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EFFECTS OF HERBAL MIX AND WEIGHT ASYMMETRY ON NUTRIENT DIGESTIBILITY, NITROGEN BALANCE AND BOWEL TRANSIT TIME OF GROWING PIGS

[1]C.P. NJOKU*, [1]A.A. AYOOLA, [2]O.E. OKE, [1]F.T. AWEDA, [1]T.R. AYANO AND [1]O. A. ADEYEMI

[1]Department of Animal Production and Health, Federal University of Agriculture, Abeokuta, Nigeria

[2]Department of Animal Physiology, Federal University of Agriculture, Abeokuta, Nigeria

*__Corresponding Author__: njokucp@funaab.edu.ng **Tel**:+2348023741145

ABSTRACT

Integrating herbs into livestock farming aligns with the global goals of sustainable livestock production, animal welfare and consumer health. This study investigated the nutrient digestibility, nitrogen balance and bowel transit time of pigs with different herbal mixes and weight asymmetry. Fifty-four (54) Large White pigs with mean weight of 15.33±0.2 kg, were assigned to nine treatments in a 3 x 3 factorial layout with each treatment consisting of three replicates of two pigs each. The pigs composed of three weight groups (homogenous light, homogenous heavy and heterogeneous weights) fed diets of different herbal mixes of leaf meals (no herbal mix, moringa-basil and neem-basil leaf meals). The ratio of the mixture of moringa or neem to basil leaves was 5:1. Bowel transit time data were obtained twice per week throughout the study duration. On the 12th week of the study, three pigs were selected from each treatment i.e., 1 pig per replicate and arranged in a clean disinfected metal metabolic cage. A 7-day adaptation period followed a 5-day period of quantification of feed intake, excreted faeces and urine. Data generated were subjected to a 2-way analysis of variance in a 3x3 experimental layout. Nutrient digestibility parameters except ash contents were not influenced ($p>0.05$) by the herbal mixes except ash contents. However, nitrogen intake, digestion and retention were significantly ($p<0.05$) influenced by dietary inclusion of herbal mix in the ration of growing pigs. The nutrient digestibility and nitrogen balance parameters of pigs were not influenced by weight asymmetry except faecal nitrogen. Herbal mix can be included in the ration of pigs in order to boost dietary mineral digestibility and nitrogen retentions.

Key words: Feed additives; weight; transit time; moringa; neem; nutrient digestibility

INTRODUCTION

In order to reduce the high cost of pig production in Nigeria, pigs can be maintained with inexpensive alternative feed sources that are nutritional and medicinal in nature rather than expensive

conventional feed ingredients and drugs in tropics and subtropics of the world, where cost of conventional feed ingredients and medication are escalating out of reach of an average farmer. Leaf meals made from neem (*Azadirachta indica,* NLM), moringa (*Moringa oleifera,* MOLM) and basil (*Ocimum gratissium,* OGM) could be integrated into the ration of domestic livestock solely or combined. The NLM and MOLM are distinguished by their high protein contents which range from 13% to 34% crude protein (CP) in NLM and 15% to 30% in MOLM on dry matter basis. Additionally, *Moringa oleifera* has an acceptable profile of essential amino acids, vitamins and minerals (Odetola *et al.,* 2012). Basil is a perennial crop available in Nigeria throughout the year. Over the past few years, medicinal plants and their extracts have been used in animal diets as feed additives in order to improve their performance, health and the quality of their products. The use of herbal plants is based on the wide range of their antimicrobial, antioxidant, and anti-coccidiostatic properties (Ly, 2008). There are also biological active components (essential amino acids, peptides, minerals and vitamins) in the herbal plants that can help to regulate animal behaviour and response to stress (Casal-Plana *et al.*, 2017).

Aggressive behaviour among pigs reared in groups can lead to compromised welfare from increase in stress levels and physical harms (injury), disease and death, with resultant economic losses for the farm (Hengyi *et al.*, 2023). Aggression is meant to establish hierarchy among group housed pigs. Once the hierarchy is formed, subservient pigs have long-term welfare-impairing problems that have been associated with physiological stress and decline immunity (Bostami *et al.*, 2015; Marchant-Forde and Marchant-Forde, 2005). Frequent deprivation of feed among the subservient pigs results in growth retardation, and deterioration in pork composition and quality, and as well as alteration in pigs' behaviours (Andersen *et al.*, 2000). The degree of the aggressive behaviour exhibited between the individuals could be determined by the degree of familiarity and weight differences among the group housed pigs (Bostami *et al.*, 2015). The importance of management strategies that could lead to reduction in the occurrence of aggressive behaviours during the rearing period cannot be overemphasised in pigs' husbandry and welfare. Thus, this present study was aimed at exploring the nutrient digestibility potentials, nitrogen retention and bowel transit time of growing pigs of similar weight groups fed diets containg herbal leaves mixes.

MATERIALS AND METHODS

The experiment was carried out at the Piggery Unit of the Directorate of University Farms, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria. Fifty-four (54) Large White breed of growing pigs with body weight range of 14.44 - 16.22 kg were bought from a commercial farm within Abeokuta metropolis. The pigs were grouped based on their body weight into 9 treatment groups with 3 replicates of 2 pigs per replicate. Two pigs in a replicate were housed together in a naturally ventilated

pen with floor dimension of 4 m by 3 m and equipped with concrete feeding and drinking troughs. Routine management practices were done on a daily basis, with fresh feed and water supplied *ad libitum* throughout the experimental period. Treatments one, two and three consisted of homogenous heavy weight pigs fed diets that had no herbal mix, diets with moringa-basil and neem-basil leaf meals respectively. Pigs on treatments four, five and six were homogeneous light pigs on diets containing no herbal mix, moringa-basil and neem-basil leaf meals, respectively. Those on treatments seven, eight and nine were heterogeneous weight pigs offered daily rations that contained no herbal mix, moringa-basil and neem-basil leaf meals, respectively. All the diets had 50% maize, 10% PKC, 2% fish meal, 6.9% wheat offal and 2% bone meal (Table 1).

