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Feed Grade Ash from Empty Palm Bunch and its Effects on Layer Performance

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Abstract

The study was undertaken to produce a palm bunch ash containing low concentration of potassium and to determine its effects on layer performance. Empty palm bunches were collected from a palm oil mill, cleaned, dried, and ashed. Ash was further soaked and filtered to obtain a low potassium palm bunch ash. Ash was included in the layer diets at 0.0kg (T1 control), 0.10kg (T2), 0.15kg (T3) and 0.20kg (T4) per 100kg of feed in partial replacement for common salt (NaCl). Proximate and mineral concentrations of the experimental diets were determined. The layer feeding trial was carried out with 240 Isa brown layer birds that were 16 weeks into lay. They were divided into four groups of 60 birds and each, replicated three times in a completely randomized design (CRD), with 20 birds per replicate, and fed the diets for 12 weeks. Laying performance responses were assessed. Ash supplemented layer diets recorded significantly higher ($p>0.05$) Cu, and Zn values than the control diets while the Na and Mg values decreased. The dietary electrolyte balance (DEB) values were higher than the recommended. The T2 and T3 groups recorded superior % hen day production (HDP) and egg shell quality, with the % improvements in HDP being 11.71 and 11.97 respectively. Again, the SFA supplementation resulted in 20.96 and 15.41% increase in the profit from egg sales over the control value. Supplementation of layer diets with treated palm bunch ash at the 0.1 and 0.15 kg/100kg diet level are recommended for improved laying and growth performance

Keywords: layers, Palm Bunch Ash, Minerals, and Poultry Feed

1.0 INTRODUCTION

Empty palm bunch wastes are readily available agro residues that have found limited application in south eastern, Nigeria. They are discarded as waste material and constitute environmental nuisance at several palm oil processing locations (Isreal and Akpan, 2016). Limited quantities are used as manure in farms, while on combustion the ash has been used to produce local soaps and as edible ash.

Since palm bunch ash like most plant ashes has been shown to contain very high levels potassium salts (Okonkwo *et al*., 2018a), which are reported to negatively influence feed intake at high inclusion level in the diets of chicken, production of low potassium palm bunch ash may result in a better mineral supplement that would have better effects on the performance and physiology of layers. This will help to solve the problem of reduced feed intake associated with higher inclusion levels of plant ash in broiler and pullet diets (Nwogu, 2013; Ohanaka, 2016) and also the poor oviductal and egg shell development in layers (Nwogu, 2013). This problem has been traced to the high dietary electrolyte balance values of diets supplemented with plant ash due to high levels of potassium, sodium and chlorine in such diets (Ohanaka, 2016; Unamba – Opara *et al.,* 2017). It is therefore believed that the reduction of these minerals in the plant ash processed for livestock feeding will yield better results. The study was undertaken to utilize a feed – grade palm bunch ash and to determine its performance effects on laying hens.

2.0 METHODS, TECHNIQUES, STUDIED MATERIAL AND AREA DESCRIPTION

i. Production of palm bunch ash (PBA)

Palm bunches from which fruits had already been harvested were collected from a palm oil mill located at Umuagwo in Ohaji Egbema LGA, Imo State, Nigeria. The empty palm bunches were gathered, washed with clean water to remove sand and other particles and sundried for seven to fifteen days. The dried palm bunch was weighed with a platform scale (Binatone SF- 400) to determine its weight in kilograms. Thereafter, the palm bunch was burnt on a cement slab at midday to produce the ash. The ash was allowed to cool for a day and was weighed again. The palm bunch ash (PBA) so produced was gathered into a polythene sac and sealed to prevent moisture absorption (Nwogu *et al*., 2012).

Low potassium PBA, however was sieved to remove unburnt parts and charcoal and thereafter mixed liberally with water in a plastic bowl to dissolve it. The mixture was allowed to settle for about two days. Thereafter, the product was sieved through a cloth or polythene woven sack, and the liquid allowed to drain out, and designated the soaked and filtered ash (SFA). The undissolved solid product was then sundried for about 6 days and stored in a polyethylene sac until needed for analysis.

