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ORIGINAL RESEARCH ARTICLE

Performance, serum and haematological indices of pigs fed watermelon waste based-diet

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ABSTRACT

This study was conducted to evaluate the performance, haematological and serum biochemical indices of grower pigs fed watermelon wastes. Sixty-four female grower pigs (11.10 ± 1.5 kg) were randomly allotted to four dietary treatments in a completely randomized design: T1 = 40% cassava peel + 60% concentrate, T2 = 40% cassava peel + 40% concentrate + 20% watermelon waste, T3 = 40% cassava peel +20% concentrate + 40% watermelon waste, T4 = 40% cassava peel + 60% watermelon waste. Pigs fed 20% watermelon based-group did not differ from those of control diet for final body weight, average body weight change and feed conversion ratio, while those on 40% and 60% watermelon waste were significantly ($P<0.05$) lower than those on the control diet. The packed cell volume (PCV), haemoglobin, eosinophils, red blood cell (RBC) were not affected when pigs were fed the watermelon waste ($P<0.05$). However, elevated platelets levels were observed for pigs on watermelon waste. The combination of 40% cassava peel + 40% concentrate + 20% watermelon wastes is recommended for grower pigs. Recycling of watermelon wastes in feeding livestock is considered an effective way of managing these fruit wastes.

Keywords: Animal nutrition, Environmental pollution, Public health, Waste recycling

INTRODUCTION

In sustainable livestock production, it is important to give credence to the efficient use of locally available feed ingredients, reduction in environmental waste and improving the feed resource base through a quest for novel feed resources. Due to the ever-changing economic situations, there is a need to develop a simple and farmer-friendly pig production system for the tropics. Most pig farmers just want an economic result, but it could be sustainable with locally available resources and at a reduced cost.

In recent times, the activities of agricultural industries have increased to satisfy the growing population in Nigeria (Ewah and Ekeng, 2009). This has resulted in an increasing amount of wastes that have been produced and constitutes environmental pollution if not properly managed (Liu *et al.*, 2012). Large quantities of agricultural solid wastes are disposed of in rivers or public places, causing environmental hazards. An alternative to such disposal methods could be recycling through livestock as feed resources (Adetunji and Adejumo, 2017; Adejumo *et al.*, 2017a). Food wastes have been described as being rich sources of essential nutrients which potentials need to be harnessed in real industrial systems (Kuppusamy *et al.*, 2017). The application of date palm waste-made compost has been reported to be beneficial in field-grown *Medicago sativa* plants, resulting in higher yields than control (Benabderrahim *et al.*, 2017). Watermelon (*Citrullus lanatus*) is mainly grown for its fruit but its wastes may be potential feed ingredients for animals, instead of being allowed to accumulate in public places thereby constituting environmental pollution, which poses a serious threat to public health (Adejumo *et al.*, 2017b). There is a growing need to divert them from the waste stream and employ them as a resource for livestock feeding, bio-fertilizer production, bio-energy generation, etc (Kivaisi, 2010). Naz *et al.* (2013) earlier reported 0.49% crude protein, 0.32% crude fibre and 0.27% ash content for watermelon fruit while Adejumo *et al.* (2017b) reported 6.53g/100g, 14.94 g/100g and 5.43 g/100g for crude protein, crude fibre and ash content for watermelon peel wastes respectively on dry matter basis. This study was therefore conducted to investigate the effects of watermelon wastes on growth performance, haematology and serum biochemical indices of grower pigs.

MATERIALS AND METHODS

This study was carried out at the Piggery Unit, Teaching and Research Farm, University of Ibadan, southwestern Nigeria, at $7^0$20N, $3^0$50E at an altitude of 200-300 m above sea level. Watermelon wastes were collected from a fruit market in southwestern Nigeria. Samples, in triplicates were analysed for proximate compositions.

Sixty-four female grower pigs (11.10 ± 1.5 kg) were randomly distributed to four dietary treatments consisting of four replicates per treatment with four pigs per replicate. The dietary layout for the experiment is presented below:

Treatment 1 = 40% cassava peel (CP) + 60% concentrate (C).
Treatment 2 = 40% CP + 40% C + 20% watermelon waste (WW).
Treatment 3= 40% CP + 20% C + 40% WW.
Treatment 4 = 40% CP + 60% WW.

