acids composition in pork.

Keywords: Deep litter, housing system, pig, performance, pork quality

Resume

La consommation de viande de porc est limitée par une teneur élevée en graisses et en acides gras saturés. Cette étude a examiné l'effet du système d'élevage sur litière profonde sur les performances des porcs et la qualité du porc. Douze porcs âgés de trois mois ont été élevés sur un sol à litière profonde (sol à litière traitée avec une solution de micro-organismes indigènes (IMO) ou sol à litière profonde non traitée). La consommation d'aliments (FI), le gain de poids (WG) et l'indice de consommation (FCR) n'ont montré aucune différence significative ($P \leq 0,05$) entre les porcs élevés sur les deux sols à litière. La quantité d'acides gras saturés (AGS), d'acides gras mono-insaturés (AGMI), d'acides gras poly-insaturés (AGPI), d'acides gras cis (AGC), d'acides gras trans (AGT) et d'acides gras oméga-6, 7 et 9 dans la viande de porc des porcs élevés sur les deux litières différait significativement ($P \leq 0,05$). Les teneurs en matière grasse brute, en protéines, en matière sèche et en phosphore n'ont pas différencié significativement ($P \geq 0,05$) dans le porc provenant de porcs élevés sur les deux sols de litière. Le traitement OMI n'a pas affecté ($P \geq 0,05$) les attributs sensoriels du porc. Des recherches devraient être menées sur les mécanismes par lesquels le plancher de litière profonde modifie la composition des acides gras dans le porc.

Mots clés : Litière profonde, système de logement, porc, performance, qualité du porc.

Introduction

Developing countries worldwide are making efforts to improve their food and nutrition security and livelihood through pig production amongst smallholder farmers in rural areas (IFPRI, 2002). Food and nutrition security particularly in Africa is still a global challenge due to the low pro-poor investment in agriculture and rural development (Van *et al.*, 2012). Pig rearing has the potential for raising household incomes for smallholder farmers especially women and it is increasingly contributing to improved nutrition and household livelihood in many regions of Africa where pork consumption and pig keeping are culturally acceptable (Ouma *et al.*, 2013). Organic animal products have received a significant attention in most developed countries in recent years as environmentally friendly products and are considered to be healthier and safer than those produced by intensive and conventional production system (Hansen *et al.*, 2006). Africa's pork consumption is growing, but is not yet as high as the global average and the growing demand for pork in the continent presents unique business opportunities and consumption is estimated to grow by an average of 3.3% until 2050 (FAOSTAT, 2011). Pork contains varying amounts of fat and the proportion usually ranges from 10-16% but it can be much higher depending on the level of trimming and various other factors (Wasilewski *et al.*, 2012). Like other types of red meat, pork is mainly composed of saturated fats and unsaturated fats present in approximately equal amounts (Nuernberg *et al.*, 2015). Nutritionists advocate for decrease in total fat intake, particularly of Saturated Fatty Acids and Trans-fatty acids which are associated with an increased risk of cardiovascular disease and some cancers (Iqbal, 2014). Consumption of pork and its products is constrained by high fat content with higher composition of saturated fatty acids. Saturated fatty acids cannot be easily utilized by the body and it is known to elevate blood cholesterol concentrations, thus increasing the risk and prevalence of coronary heart diseases in humans (Dugan *et al.*, 2015). The use of Indigenous Micro-organism (IMO) on deep litter floor housing system has been suggested to produce high lean pork with low fat content (Ndyomugenyi and Kyasimire, 2015). Despite the suggestion regarding the use of IMO in producing good quality pork, little work has been done to establish its (IMO) effectiveness. Therefore, this study aimed to evaluate the effect of deep litter floor housing system on performance of pigs and pork quality.

Materials and Methods

Study area. The study was carried out in Paicho and Koro sub-counties in Gulu and Omoro Districts in northern Uganda. The districts are located between longitudes 30° 21' east to longitude 32° east and latitude 2° north to latitude 4° north. The districts occupy 3,449 km² and receive an average rainfall of 1,500 ml per annum with a monthly average varying between 14 ml in January and 230 ml in August. The wet season normally extends to October with the highest rainfall in May, August and October. The dry season is from November through March. The average maximum temperature is 30°C with a minimum of 18°C (Ikwap *et al.*, 2014).

Experimental design and treatments. A Completely Randomized Design (CRD) was used for the study where twenty four- three months old healthy crosses of Large White and Landrace pigs were purchased with funding from Community Action Research Project (CARP+1) under RUFORUM from the existing pig farmers within the two districts and, randomly distributed into six piggy units where three were deep litter floor units with IMO treatment (experimental units) and the other three were deep litter floor units without IMO treatment (control). The bedding in all the units were laid systematically in layers on bare soil ground with charcoal as the first layer, followed by tree shoots, maize stalks, dry red soil mixed with lime and wood shavings. The IMO

solution was applied on daily basis in all the experimental units and all pigs were fed on growers' mash consisting of Maize bran (74 kg), Fishmeal (5 kg), Soybean meal (10 kg), Sunflower cake (5 kg), Lake Shells (4 kg), Bone ash (1 kg), Salt (0.5 kg) and Premix (0.05 kg).