The procedure involved in the determination of bowel transit time of pigs on the different treatment groups was as outlined by Platel and Srinivasan (2001). The daily rations of the pigs were mixed with ferric oxide red (0.5%) as an unabsorbable marker before being offered to the pigs. The time of first appearance of faeces with maker was recorded for the pigs in each replicate group as the transit time. This was carried out twice per week with an interval of five days throughout the study duration.

Metabolic Trial

On the 12th week of the experiment, three pigs were selected from each treatment and arranged in clean disinfected metal metabolic cages. A 7-day adaptation period was observed, then followed by 5 days quantification of feed intake and excreted faeces. Faeces were collected quantitatively and stored in a freezer until analysed. After the collection period, faeces samples were thawed, homogenised and dried in a forced air cabinet. The oven-dried faeces and feed materials were milled to 2mm particle size and analysed for proximate composition as described by AOAC (2000) protocols. Digestibility of nutrients in the experimental diets was determined using the formula:

$$\text{Nutrient Digestibility} = \frac{Nutrien\ in\ feed\ (g) - Nutrient\ in\ faeces\ (g)}{Nutrient\ in\ feed} X\ 100$$

Nitrogen Balance

During the metabolic study, faeces samples were collected quantitatively, weighed and frozen. Urine samples were also collected continuously over a 5-day period in a plastic container containing H_2SO_4 (10%, v/v) in order to prevent ammonia loss by keeping the pH of the aliquot below 3. A 20% aliquot part of the daily urine production was retained and stored properly in a freezer. Prior to analysis, the samples were thawed and mixed thoroughly, faecal samples were dried in a force air cabinet at 65°C. Sub-samples of oven-dried

faeces and feed were milled separately to 1 mm particle size and analysed for their proximate compositions, following the protocols of AOAC (2005).

Statistical Analysis

Data generated were subjected to two-way Analysis of Variance in a 3x3 factorial arrangement using SAS (2002). Significantly ($P< 0.05$) different means among the variables were separated using New Duncan's Multiple Range Test as contained in the same statistical package.

RESULTS

All nutrient digestibility parameters considered in this present study were not significantly ($p>0.05$) influenced by the herbal mixes except ash digestibility (Table 2). Pigs on rations containing no herbal mix and moringa-basil leaf meals had comparable ash digestibility values (80.69 and 80.52%) which differed significantly from 60.04% noted for pigs on neem-basil leaf meal diet. Slight increase in crude protein digestibility of pigs on ration containing moringa-basil leaf meal over others on diets containing no herbal mix and neem-basil leaf meal was noted. Pigs on moringa-basil ration had the highest numerical crude fibre digestibility (59.32 %) followed by pigs on control ration while the least crude fibre digestibility was recorded for pigs on ration containing neem-basil leaf meal. Dry matter digestibility followed the same trend as crude fibre digestibility with pigs on ration containing moringa-basil recording the highest numerical value (57.75± 10.26%), while those on ration containing neem-basil leaf meal had the least value (50.50±9.57%). The ether extract digestibility was highest (29.80±8.83%) for pigs on ration containing neem-basil leaf meal compared to the values (25.57± 8.17 and 10.71±5.68%) obtained for pigs on rations containing moringa-basil leaf meal and no herbal mix, respectively.

The present study showed that all the nutrient digestibility parameters evaluated did not change significantly with weight asymmetry. However,there were numerical differences in the values of most parameters considered, crude protein digestibility was higher in homogeneous heavy weight pigs followed by homogeneous light weight and heterogeneous weight pigs. Heterogeneous weight pigs had the least crude fibre digestibility while the highest crude fibre digestibility was documented for homogeneous heavy weight pigs. Homogeneous heavy weight pigs recorded the highest ash digestibility values compared to the values gotten for homogeneous light weight pigs and heterogeneous weight pigs. Dry matter digestibility ranged from 49.80% for heterogeneous weight pigs to 56.93% for homogeneous light weight pigs (Table 2). Heterogeneous weight pigs recorded the highest ether extract digestibility while homogeneous heavy weight pigs had the least ether extract.

Table 1: Percentage composition of experimental diets of growing pigs

Ingredients	Control Diet	Neem-Basil Diet	Moringa-Basil Diet
Maize	50	50	50
PKC	10	10	10
Basil Leaf	0	2	2
Moringa Leaf	0	0	10
Neem Leaf	0	10	0
Soya Bean Meal	18	8	8
GNC	9	7	7
Fish Meal	2	2	2
Wheat Offal	6.9	6.9	6.9
Bone Meal	3	3	3
Lysine	0.3	0.3	0.3
Methionine	0.25	0.25	0.25
*Premix	0.3	0.3	0.3
Salt	0.25	0.25	0.25
TOTAL	**100**	**100**	**100**
Determined analysis			
Metabolizable energy (Kcal/kg)	2834.59	2541.99	2805.90
Ether extract (%)	4.56	4.84	4.49
Crude fibre (%)	4.68	6.40	5.56
Ash	3.05	3.54	3.1

*To supply the following per kg diets; Vit A 12600 IU; vit D_3 2800 IU; vit E 49 IU; vit k 32.8 mg; vit B_1 1.4 mg; vit B_2 5.6 mg; vit B_6 1.4 mg; vit B_{12} 0.014mcg; Niacin 21mg; Pantothenic Acid 14 mg; Folic Acid 1.4 mg; Biotin 0.028 mg; Chlorine chloride 70 mg; Manganese 70 mg; Zinc 140 mg; Iron 140 mg; Copper 140 mg; Iodine 1.4 mg; Celenium 0.28 mg; Cobalt 0.7 mg; Antioxidant 168 mg.