Evaluation of the performance effects of the processed PBA with layers

ii. Experimental Animals and Design

Two hundred and forty (240) Isa brown layer birds that are 16 weeks in lay and raised in a reputable farm was used for the experiment. The birds were housed in a standard layer pen on deep litter and divided into four groups of sixty birds per group and each group further replicated three times with ten birds per replicate in a completely randomized design (CRD). The birds were reared under proper feeding, medication and vaccination management as practiced at the Teaching and Research Farm of FUTO. Briefly, the birds were fed commercial mash, starting with chick mash for the first eight weeks of life, followed by grower mash till point of lay (18- 20 weeks) before changing to layer mash. At 13 weeks of lay, the birds were divided into their respective groups and replicates on deep litter such that the maximum stocking density will be 20 mature hens (Oluyemi and Roberts, 2000).

On the 16th week of lay, the birds were assigned to the experimental diets (T1 to T4) and were fed the experimental diets for two weeks to acclimatize them before data collection. The birds were given feed at 0.13kg per bird per day (Oluyemi and Roberts, 2000) and water *ad libitum* throughout the experimental period of twelve weeks. Data collection commenced from the 18th week of lay and lasted for 12 weeks.

Table1: Ingredient composition of SFA supplemented diets in layer birds (100kg)

Ingredients	T1	T2	T3	T4
Maize	44.00	44.00	44.00	44.00
Wheat offal	19.00	19.00	19.00	19.00
Soya bean meal	16.00	16.00	16.00	16.00
Brewers Dried Grain	5.00	5.00	5.00	5.00
PKC	4.00	4.00	4.00	4.00
Fish meal	1.60	1.60	1.60	1.60
Limestone	7.00	7.00	7.00	7.00
Bone meal	2.50	2.50	2.50	2.50
Premix	0.25	0.25	0.25	0.25
Lysine	0.20	0.20	0.20	0.20
Methionine	0.20	0.20	0.20	0.20
Salt	0.25	0.15	0.10	0.05
Ash	-	0.10	0.15	0.20
Total	100	100	100	100
Nutrient calculated				
Crude protein	16.20	16.20	16.20	16.20
Crude fibre	5.7	5.7	5.7	5.7
Met. Energy (ME. Kal/kg)	**2650**	**2650**	**2650**	**2650**

Vitamin premix contains the following per kg of feed: Vit A = 5,000,000IU, Vit D3 = 1,000,000IU, Vit E = 1875IU, Vit K = 1255gm, Thiamin (B1) = 0.6255gm, Riboflavour = 1.875gm, Calcium panthothenate = 2.8kg, Nicotinic acid = 5.625gm, Pyridoxin = 0.625gm, Vit B12 = 5gm, folic acid = 0.31gm, Biotin = 0.1gm, Cholin chloride = 150gm, methionine = 75gm. Manganese = 5gm, Iron = 10gm, Copper = 1.5gm, Iodine = 0.5gm, Cobalt = 1.0gm, Selenium = 0.05gm, Antioxidiane 50gm, Antimold = 7.5gm, Nigrovin = 10gm, lysine = 75gm.

iii. Preparation of Experimental Diets

The feed ingredients used in diet formulation were purchased from a reliable source in Owerri, Imo State. Four experimental layer diets were formulated such that the control diet does not contain treated palm bunch ash, whereas the other three diets contained graded levels of the ash at 0.10, 0.15, 0.2 kg/100kg of feed respectively as replacement for common salt. All other ingredients were of equal proportions across the test diets (Table 1). The calculated nutrient values of the experimental diets were determined, while the mineral concentrations and dietary electrolyte balance (dEB) of the experimental diets were also assayed.