Determining growth performance of pigs raised on IMO treated and untreated deep litter floor. The growth performance of pigs on both IMO treated and untreated deep litter floor was determined by measuring the weight gain (WG), feed intake (FI) and feed conversion ratio (FCR). To determine the WG, pigs were weighed at the beginning of the experiment and after every one week for 12 weeks using a spring balance weighing scale. The FI was determined weekly by subtracting the total feed left by pigs from the total feed given to the pigs in a week. Pigs in all units were fed and watered daily two times (in the morning and evening) by the host farmer under direct supervision of the researcher, the daily application of IMO solution on deep litter floor was also done by the host farmer. Pigs in all the units were given appropriate veterinary attention whenever bad health arose. The ratio of FI to WG was used to calculate the FCR.

Determination of pork quality characteristics from pigs raised on IMO treated and untreated deep litter floor. To determine pork quality characteristics and sensory attributes, one pig was randomly selected at the end of the study from each of the six units and slaughtered in a humane manner by Stunning using mechanical instrument (Council of Europe, 1991). Attributes of quality characteristics measured include; Fatty acid profiling, nutrient composition (protein, fat, ash, dry matter, crude fiber and phosphorus), back-fat thickness, taste, colour, texture, odour and overall acceptability. Health examination was done on all the pigs in both IMO treated and untreated deep litter floor units to identify any possible signs of infection before being selected for slaughter. Post-mortem meat inspection was done on all the carcasses by a qualified Veterinarian after slaughtering before picking the pork samples for laboratory analysis and sensory attributes evaluation.

Data analysis. Data for all the objectives were analysed using Statistical Package for the Social Sciences (SPSS) version 20.0 and One-way ANOVA was used to test the effect of deep litter floor housing system on FI, WG, FCR, Pork quality characteristics and pork sensory attributes from pigs raised on IMO treated and untreated litter floor. The means were separated by Least Significant Difference (LSD) Tests at 5 % significant level ($P \leq 0.05$).

Results

Growth performance of pigs raised on deep litter floor. Feed intake (FI), weight gain (WG) and feed conversions ratio (FCR) for pigs raised on both IMO treated and untreated deep litter floor houses were not significantly ($p \geq 0.05$) different (Table 1).

Table 1. Effect of deep litter floor on growth performance of pigs

Variables	Litter floor without IMO	Litter floor with IMO	LSD	P-value
Initial weight (kg)	13.713±2.47	15.626±3.696	0.452	0.714
Final weight (kg)	29.127±5.645	39.630±7.949	0.118	0.204
Weekly weight gain(kg)	17.420± 3.591	24.003± 4.775	0.032	0.053
Daily weight gain(g)	0.183± 0.045	0.287± 0.055	0.024	0.051
Feed intake (kg)	8.657± 1.702	9.747± 1.152	0.355	0.623
Feed Conversion Ratio	0.573± 0.123	0.413± 0.068	0.079	0.082

IMO= Indigenous Micro-organisms

Effect of deep litter floor on nutrient composition of pork. Deep litter floor treated or untreated with IMO did not affect ($P \leq 0.05$) the nutrient composition of pork (Table 2).

Table 2. Effect of deep litter floor on nutrient composition of pork (%)

Variables	Litter floor without IMO	Litter floor with IMO	LSD	P-value
Crude fibre	3.220± 2.120	1.570± 0.873	0.204	0.281
Crude fat	45.760± 10.304	35.490± 9.137	0.236	0.266
Crude protein	26.413± 5.776	27.263± 3.105	0.812	0.833
Ash content	1.360±0.226	1.277±0.117	0.551	0.601
Dry matter	67.480± 5.995	62.270± 7.697	0.408	0.407
Phosphorus	0.233± 0.021	0.213± 0.021	0.284	0.305

Carcass back-fat thickness of pigs raised on deep litter floor. Litter floor treated or untreated with IMO solution did not affect ($p \geq 0.05$) the back-fat thickness of pig carcass (Table 3).