Weight gain of pigs in each treatment, before the animals were served feed was done weekly using a weighing scale. At the end of the experiment, the total body weight gain was determined by subtracting initial body weight from the final body weight. Feed conversion ratio (FCR) was obtained.

Table 1. The gross compositions of concentrate ration for grower pigs

Ingredients	**Proportion (g/100g)**
Maize	40.00
Wheat offal	20.00
Groundnut cake	17.00
Palm kernel cake	15.50
Soybean meal	2.50
Salt	0.50
Limestone	1.25
Premix**	0.25
Palm oil	3.00
Total	100
Calculated values	
Crude protein (%)	17.53
Crude fibre	5.38
Ca (%)	1.32
P (%)	0.51
Metabolizable energy (Kcal/kg)	2811.00
Analysed values	
Crude protein	16.48
Crude fiber	5.65
Ca %	1.08
P (%)	0.39

**2.5kg of premix contains: Vitamin A = 8000000i.u., vitamin D3 = 1500000i.u. vitamin E = 7000mg, vitamin K3 = 1500mg, vitamin B1 = 2000mg; vitamin B2 = 2500mg, niacin = 15000mg, pantothenic acid = 5500mg, vitamin B6 = 2000mg, vitamin B12 = 10mg, folic acid = 500mg, biotin = 250mg, choline chloride = 175000mg, cobalt = 200mg, copper = 3000mg, iodine = 1000mg, iron = 21000mg, manganese == 40000mg, selenium = 200mg, zinc = 31000mg, antioxidant = 1250mg

On the last day of the experiment, three pigs were randomly selected from each replicate for blood sampling. Five mL blood was collected from the pigs into EDTA bottle for haematological evaluation. The haematological parameters determined were packed cell volume (PCV), red blood cell (RBC) counts, White blood cell (WBC) counts, haemoglobin concentration (Hb) and platelets. Packed cell volume and haemoglobin concentration were determined according to the procedure of Mitruka and Rawnsley (1977). The analysis of the RBC counts and WBC counts was done using neubauer haemocytometer (Schalms *et al*., 1975). Leucocyte differential count: neutrophils, lymphocytes, monocytes, eosinophils, basophils were determined as described by Schalms *et al*. (1975).

Blood samples for serum parameters were collected into sample bottles without anticoagulants and were allowed to coagulate. Coagulated blood samples were centrifuged to separate the blood cells from the serum after which it was stored at 20^0C for further analysis of total protein, albumin, glucose, cholesterol, triglyceride, and globulin. Serum total protein was determined using the biuret method (Peter *et al*., 1982).

The data obtained were analyzed using One-way Analysis of Variance (ANOVA) of SAS 2010 and the significant means were analyzed according to Duncan's multiple range test.

RESULTS AND DISCUSSION

The growth performance parameters, serum biochemical parameters and haematological parameters of pigs fed watermelon waste diets are shown in Tables 2, 3 and 4 respectively. Initial weight ranged from 11.10 to 12.68 kg. Final weight was significantly ($P<0.05$) lower for 40% WW based-diet (27.46 kg) and 60% WW based-diet (21.76 kg) when compared with the control group (31.70 kg). However, pigs on 20% WW based-diet were statistically similar to the control group (31.70 kg) and 40% WW based-diet (27.46 kg). Average weight gain/week followed a similar pattern. Pigs on 60% WW based-diet obtained the least feed intake per week (7.75 kg) when compared with other treatments. The values obtained for pigs on 20% (9.51 kg) and 40% (9.16 kg) WW based-diets were statistically similar to those on the control diet (9.15 kg). The values of feed conversion ratio obtained by pigs on 40% (4.18) and 60% (5.11) WW based-diets were significantly ($P<0.05$) higher than those on control diet (3.51) and 20% (3.73) WW based-diet.

Table 2. Performance characteristics of pigs fed diets supplemented with watermelon wastes

Parameters	T1	T2	T3	T4	SEM
Initial weight(kg)	12.68	11.87	12.08	11.10	0.08
Final weight (kg)	31.70^a	29.83^{ab}	27.46^b	21.76^c	0.32
Average weight gain/week (kg)	2.72^a	2.57^{ab}	2.20^b	1.52^c	0.17
Average Feed intake/week(kg)	9.15^a	9.51^a	9.16^a	7.75^b	0.32
Feed Conversion Ratio	3.51^a	3.73^a	4.18^b	5.11^c	0.03