Table 2: Effects of herbal-mix feed additives and weight asymmetry on nutrient digestibility of growing pigs

	Herbal-mix feed additives			Weight asymmetry		
Parameters	**N.H**	**M.B**	**N.B**	**HHW**	**HLW**	**HW**
Crude Protein	58.19±6.01	68.10±5.57	48.44±11.43	66.14±4.69	55.35±7.78	53.24±11.61
Crude fibre	47.60±5.88	59.32±7.91	38.90±. 8.36	40.46±7.22	48.27±7.27	57.10±8.73
Ash	80.69±2.48a	80.52±3.41a	55.04±8.18b	63.67±12.77	62.87±11.86	54.72±16.13
Dry matter	54.48±5.90	57.75±10.26	50.50±9.57	49.88±7.95	56.93±7.65	55.93±10.46
Ether extract	10.71±5.68	25.57±8.17	29.80±8.83	19.58±6.05	20.69±8.54	25.82±8.48

assb-Means with different superscripts on the sample row are significant($p<0.05$) different

There were no significant differences in the effects of the interaction between herbal-mix feed additives and weight asymmetry on all parameters except ash digestibility (Table 3). Homogenous heavy weight pigs fed moringa-basil leaf meals had the highest crude protein digestibility value of 73.38% while their homogeneous light weight counterparts on neem-basil ration had the lowest crude protein digestibility value (33.77%). The significantly higest crude fibre digestibility of 75.65% was recorded for homogeneous light weight pigs on ration containing moringa-basil leaf meals while the homogeneous heavy weight pigs fed neem-basil leaf meals diet got the lowest crude protein digestibility value of 30.38%. Comparable significant ash digestibility values were recorded for homogeneous heavy weight pigs fed control ration (84.02%) and heterogeneous weight pigs on moringa-basil leaf meals (84.80%) which differed significantly from the least values noted for pigs on neem-basil leaf meals in all the categories of weight asymmetry. Dry matter digestibility values ranged from 39.60% recorded for homogeneous heavy weight pigs on neem-basil leaf meals to 69.53% observed in heterogeneous weight pigs fed moringa-basil leaf meals. The highest ether extract digestibility value (31.52%) was observed in heterogeneous weight pigs on neem-basil leaf meal while their heterogeneous weight counterparts on control ration recorded the least ether extract value of 4.59% (Table 3).

Nitrogen intake, percent nitrogen digestion and retention were significantly ($p<0.05$) influenced by dietary inclusion of herbal-mix in the ration of growing pigs (Table 4). Pigs on diets containing moringa-basil leaf meal mix recorded higher significant values in the nitrogen intake, digestion and retention when compared to the lower values recorded for pigs on diet with neem-basil leaf meal mix.

Weight asymmetry had no significant effect on nitrogen balance of growing pigs. Although, percentage nitrogen digestion and retention were higher in heterogenous weight pigs' group compared to the values in the homogenous weight groups (Table 4). Nitrogen in urine (g/day), nitrogen digestion (g/day) and retention (g/day) and total excreted nitrogen (g/day) were significantly affected by interaction between herbal-mix leaf meal and weight asymmetry (Table 5). Homogenous heavy weight pigs fed diets with no herbal-mix and moringa-basil leaf meal mix, likewise, the homogenous light weight pigs on diet with no herbal-mix recorded higher nitrogenin in urine, whereas, lower nitrogen in urine value was recorded for homogenous light weight pigs on diet containing neem-basil leaf meal mix. Nitrogen digestion was significantly lower in homogenous light weight pigs on ration containing moringa-basil leaf meal mix compared to the higher nitrogen digestion in pigs on neem-basil leaf meal mix. Total excreted nitrogen was lower in homogenous weight pigs fed diet containing neem-basil leaf meal mix in comparison with the values noted for homogenous heavy weight pigs irrespective of the diets offered to them. Groups of pigs with homogenous light weight fed diet containing neem-basil leaf meal had higher nitrogen retention (g/day) when compared to the nitrogen retention of the homogenous heavy weight pigs and light weight counterparts on diets contain-

ing no herbal-mix and those on moringa-basil leaf meals. Higher percentage nitrogen retentions were obtained in homogenous heavy and light weight pigs fed diet containing neem-basil leaf meals compared to the results obtained in homogenous heavy and light weight pigs on no herbal and those of moringa-basil leaf mix diets. The percentage nitrogen digestion values ranged from 26.08±28.45% (homogenous heavy weight pigs on diets containing moringa-basil leaf meal) to 75.10±0.51% noted for groups of pigs with homogenous light weights fed diets containing neem-basil leaf mix meals (Table5).