Table 3. Effects of deep litter floor on carcass back-fat thickness (cm)

Variables	Litter floor without IMO	Litter floor with IMO	LSD	P-value
Neck 1st cervical vertebra	2.700±0.458	1.933±0.288	0.038	0.070
Over the shoulder	2.600±0.458	1.866±0.322	0.053	0.086
Beginning of the back	1.700±0.529	1.100±0.000	0.053	0.121
Centre of the back	0.967±0.551	0.900±0.265	0.839	0.859
Gluteus medius muscle	1.167±0.862	1.167±0.208	1.000	1.000
Thigh	1.233±0.737	1.100±0.361	0.763	0.792

Fatty acids composition in pork from pigs raised on deep litter floor. Most fatty acids (88.9%) found in pork from pigs raised on both IMO treated and untreated deep litter floor were unsaturated. Saturated fatty acids (SFAs), Mono-unsaturated fatty acids (MUFAs), Poly-unsaturated fatty acids (PUFAs), Trans-fatty acids (TFAs), Cis-fatty acids (CFAs) and Omega-6, 7 and 9 fatty acids differed significantly ($P \leq 0.05$) in pork from pigs raised on IMO treated and untreated deep litter floor (Table 4). However, no significant ($P \leq 0.05$) difference was observed in the composition of Omega-3 fatty acids in pork from pigs raised on both floors. The SFAs, MUFAs, TFAs, Omega-7 and 9 fatty acids were higher by 0.3%, 0.09%, 0.3%, 0.03% and 0.1% respectively in pork from pigs raised on deep floor without IMO treatment while USFAs, PUFAs, CFAs and Omega-6 fatty acid were higher by 0.4%, 0.5%, 0.4% and 0.5% respectively in pork from pigs raised on IMO treated deep litter floor.

Table 4. Fatty acids composition in pork from pigs raised on deep litter floor (%)

Variables	Litter floor without IMO	Litter floor with IMO	LSD	P-value
Saturated fatty acids	3.259± 0.931 ^a	2.926±0.657 ^b	0.002	0.007
Unsaturated fatty acids				
Mono-unsaturated fatty acids	3.830±0.504 ^a	3.744±0.167 ^b	0.017	0.050
Poly-unsaturated fatty acids	2.783±1.004 ^b	3.330±0.501 ^a	0.000	0.001
Trans-fatty acids	0.825±0.0378 ^a	0.478±0.055 ^b	0.000	0.001
Cis-fatty acids	6.626±0.399 ^b	7.027±0.664 ^a	0.000	0.001
Omega-3 fatty acids	0.561±0.085	0.440±0.070	0.165	0.128
Omega-6 fatty acids	2.764±0.628 ^b	3.283±0.389 ^a	0.000	0.000
Omega-7 fatty acids	0.498±0.011 ^a	0.469±0.014 ^b	0.033	0.045
Omega-9 fatty acids	3.788±0.253 ^a	3.674±0.106 ^b	0.000	0.002

Means within a row with different superscripts differ significantly ($p \leq 0.05$)

Conclusions

Deep litter floor whether treated with indigenous microorganism (IMO) solution or not treated does not affect the growth performance of pigs, nutrient composition of pork and back-fat thickness. Out of the 16 fatty acids identified in pork from pigs raised on both deep litter floor treated or not treated with IMO solution, over 88% were unsaturated. This indicates that this kind of pork is highly digestible and good for human consumption. Whether the deep litter floor was treated with IMO solution or not treated, the sensory attributes of fried and roasted pork with respect to colour, texture, odour, taste and overall acceptability were not affected.

Conclusion

Deep litter floor treatment with Indigenous Micro-organisms (IMO) solution does not affect pig's feed intake (FI), feed conversion ratio (FCR), carcass back-fat thickness, pork nutrient composition and sensory attributes but rather enhanced the composition of unsaturated fatty acids in pork and weight gain (WG) in growing pigs.

Recommendations

- Further research should be conducted to explore the mechanisms by which deep litter floor whether treated or untreated with IMO solution modifies fatty acids composition in pork.
- More studies should also be conducted to profile the amino acids in pork of pigs raised on IMO treated and untreated deep litter floor.
- The effectiveness of IMO in breaking down different deep litter floor bedding materials also needs further studies.
- There is need to enhanced community knowledge and uptake of IMO technology for pig production.

Acknowledgement

The authors with great gratitude acknowledge the funding from MASTERCARD through the Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) that facilitated the study and dissemination of the findings to the pig farmers in the study area. This paper is a

contribution to the 2019 Fifteenth RUFORUM Annual General Meeting.

References

- Dugan, R. E. M., Vahmani, P., Turner, D. T., Mapiye, C., Juárez, M., Prieto, N., Beaulieu, D. A., Zijlstra, R. T., Patience, F. J. and Aalhus, J. L. 2015. Pork as a source of Omega-3 (n-3) Fatty acids. *J. Clinical Medicine* 4: 1999–2011.
- FAOSTAT. 2011. FAO Statistics Division. Rome: Food and Agriculture Organization of the United Nations.
- Hansen, L. L., Claudi, M. C., Jensen, S. K. and Andersen, H. J. 2006. Effect of organic pig production systems on performance and meat quality. *Meat Sci* 74: 605–615.
- IFPRI. 2002. Reaching sustainable food security by 2020. Getting the priorities and responsibilities. Washington, D. C: International Food Policy Research Institute.
- Ikwap, K., Jacobson, M., Lundeheim, N., Owiny, D. O., Nasinyama, G. W., Fellstrom, C. and Erume, J. 2014. Characterization of pig production in Gulu and Soroti districts in northern and