Means with different superscripts within the same row are significantly different. *P* = 0.05; SEM = standard error of the mean; T1 = 40% cassava peel+60% concentrate; T2 = 40% cassava peel +40% concentrate +20% watermelon wastes; T3 = 40% cassava peel +20% concentrate + 40% watermelon wastes; T4 = 40% cassava peel + 60% watermelon wastes

Table 3. Serum biochemical parameters of pigs fed diets supplemented with watermelon waste

Parameters	T1	T2	T3	T4	SEM
Glucose (mg/dL)	86.82^a	74.38^{ab}	72.64^{ab}	67.41^b	0.66
Cholesterol (mg/dL)	128.88^a	120.00^b	128.34^a	107.22^c	1.01
Triglyceride(mg/dL)	137.31^b	165.68^a	134.08^b	78.60^c	2.17
Albumin (g/dL)	2.81	2.79	2.45	2.54	0.53
Total Protein (g/dL)	5.90	5.64	5.75	5.52	0.07
Globulin (mg/dL)	3.32	2.83	3.30	2.80	0.05

Means with different superscripts within the same row are significantly different. *P* = 0.05; SEM = standard error of the mean; T1 = 40% cassava peel+60% concentrate; T2 = 40% cassava peel +40% concentrate +20% watermelon wastes; T3 = 40% cassava peel +20% concentrate + 40% watermelon wastes; T4 = 40% cassava peel + 60% watermelon wastes

Table 4. Haematological parameters of pigs fed diets supplemented with watermelon waste

Parameter	T1	T2	T3	T4	SEM
Packed cell volume (%)	32.33	33.33	32.33	31.67	0.19
Haemoglobin (gm/dL)	15.67	17.20	15.13	15.30	0.14
Red blood cell($x10^6$/uL)	8.11	8.45	7.72	7.57	0.07
White blood cell ($x10^3$/uL	15.03	15.09	16.03	16.27	0.21
Lymphocytes (%)	63.33	67.33	67.00	66.67	0.`16
Neutrophils (%)	31.67	28.66	29.33	30.33	0.28
Platelet ($x10^3$/uL)	111.67^c	200.33^a	161.00^b	174.00^b	1.62
Monocytes (%)	2.00	1.67	2.00	1.67	0.07
Eosinophils (%)	3.00	2.33	1.67	1.33	0.10

Means with different superscripts within the same row are significantly different. P = 0.05
SEM = standard error of the mean; T1 = 40% cassava peel+60% concentrate; T2 = 40% cassava peel +40% concentrate +20% watermelon wastes; T3 = 40% cassava peel +20% concentrate + 40% watermelon wastes; T4 = 40% cassava peel + 60% watermelon wastes

Albumin, total protein and globulin did not differ across the treatments. Pigs on 60% (67.41 mg/dl) WW based-diet obtained significantly (P<0.05) lower glucose than those on control diet (86.82 mg/dl), while the values obtained for those on 20% (74.38 mg/dl) and 40% (72.64 mg/dl) were statistically similar to those on control diet and 60% WW based-diet. 20% (165.68 mg/dl) raised triglyceride when compared with the control group (137.31 mg/dl), while 40% (134.08 mg/dl) and 60% (78.60 mg/dl) WW based-diets lowered (P<0.05) triglyceride when compared with the control group. No difference (P>0.05) was observed for haematological parameters except for platelets that recorded significantly higher values for watermelon supplemented diets as against the un-supplemented watermelon diet.

Findings from the present study agree with the reports of Okai *et al*. (2009), who found out that final weight gain decreased as the inclusion of dried sweet orange increased in the diet of rats. Westendorf *et al.* (1998) reported that feeding food waste and energy supplement to finishing pigs resulted in lower feed intake and similar weight gain. Also, Chae *et al.* (2000) reported that food waste (40%) reduced feed intake and weight change in growing and finishing pigs. Similarly, 60% WW based-diet resulted in decreased feed intake which consequently resulted in decreased body weight. There is evidence in the literature that the extent to which an animal consumes a particular feed is dependent on the fibre source (Linderman et al., 1986), palatability of the feed, (Chery and Jones 1982), its composition and chemical variation. Kwak and Kang (2006) observed a high feed intake due to relatively low energy levels in food waste mixture. However, there was a decrease in feed efficiency. Kanan *et al.* (2015) reported that when over 20% mango fruit rejected meal was included in broiler chickens' diet it did not support growth performance. Adebiyi *et al.* (2017) also reported a significant variation in weight and FCR of pigs fed rice waste-based diets, the FCR increased with an increase in rice waste incorporated into the diet and the lowest value was observed in the control diet which was absent of rice wastes.