Table 3: Interactive effects of herbal-mix feed additives and weight asymmetry on nutrient digestibility of growing pigs

	Homogenous heavy weight			Homogenous light weight			Heterogenous weight		
Parameters (%)	**NH**	**MB**	**NB**	**NH**	**MB**	**NB**	**NH**	**MB**	**NB**
Crude protein (%)	67. 59±2.05	73. 38±5.02	57. 44±13. 06	64. 30±10. 95	61. 66±18. 50	33. 77±31. 41	42. 70±7.23	69. 26±5.28	54. 10±21. 73
Crude fibre	47. 10±4.93	43. 90±17. 08	30. 38±17. 61	59. 59±9.61	75. 65±5.22	36. 06±15. 19	36. 12±11. 19	58. 42±10. 70	50. 27±17. 25
Ash	84. 02±0.29a	80. 48±3.92a	26. 50±18. 82b	82. 92±6.20a	76. 28±11. 07a	4. 95±2. 36b	75. 13±2.62a	84.80±0. 92a	28. 67±13. 34b
Dry matter	48. 66±3.13	61. 38±7.73	39. 60±25. 28	66. 22±14. 15	42. 35±33. 44	59. 23±4.82	48. 60±10. 33	69. 53±3.42	52. 67±22. 65
Ether extract	7. 98±5. 20	19. 22±14. 91	31. 52±4.65	19. 55±18. 25	27. 86±25. 76	30. 04±44. 56	4. 59±0. 80	29. 63±7.36	27. 84±25. 47

[ab]-Means on the same row with different superscripts are significantly ($p<0.05$) different. NH = No herbal, MB = moringa-basil additive, NB = Neem-basil additives

Table 4: Effects of herbal-mix feed additives and weight asymmetry on nitrogen balance of growing pigs

	Herbal-mix feed additives			Weight asymmetry		
Parameters (g/day)	**NH**	**MB**	**NB**	**HHW**	**HLW**	**HW**
Nitrogen intake	21.07±1.71[ab]	25.46±4.70[a]	20.00±3.54[b]	27.06±18.29	26.11±18.77	26.96±18.03
Nitrogen in faecal	2.66±0.93	3.15±1.72	3.37±1.17	4.88±2.32	4.01±1.35	4.43±1.65
Nitrogen in urine	10.00±2.89	8.25±2.20	10.45±2.13	13.35±8.51	12.24±5.27	10.41±6.28
Nitrogen digestion	18.41±1.91[ab]	22.32±4.30[a]	16.64±3.00[b]	18.62±5.82	19.08±6.19	19.72±2.77
Total nitrogen excreted	12.65±2.75	11.39±3.13	13.81±2.14	14.32±2.19	11.80±3.62	11.74±1.53
Nitrogen retention	8.42±4.34[ab]	14.07±5.15[a]	6.19±4.16[b]	7.57±5.16	9.93±7.02	11.18±4.28
% Nitrogen retention	38.84±17.80[ab]	54.21±14.67[a]	29.49±15.16[b]	32.44±16.47	42.76±23.84	47.34±12.59
% Nitrogen digestion	44.89±20.40[ab]	61.48±14.14[a]	35.36±18.32[c]	37.97±20.11	48.08±24.30	56.17±14.12

[ab]-Means on the same row with different superscripts are significantly ($p<0.05$) different. NH = No herbal, MB = moringa-basil additive, NB = Neem-basil additives, HHW = Homogenous heavy weight, HLW = Homogenous light weight, HW = Heterogenous weight

Table 5: Interactive effects of herbal-mix feed additives and weight asymmetry on nitrogen balance of growing pigs

	Homogenous heavy weight			Homogenous light weight			Heterogeneous weight		
Parameters (g/day)	NH	MB	NB	NH	MB	NB	NH	MB	NB
Nitrogen intake	20.29±1.11	18.35±0.08	27.03±6.12	20.11±1.37	19.05±0.40	26.04±5.30	22.81±1.56	22.61±6.47	23.32±5.46
Nitrogen in urine	11.66±1.53^{a}	11.22±3.84^{a}	10.26±2.16^{ab}	11.52±2.91^{a}	9.78±1.82^{ab}	5.99±1.02^{b}	6.81±0.75^{ab}	10.34±1.60^{ab}	8.49±0.41^{ab}
Nitrogen in faecal	2.41±0.12	3.03±0.78	4.39±2.63	2.29±1.21	3.95±0.94	1.95±0.72	3.36±1.14	3.11±2.06	3.10±1.16
Nitrogen digestion	17.88±1.00^{ab}	15.32±0.71^{ab}	22.64±3.50^{ab}	17.90±2.58^{ab}	15.09±0.54^{b}	24.10±4.53^{a}	19.46±2.70^{ab}	19.50±4.41^{ab}	20.22±6.62^{ab}
Total nitrogen excreted	14.07±1.41^{a}	14.25±4.62^{a}	14.65±0.47^{a}	13.72±4.12^{a}	13.75±0.88^{a}	7.93±1.74^{b}	10.17±0.39^{ab}	13.44±0.46^{a}	11.60±0.75^{ab}
Nitrogen retention	6.22±2.53^{b}	4.10±4.54^{b}	12.38±5.66^{ab}	6.38±5.49^{b}	5.31±1.28^{b}	18.11±3.56^{a}	12.64±1.95^{ab}	9.16±6.01^{ab}	11.72±6.21^{ab}
% Nitrogen retention	30.37±10.79^{b}	22.38±24.36^{b}	44.57±10.83^{a}b	30.89±25.21^{b}	27.79±6.14^{b}	69.58±0.49^{a}	55.26±4.78^{ab}	38.29±15.61^{a}b	48.47±15.29^{ab}
% Nitrogen digestion	34.45±12.21^{ab}	26.08±28.45^{b}	53.39±16.74^{ab}	33.80±26.81^{ab}	35.35±9.76^{ab}	75.10±0.51^{a}	64.92±1.01^{ab}	44.64±20.71^{ab}	55.95±12.41^{ab}

^{ab}-Means on the same row with different superscripts are significantly ($p<0.05$) different. NH = No herbal, MB = moringa-basil additive, NB = Neem-basil additives

Effect of herbal-mix feed additives on bowel transit time of growing pigs. Statistically non significant bowel transit time values were obtained for growing pigs of different weight groups fed rations containing different herbal-mix leaf meal as depicted on Figures 1. Likewise, the interaction between herbal-mix feed additive and weight asymmetry had no positively ($P>0.05$) influence on bowel transit time of growing pigs (Figure 2).