Data collection on production performance

- **a) Feed intake:** Daily feed intake of each treatment group was pre-determined each day by giving 0.13kg/bird and adding - up the quantity consumed by each replicate group.
- **b) Weight change:** The initial body weights of the birds in each replicate were taken at the beginning of the experiment and thereafter at the end of 12 weeks of feeding. Weight change was calculated by subtracting the initial weight values of the birds from their final weight values.
- **c) Hen-day production:** Eggs laid by each replicate group of birds were collected twice daily, morning (7-11am) and evening hours (4-5pm). The number of eggs collected each day was used to determine the hen-day production according to the method reported by Anyaehie (2006).

  Hen-day egg production (%)

$$\frac{\text{Total No. of eggs laid/day}}{\text{No of Birds alive}} \times \frac{100}{1}$$

- d) **Weekly average egg weight**: The average weekly egg weight was determined by weighing of each egg produced by each replicate group of birds with an electronic balance (Binatone BF- 400) on a specified day of the week.
- e) **Egg mass:** All eggs collected from each replicate were weighed with an electronic digital scale to determine average egg weight and the daily values were summed weekly to obtain the weekly egg mass.
- f) **Egg conversion ratio**: The egg conversion ratio was determined by calculating the quantity of feed required to produce 1kg of egg.
- g) **Economics of Egg Production**: The economics of egg production was determined by calculating the cost of each treatment diet, obtained by calculating the costs of the ingredients used in formulating each treatment diet as against the revenue from egg sales.

3.0 RESULTS

i. Proximate composition of experimental layer diets

The results of the proximate analysis of the experimental layer diets are presented in Table 2

Table 2: Proximate composition of the experimental layer diets

Parameter	T1	T2	T3	T4	SEM
Dry matter content %	92.00	91.40	91.61	91.64	0.56
Moisture %	8.00^{c}	8.60^{a}	8.39^{b}	8.36^{b}	0.07
Crude Protein %	21.86^{a}	21.09^{b}	20.15^{c}	18.08^{d}	0.63
Crude fat %	4.32^{a}	2.99^{b}	2.58^{c}	2.20^{d}	0.24
Crude fibre %	4.27^{d}	4.46^{c}	4.76^{b}	4.98^{a}	0.08
Total Ash %	11.68^{d}	12.18^{b}	12.07^{c}	12.45^{a}	0.08
NFE	47.10^{d}	50.68^{c}	52.05^{b}	54.76^{a}	0.83

Means with different superscript on the same horizontal row are significantly different @P< 0.05

ii. Mineral composition of experimental layer diet

The mineral concentrations in the experimental feeds are shown in Table 3.

Table 3: Mineral concentration in the experimental layer diets

Parameters	T1	T2	T3	T4	SEM
Ca	23064.11^{d}	24772.10^{b}	23866.09^{c}	25363.32^{a}	264.26
Mg	2780.47^{a}	2711.05^{ab}	2601.50^{b}	2790.08^{a}	31.10
K	10600.15^{d}	11620.64^{c}	12109.72^{b}	12523.33^{a}	216.45
P	2800.72^{d}	3008.95^{c}	3264.44^{b}	3540.80^{a}	85.72
Na	2303.30^{a}	2108.75^{b}	2095.37^{c}	2055.60^{d}	28.93
Mn	73.23^{a}	69.22^{b}	66.76^{c}	62.68^{d}	1.16
Fe	169.33^{d}	195.56^{b}	183.38^{c}	208.73^{a}	4.41
Cu	9.13^{d}	9.55^{c}	10.98^{b}	12.54^{a}	0.40
Zn	40.40^{c}	43.29^{b}	44.04^{b}	47.09^{a}	0.75
Cr	3.27	3.25	3.31	3.28	0.01
Cl	2.55^{d}	2.69^{c}	2.79^{b}	3.07^{a}	0.06

Means with different superscript on the same horizontal row are significantly different @P< 0.05

iii. The mineral ratios and the dietary electrolyte

The mineral ratios and the dietary electrolyte balance results of the experimental layer diets are shown in Table 4.