According to Khan and Zafar (2005), haematological parameters are good indicators of the physiological status of animals. From the results of haematological parameters in this study PCV, haemoglobin, RBC, WBC, lymphocytes, neutrophils, monocytes, eosinophils of the pigs fed the different dietary treatments were within the normal range as documented by Mitruka and Rawnsley (1977). The PCV is the volume of packed red blood cells divided by the volume of the blood sample. Olayemi *et al.* (2006) earlier reported that there were nutritional adequacy and safety in weaner pigs fed diet containing graded level of wild sunflower leaf meal. The authors related it to the ability of wild sunflower leaf meal to provide and maintain the essential amino acids in the diets, which are necessary for normal functions of the blood cells producing tissues and organs.

The major functions of the white blood cells and its differentials are to fight infection as well as to boost the immune response of animals. Pigs fed 60% watermelon waste had the highest WBC count (16.27 x 10^3/ul), though it was not significantly (P>0.05) different from other treatments (Table 4). An increase in WBC may be due to the presence of foreign organisms. One of the factors that have been documented to affect

WBC counts is the level of protein in the diet (Unigwe *et al.*, 2016). A previous study by Adebiyi *et al.* (2017) reported that pigs fed 37.50 % rice wasted had increased WBC and lymphocytes compared to pigs fed other diets. Blood platelets (Table 4) which are responsible for blood clot, was higher in watermelon waste-based groups. This observation may be partly attributed to the dietary treatments and other physiological factors (Etim *et al.*, 2014), which influence the concentration of blood platelet in animals. Pigs on dietary treatment 2 had a significantly (P<0.05) higher blood platelet when compared to treatments 1, 3, and 4. The observation depicts the varied degree of blood clotting of the pigs fed the respective diets. Ekenyem and Madubuike (2007) concluded that the observed increase in WBC and blood clotting time in pigs fed increasing levels of *Ipomoea asarifolia* leaf meal (IALM) indicated that IALM contained a substance which interfered with clotting. The inclusion of watermelon waste in the diet had no significant effect on haematology of the animals except the blood platelet. So, it may be said that the inclusion of watermelon wastes in the diets of the experimental animals did not interfere with the physiological status of the animals.

Albumin, a component of serum total protein was not significantly (P>0.05) affected by supplementing diets with watermelon waste (Table 3). Blood glucose was significantly affected by the diet supplemented with watermelon waste, although the values fell within the normal range as documented by Merck manual (2012). It was observed that glucose level decreased as inclusion of watermelon wastes in the diets increased. This is in line with the report of Ahn *et al.* (2011) that the rat fed with watermelon and ethanol extract supplemented diet had significantly (P<0.05) decreased blood glucose level. This might imply that watermelon wastes do not contain high soluble carbohydrate upon metabolism that releases glucose. Adebiyi *et al.* (2017) also reported that the addition of rice waste improved the serum glucose and cholesterol content of pigs. Triglyceride concentration was significantly affected by watermelon waste. The main function of triglyceride is to store energy for later use. When animals consume more calories than the body can use, it is stored in the form of triglyceride. Triglyceride concentration reduced as the percentage of watermelon waste increased in the diet. This present study suggests that the watermelon waste has low calorie, resulting in decreased weight gain at higher (60 %) inclusion level. Abbasi *et al.* (2015) reported that triglyceride concentration decreased as the inclusion levels of sweet orange pulp increased in the diet of broilers. In contrast, Akinfala and Tewe (2001) reported that feeding varying levels of whole cassava plant had no effect on the various serum biochemical parameters investigated. Adejumo *et al.* (2017b) earlier reported that feeding watermelon wastes to laboratory rats did not result in liver inflammation, neither did it raise liver function enzymes.

CONCLUSION

The wastes evaluated in this study belong to the group of potential or non-conventional feedstuffs. Their utilization may lead to its disappearance from the refuse dump, thus a great positive impact on the environment. Utilization of watermelon wastes at the recommended levels did not pose any negative health implication on the pigs. It is evident from this study that watermelon wastes can be included in the diet of grower pigs at 20% without adverse effects on the performance and hematological response of the animals.

CONFLICT OF INTEREST

We have no conflict of interest regarding this manuscript.

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