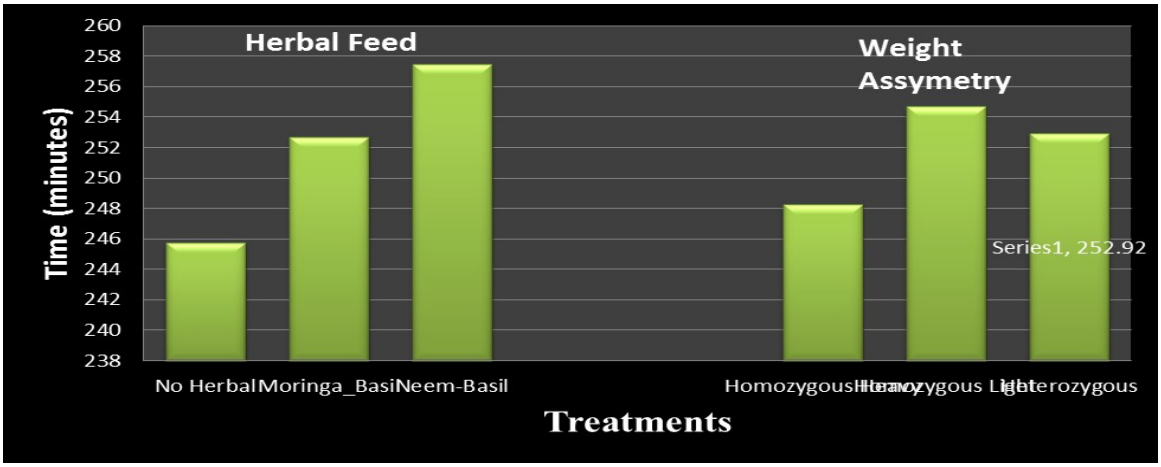

Figure 1: Effect of herbal-mix leaf meal on bowel transit time

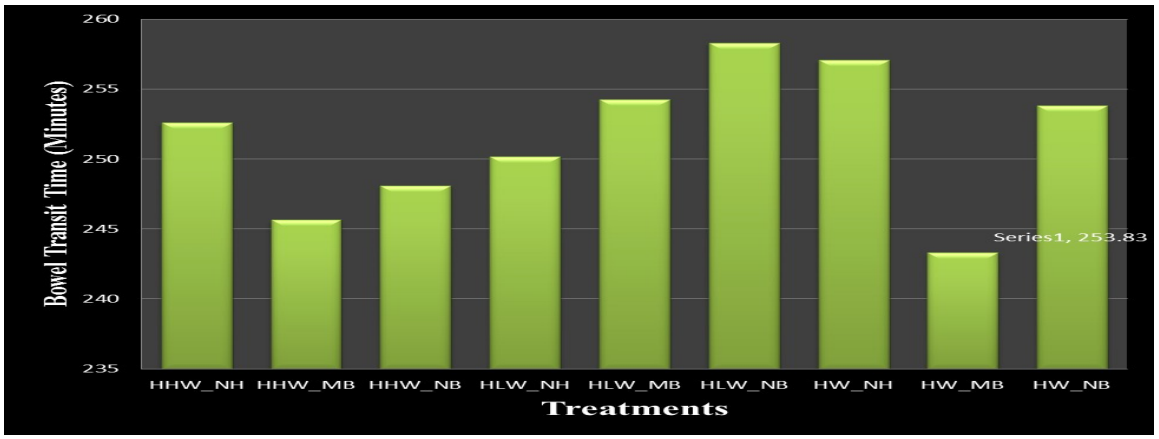

Figure 2: Interactive effects of herbal-mix feed additives and weight asymmetry on bowel transit time

HHW_NH = Homozygous heavy weight pigs on diet without herbal-mix feed additive HHW_MB = Homozygous heavy weight pigs on diet with moringa-basil leaf meal feed additive HHW_NB = Homozygous heavy weight pigs on diet with neem-basil leaf meal feed additive HLW_NH = Homozygous light weight pigs on diet without herbal-mix feed additive

HLW_MB = Homozygous light weight pigs on diet with moringa-basil leaf meal feed additive HLW_NB = Homozygous light weight pigs on diet with neem-basil leaf meal feed additive HW_NH = Heterozygous weight pigs on diet without herbal-mix feed additive