Table 4: Mineral ratios and the dietary electrolyte balance of the experimental layer diets

Parameters	T1	T2	T3	T4	SEM
Sodium/Potassium ratio	0.22	0.18	0.17	0.18	0.01
Calcium/ Phosphorus ratio	8.24a	8.23a	7.24b	7.16b	0.16
Dietary electrolyte balance	371.48d	389.13c	401.08b	409.92a	4.34

Means with different superscript on the same horizontal row are significantly different @P< 0.05

iv. Laying performance of hens fed SFA supplemented diets

Table 5 show the laying performance of the hens fed the SFA supplemented diets.

Table 5: Laying performance of hens fed SFA supplemented diets

Parameters	T1	T2	T3	T4	SEM
Initial weight(g)	1816.67	1940.00	1966.67	1816.67	38.21
Final weight (g)	1700.00	1700.00	1833.33	1733.33	38.84
Weight change (g)	-116.67^{b}	-240.00^{c}	-133.33^{b}	-83.33^{a}	61.11
Feed intake (g)	120.33^{c}	120.67^{c}	130.00^{a}	126.00^{b}	1.22
Hen day production (%)	76.66^{b}	85.57^{a}	85.77a	80.00^{ab}	1.41
Egg mass	46.00^{b}	52.67^{a}	57.46^{a}	48.00^{b}	0.85
Egg conversion ratio	2.60^{a}	2.30^{b}	2.53^{a}	2.63^{a}	0.04

Means with different superscript on the same horizontal row are significantly different @P< 0.05

v. Cost benefit analysis of egg production

Table 6 shows the cost benefit analysis of egg production from laying hen fed processed palm bunch ash supplemented diets.

Table 6: Cost- benefit analysis of laying hens fed PBA

Parameters	T1	T2	T3	T4	SEM
Total feed intake (Kg)	10.07^{c}	10.13^{c}	10.92^{a}	10.57^{b}	0.11
Total egg produced	64.00^{c}	72.00^{a}	72.00^{a}	67.00^{b}	1.06
Cost of feed consumed (N)	1329.68^{c}	1337.60^{c}	1441.44^{a}	1395.68^{b}	13.92
Feed cost/crate of egg (N)	623.39^{a}	558.76^{c}	600.69^{b}	625.00^{a}	8.43

Revenue (N)	3200.00[c]	3600.00[a]	3600.00[a]	3350.00[b]	52.99
Profit (N)	1870.32[c]	2262.40[a]	2158.56[b]	1954.32[c]	48.82

Means with different superscript on the same horizontal row are significantly different @P< 0.05

4.0 DISCUSSION

i. Proximate composition of experimental layer diets

The dry matter contents of the experimental diets were adequate for laying hens while the corresponding moisture contents were lower than the 12 -15% recommended for tropical poultry rations (Esonu, 2006). The crude protein values were relatively high with the control diet recording 21.86% which was significantly higher than the values recorded by the ash supplemented diets. The variations in these crude protein values are interesting since the only variable factor in the feed is the graded ash supplementation. The calculated nutrient compositions reported in table 1. gave the crude protein value as 16.20%, crude fibre as 5.7% and metabolizable energy as 2650kcal/kg indicating that ingredient values used in the calculation of the CP are low. These values are however within the ranges allowed for laying hens in the tropics (SON, 2003). It is also of note that the CP values decreased significantly ($p<0.05$) with increasing inclusion values of the SFA, such that the control diet recorded the highest value, while T4 recorded the lowest. Adsorbent materials such as activated carbon, and different feed grade clays, and aluminosilicates have been shown to reduce the concentration of nitrogen in diets without negative effects on production performance (Machacek *et al*., 2010). This has been attributed to the strong binding properties of these materials that make the nitrogen partially unavailable to laboratory analysis (Grenier and Applegate, 2013). It is therefore possible that the SFA has some adsorbent properties that made it to reduce the CP, and crude fat contents of the experimental diets.