HW_MB = Heterozygous weight pigs on diet with moringa-basil feed additive

HW_NB = Heterozygous weight pigs on diet with neem-basil leaf meal feed additive

DISCUSSION

Herbal products are preparation containing single or mixtures of different medicinal plant parts that can be added to livestock feeds or water in the form of herbal extracts or meals (Hanczakowska *et al.* 2007). The products gotten from mixture of different herbal plants had been proven to be more effective as presented by Grela *et al.* (2007). They serve multiple functions like anti- bacterial, anti-viral, anti-inflammatory, anti-oxidant; they also stimulate appetite, regulate digestion and metabolism, also, they have anti-diarrheal effect and stimulate hormonal and immune systems (Grela and Semeniuk, 2006). The vital aim of using herbal additives in pig production is to stimulating pigs' growth rate through decrease in incidence of digestive tract infections (Lin *et al.* 2000). Herbs incorporated in fattener ration are supposed to boost growth rate and meat quality. From this study, it was observed that herbal-mix feed additive had no positive impact in nutrient digestibility parameters except ash digestibility. The slight increase in crude protein and crude fibre digestibility of pigs on ration containing mixture of moringa-basil leaf meals over other treatment groups, although not significantly, suggest positive combination effects of bioactive substances present in the mixture of moringa and basil leaf meals on the metabolism of growing pigs leading to improved digestive processes and nutrient metabolism as presented by Lin *et al.* (2000) and Cullen *et al.* (2005). This result is in tandem with the report of Chen *et al.* (2005) that observed statistical similar values in crude protein and dry matter digestibility of pigs fed ration containing complex probiotics. Moringa leaf meal have been reported to provide a suitable protein source for ruminant and monogastric livestock (Soliva *et al.*, 2005). However, it is in variance with the study of Maxwell *et al.* (1983) that reported statistically improvements of crude protein and organic matter digestibility in pigs fed diets containing probiotic. The similarity in digestibility coefficient of crude fibre observed in this study could therefore be attributed to ingredient matrix of the diets, levels of fibre and individual variations among the pigs fed the treatment diets. The significant differences noted in ash content can be associated with the rate of passage of digesta in the gastrointestinal tract. Jimenez-Moreno *et al.* (2010) reported that the presence of dietary fibre increases the rate of digesta passage which in turn impairs the rate of nutrient digestibility resulting to low ash digestibility. The high fibre content and presence of anti-nutritional factors in diet containing mixture of neem and basil leaf meals could have contributed to low ash digestibility in this present study. Caperna *et al.* (1991) asserted that growth hormone treatment enhanced ash accretion in muscle. According to Souffrant (2001) fibre is a heterogeneous mixture of polysaccharides (structural and non- structural) and lignin that are not digested by endogenous secretions of the digestive tract. Fibre utilization by pigs have been re-

ported to be influenced by the physical and chemical composition of the diet, level of feeding, age and weight of animal, adaptation to the fibre diet and individual variation among the pigs (Morel *et al.*, 2006).

The improvement in nitrogen intake, percentages nitrogen digestion and retention in pigs on moringa-basil leaf mix compared to the pigs on other treatment groups points to the fact that the herbal mix (moringa and basil leaf meals) resulted to higher activities of digestive enzymes and nutrient absorption as indicated in this present study. The significance of these parameters' points to the fact that moringa-basil leaf meals contain more soluble plant protein than those of control and neem-basil leaf mix diets. Chrubasik *et al.* (2005) reported that inclusion of herbs and spices in the ration of farm animals exerts beneficial effects (laxative and spasmolytic effects) within the animal gastrointestinal tracts. Also, Platel and Srinivasan (2004) asserted that dietary inclusion of herbs and spices in the diets of rats stimulated more flow of saliva, bile acid, mucus and improvement in the activities of enzymes like lipase, amylase, aminopeptidase, maltase and trypsin. *Niazirin* is one of the active biotic components in *Moringa oleifera* which had been hypothesized to enhance vitamins, minerals and other micro-nutrient absorptions in the gastrointestinal tract of pigs (Stohs and Hartman, 2015). The results obtained in this present study concurs with the reports of Adelusi *et al.* (2016), who reported that feeding of West African Dwarf goats with diet containing *Newbouldia laevis* leaf resulted to higher nitrogen balance and retention. The reports of Windisch *et al.* (2008) and Lan *et al.* (2016) also concurred with the present result, they observed higher ileal amino acid digestibility in weaner pigs fed diets supplemented with herbal extract. The authors attributed the significant effects observed in pigs on dets containing phytogenic extract to enhancement in synthesize and function of digestive enzymes in the guts of pigs. Likewise, Straub *et al.* (2005) concluded that addition of rhubarb at the rate of 0.25% in the diet of weaning pigs improved energy and nitrogen metabolisms of the pigs, when the results were compared to those obtained for pigs on control diets and those of higher doses (>1%) of rhubarb supplements.

Systematic management and breeding have certainly altered not only the growth potential but also significantly changed the structure and morphology of their digestive tract (Uni *et al.*, 1995). In the present study, nutrient digestibility was not affected by weight asymmetry. This indicates that the grouping of pigs according to weight did not impose physiological stress in the pigs which could have deleterious effect on the digestive processes of pigs. Zuprizal *et al.* (1993) found that true digestibility of protein and amino acids decreased due to stress. Hai *et al.* (2000) reported that the activities of several enzymes (trypsin, chymotrypsin and amylase) decreased significantly due to different types of stress. Liver and pancreas are the important part in the function of digestive system. From this study, mixing of pigs did not results in agonistic behaviour eliciting social stress that may produce gastro-intestinal disturbances and adversely affect the pig performance (D'Souza *et al.*, 1995). In

addition, different types of stress impair absorption of different vitamins and causes reduction in plasma and tissue concentrations of minerals which are related to digestive and immune system (MacPherson, 1994). Furthermore, loss of mineral impairs the protection of liver and pancreatic tissue which alters the proper secretion of bile salts and pancreatic juices (MacPherson,1994), reduce digestibility of nutrients along with a reduced intake, eventually decreased performance of livestock. The concept can explain how different stress can impact on the physiological and biochemical process in general in the present study. The higher numerical crude protein, crude fibre, ash and dry matter digestibility values in the homogeneous group (heavy and light weights) compared to the heterogeneous weight group points to the facts that more stable social order in the pigs with closely related weight than those with higher weight differences, resulting to less social and behavioural stresses.

Transit time have been reported to be influenced by the amount of feed intake and the level of dietary fibre in the ration of animal as indicated by Sarria *et al.* (2012). In this present study, dietary inclusion of herbal leaf meal increased the crude fibre content of the diet with the diet containing neem leaf meal recording the highest value which might have led to the prolonged time for the first appearance of faeces with marker when compared to the time recorded for pigs in control group though not significant. The non significant differences in the transit time is in line with the observation of Cherbut *et al.* (1988) who reported no statistically significance differences in the rate of passage of digesta of pigs on high dietary fibre ration with those on basal diet. The presence of fibre in the gastrointestinal tract have been reported to delays the gastric emptying period by increasing the amount of mechanical mixing needed to decrease the particle size of feed small enough to permit the process of gastric emptying. Likewise, delay the absorption of nutrients in the intestinal tract of the animal. (Hellemeier, 1995). Earlier authors concluded that insoluble fibres increase the bulk of faecal, reduce gut transit time and retain moisture in the faecal stream resulting from partial colonic microbial fermentation (Topping and Bird, 1999; Marlett *et al.*, 2000)

CONCLUSION

Herbal-mix feed additives positively influenced ash digestibility of growing pigs but had no influence on bowel transit time of the pigs. Weight asymmetry had no impacts on nutrient digestibility and bowel transit time of growing pigs. Hence, the integration of herbal leaf meal in the ration of growing pigs can be adopted to enhance mineral utilization of the diet.

REFERENCES

Adelusi, O.O., Isah, O.A., Onwuka, C.F.I., Yusuf, O.A., Ojo, V.O.A., Aderinboye, R.Y. 2016. Performance, digestibility and nitrogen balance of West African Dwarf

goats fed *Azadirachta indica*, *Newbouldia laevis* and *Spondias mombin* leaves. *Nigerian Journal of Animal Science* 2:507-517.

Andersen, I. L. , Andenaes, H., Boe, K.E. , Jensen, P. , Bakken, M. 2000. The effects of weight asymmetry and resource distribution on aggression in groups of unacquainted pigs. *Applied Animal Behaviour Science* 68: 107–120.

AOAC. 2000. Official Methods of Analysis, 17th ed. Association of Official Analytical Chemists, Arlington, V.A., USA.

AOAC. 2005. Official Methods of Analysis of AOAC International 18th E.d., AOAC International, Gaithersburg, MD, USA

Bostami, A.B. M.R. , Ahmed, S. T., Islam, M.M., Mun, H.S., Seung, Y.J. , Yang, C. 2015. Effect of weight asymmetry on growth performance, carcass characterisyics and economical analysis in pigs. *Global Advanced Research Journal of Agricultural Science* 4 (1): 6-16.

Caperna, T.J. , Kornarek, D.R., Gavelek, D. , Steele, N.C. 1991. Influence of dietary protein and recombinant porcine somatotropin administration in young pigs: II. Accretion rates of protein collagen and fat. *Journal of Animal Science* 69 (10): 4019.

Casal-Plana, N., Manteca, X., Dalmau, A. Fàbrega, E. 2017. Influence of enrichment material and herbal compounds in the behaviour and performance of growing pigs. *Applied Animal Behaviour Science* 195: 38–43.

Chen, Y.J. , Son, K.S., Min, B. J. , Cho, J. H., Kwon, O.S., Kim, I. H. 2005. Effects of dietary probiotic on growth performance, nutrient digestibility blood characteristics and fecal noxious gas content in growing pigs. *Asian-Aust. Journal of Animal Science* 18:1464-1468

Cherbut, C. , Barry, J. L. , Wyers, M., Delort-Laval, J. 1988. Effect of the nature of dietary fibre on transit time and faecal excretion in the growing pig. *Animal Feed Science and Technology* 20: 327–333

Chrubasik, S., Pittler, M.H., Roufogalis, B.D. 2005. *Zingiberisr hizome:* A comprehensive review on the ginger effect and efficacy profiles. *Phytomedicine,* 12:684–701.

Cullen, S. P. , Monahan, F. J. , Callan, J. J. , O' Doherty, J. V. 2005. The effect of dietary garlic and rosemary on grower-finisher pig performance and sensory characteristics of pork. *Irish Journal of Agriculture and Food Resource* 44 (1): 57-67.

D' Souza, D.N. , Eldridge, G.A. , Warner, R.D., Leury, B. J. , Dunshea, F. R. 1995. Manipulating pig production V: The effects of adverse handling of pigs on farm and at the abattoir on meat quality.

In: D. P., Hennessy & P. D. Cranwell (Eds.), pp. 258

Grela, E.R., Semeniuk, V. 2006. Konsekwencje wycofania antybiotykowych stymulatorów wzrostuz żywienia zwierząt. *Med. Wet.* 62 (5): 502-507.

Grela, E. R., Gruszczyk, M., Czech, A. 2007. Effectiveness of herbs mixture in growing-finishing pig diets. *Herba Pol.* 53 (3): 343-349.

Hai, B. Y. L., Rong, D., Zhang, Z.Y. 2000. The effect of thermal environment on the digestion of broilers. *Journal of Animal Physiology and Animal Nutrition* 83: 57-64

Hanczakowska, E., Swiatkiewicz, M., Szewczyk, A. 2007. Efficiency of herb preparation and gallic acid in pig feeding. *Annals of Animal Science* **7**: 131-139.