The crude fibre values although significantly different ($p<0.05$) across feed sample were similar to the calculated values of 5.7% reported in table 3.1. The total ash content expectedly increased with the increasing inclusion levels of the ash supplement, with T4 recording significantly higher ($p<0.05$) value than the rest, and the control recording the lowest. Indeed, Duruanyim (2017) had observed that because of its high water holding capacity, palm bunch ash in its raw form has the potential of being a carrier or absorbent of essential water soluble nutrients and chemical. The NFE values also increased progressively with increasing SFA supplementation with the control diet recording significantly lower ($p<0.05$) than the ash supplemented diets and the T4 equally recording significantly higher values ($p<0.05$) than the others.

ii. Mineral composition of experimental layer diet

Expectedly the concentrations of most of the macro – minerals (Ca, Mg, K and P), micro- minerals (Fe, Cu, and Zn) and Cl increased significantly ($p<0.05$) with increasing supplementation level of the SFA, such that T4 recorded the highest levels. Sodium and Mn values however decreased with the increasing SFA supplementation level, such that the control values were significantly lower ($p<0.05$) than the values recorded in the ash treated diets. This is probably because the ash sample was included as a partial replacement of salt in the diets. The decrease in Mn contents however cannot readily be explained except by the possibility that the common salt partially replaced with SFA also contains Mn in addition to its major constituents of Na, and Cl.

iii. Mineral ratios and the dietary electrolyte balance

There was a progressive reduction in the Ca/P ratio with increasing inclusion levels of the SFA in the layer diets. The T1 and T2 values were similar, and significantly higher ($p<0.05$) than the T3, and T4 values. Pastore *et al.* (2012) studied the effects of three Ca/P ratios (12.12:1, 10.53:1 and 9.30:1) in layers, and reported that the 12.12:1 ratio met the requirement for calcium, and available phosphorus in white egg layers during the period from 42 to 58 weeks of age. The range of Ca/P ratios recorded in this study (7.16 -8.24) were much lower, but similar to the 7.2 – 8.37 ratios reported by Chandramoni *et al*. (1998) as the optimal ratio in diets for caged layers in a tropical climate.

The Na/K ratio values were similar across treatments. Unamba- Opara *et al*. (2017) reported a range of 0.04 – 0.32 Na/K ratio in commercial layer rations sold in Nigeria. These values are similar to the range of 0.17- 0.22 recorded in the present study, and are also with normal reference values for laying hens in the tropics (SON, 2003).

The dietary electrolyte balance (DEB) calculations for the diets showed expectedly that values increased significantly ($p<0.05$) with the increasing inclusion levels of the SFA. The values ranged from the 371.48 meq/kg diet recorded in the control to the 409.92 meq/kg diet recorded in T4. Nobakht *et al*. (2007) recommended a DEB of 360mEq/kg diet during the early laying periods although this could be adjusted during different periods of production. Unamba- Opara *et al*. (2017) reported a range of 161.16 to 326.61 mEq/Kg diets in commercial layer rations sold in Nigeria. It would therefore seem that the values recorded in our experimental diets are relatively high, and may influence layer performance.

iv. Laying performance of hens fed SFA supplemented diets

Generally, T2 and T3 groups recorded superior values for all the parameters measured, indicating probably that the SFA supplementation at 0.10 – 0.15kg/100kg diet may be optimal for egg production. Specifically, the T4 birds recorded significantly lower loss ($p<0.05$) in weight due to laying intensity than the other groups after 12 weeks of lay. The T2 group recorded significantly higher weight loss ($p<0.05$) than the other groups which is reflective of its significantly lower ($p<0.05$) feed intake than T3 and T4.