Hellemeier, C. 1995. An overview of the effects of dietary fibre on gastro-intestinal transit. Padietrics, pp.997-999. Downloaded from www.aappublications.org/nes on July 25, 2019

Hengyi, J., Guanghei, T., Jionghua, Y., Yanbin, W., Huixiang, D. and Yanrong, Z. 2023. Efficient aggressive behaviour recognition of pigs based on temporal shift module. *Animals* 13(13): 2078

Jiménez-Moreno, E., González-Alvarado, J. M., González-Sánchez, D., Lázaro, R., Mateos, G.G. 2010. Effects of type and particle size of dietary fibre on growth performance and digestive traits of broilers from 1 to 21 days of age. *Poultry Science* 89: 2197-2212.

Lan, R.X., **Li, T.S., Kim, L.H**. 2016. Effects of essential oil supplementation in different nutrient densities on growth performance, nutrient digestibility, blood characteristics and faecal microbial shedding in weaning pigs. *Animal and Feed Science Technology* 214:77-85.

Lin, B., Qui, I. T., Huang, C.H., Li, G.P., Huang, Y. F. 2000. Effect of Chinese medicinal herbs on blood biochemical parameters of piglets early weaning diarrhoea. *Fujian Journal of Agricultural Science* 15: 37-40.

Ly, J. 2008. Studies on factors affecting faecal output in growing pigs. An approach to the effects of level of feed intake and sex. *Revista Computadorizada de Produccion Porcina* 15 (3): 255-260

MacPherson, A. 1994. Selenium, vitamin E and biological oxidation. In: Cole, D. J. & Garnsworthy, P. J. (eds), Recent Advances in Animal Nutrition. Butterworth and Heinemann, Oxford, pp. 3–30

Marchant-Forde, J. N., Marchant-Forde, R.M. 2005. Minimizing inter-pig aggression during mixing. *Pig News and Information* 26 (3): 63N-71N

Marlett, J. A., Kajs, T. M., Fischer, M. H. 2000. An unfermented gel

component of psyllium seed husk promotes laxation as a lubricant in humans. *The American Journal of Clinical Nutrition* 72:784-789.

Maxwell, V.C., Buchanan, D. S., Owens, F. N., Gilliland, S. E., Luce, W. G., Vend, R. 1983. Effect of probiotic supplementation on performance, faecal parameters and digestibility of growing- finishing swine. *Oklahoma Agric. Exp. Sta. Anim. Sci. Res. Rep.* 114-157

Morel, P. C.H., Lee, T.S., Moughan, P. J. 2006. Effect of feeding level, live weight and genotype on the apparent digestibility of energy and organic matter in the growing pig. *Animal Feed Science and Technology* 126: 63-74

Odetola, O.M., Adetola, O.O., Ijadunola, T. I., Adedeji, O.Y., Adu, O.A. 2012. Utilization of Moringa (*Moringa oleifera)* leaves meal as a replacement for soya bean meal in rabbit's diets. *Scholarly Journal of Agricultural Science* 2 (12): 309-313

Platel, K., Srinivasan, K. 2001. Studies on the influence of dietary spices on food transit time in experimental rats. *Nutrition Research* 21:1309 – 1314

Platel, K., Srinivasan, K. 2004. Digestive stimulant action of spices: A myth or reality? *Indian Journal of Medcall Research* 119:167–179.

Sarriá, B., Martínez-López, S., Fernández-Espinosa, A., Gómez-Juaristi, M., Goya, L., Raquel-Mateos, R., Bravo, L. 2012. Effects of regularly consuming dietary fibre rich soluble cocoa products on bowel habits in healthy subjects. *Journal of Nutrition and Metabolism* 9 (1):33. http://www.nutritionandmetabolism.com/content/9/1/33

SAS Institute Inc. 2002. SAS/STAT User's Guide, Version 9.2. SAS Institute Inc., Cary, NC

Soliva, C.R., Kreuzer, M., Foidl, N., Foidl, G., Machmüller, A., Hess, H.D. 2005. Feeding value of whole and extracted *Moringa oleifera* leaves for ruminants and their effects on ruminal fermentation in vitro. *Animal Feed Science and Technology* 118: 47-62

Souffrant, W. 2001. Endogenious nitrogen losses during digestion in pigs. In: Verstegen M., Huisman J. & Den Hartog L. (Eds.) Digestive Physiology in Pigs. *EAAP Publication, Rome* 54: 147-166

Stohs, S.J., Hartman, M.J. 2015. Review on the safety and efficacy of *Moringa oleifera*. *Phytotherapy Research*, 29:796-804.

Straub, R., Gebert, S., Wenk, C., Wanner, M. 2005. Growth performance, energy and nitrogen balance of weaning pigs fed cereal-based diet supplemented with Chinese rhu-

barb. *Livestock Production Science* 92(3): 261-269.

Topping, D. L., Bird, A.R. 1999. Food, nutrients and digestive health. *Austria Journal of Nutrition and Dietetic* 56: S22-S34.

Uni, Z. , Yael, N., David, S. 1995. Post hatch changes in morphology and function of the small intestines in heavy- and light- strain chicks. *Poultry Science* 74: 1622-1629.

Windisch, W., Schedle, K., Plitzner, C., Kroismayr, A. 2008. Use of phytogenic products as feed additives for swine and poultry. *Journal of Animal Science* 86 (Supplement 14): E140-E148.

Zuprizal, M., Larbier, A. M., Channeau, M., Geraert, P.A. 1993. Influence of ambient temperature on true digestibility of protein and amino acidsnm of rape seed and soybean meals in broilers. *Poultry Science* 72: 289–295.

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