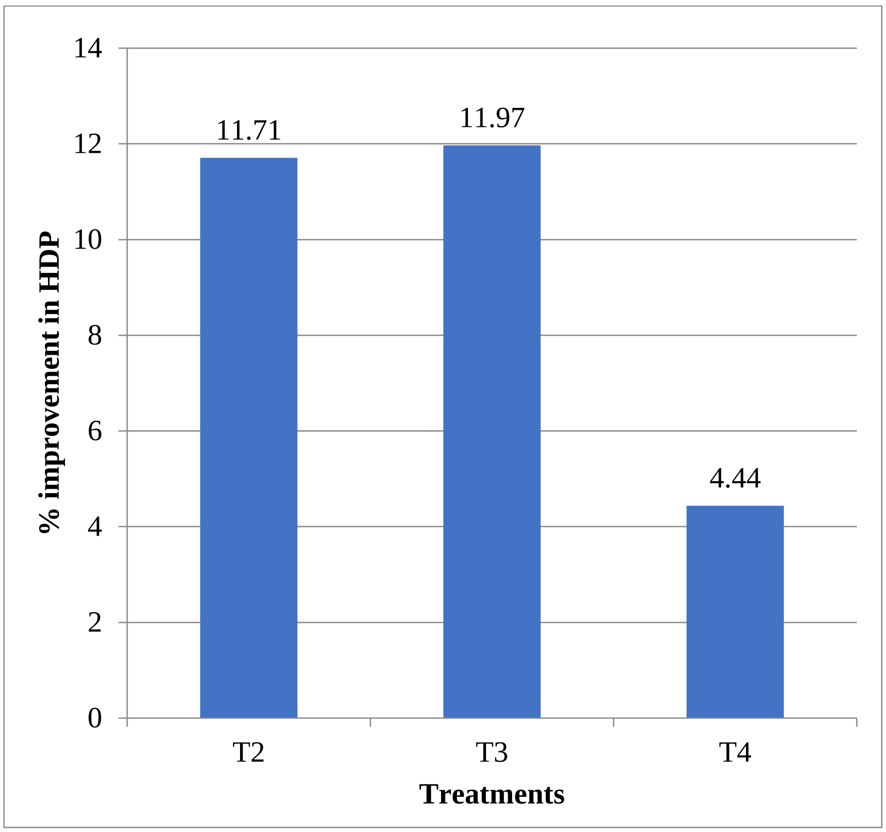

Fig. 1: The percentage improvements in the HDP due to SFA supplementation of layer diets

Progressive reduction in feed intake, irrespective of animal species or type of plant ash with increasing ash inclusion levels in the diets of livestock has been a recurrent observation in the reports of several authors (Ebere, 2013; Iwu, 2013; Nwogu, 2013; Ohanaka, 2016). This phenomenon has been attributed to the high alkalinity caused by the high potassium contents of the ash supplemented diets (Ohanaka, 2016). Nwogu (2013) also reported that egg mass, hen day production, and shell thickness were progressively reduced as a result of this reduction in feed intake, while Ohanaka (2016) reported significant reductions in broiler growth. The present feed intake, and egg mass results therefore shows that the soaking and filtering of palm bunch ash to alter its mineral compositions

(SFA), and inclusion of then SFA in layer diets as partial replacement of common salts successfully abolished the adverse reduction in feed intake, and other laying performance indices.

The percentage hen day production (HDP) increased significantly above the control value ($p<0.05$) as a result of the 0.10, and 0.15kg/100kg feed (T2 and T3) supplementation of the SFA, but declined to statistically similar value ($p<0.05$) with the control at the 0.2kg/100kg feed supplementation level (T4). The T2, and T3 results were also statistically similar ($p<0.05$). The percentage improvement in the HDP due to the SFA supplementation (Fig 1) shows that the best effects (11.71 and 11.91%) were achieved at the 0.1, and 0.15 Kg/100kg feed inclusion levels. The 0.1kg/100kg supplementation level could therefore be regarded as the optimum SFA supplementation level in laying hens.

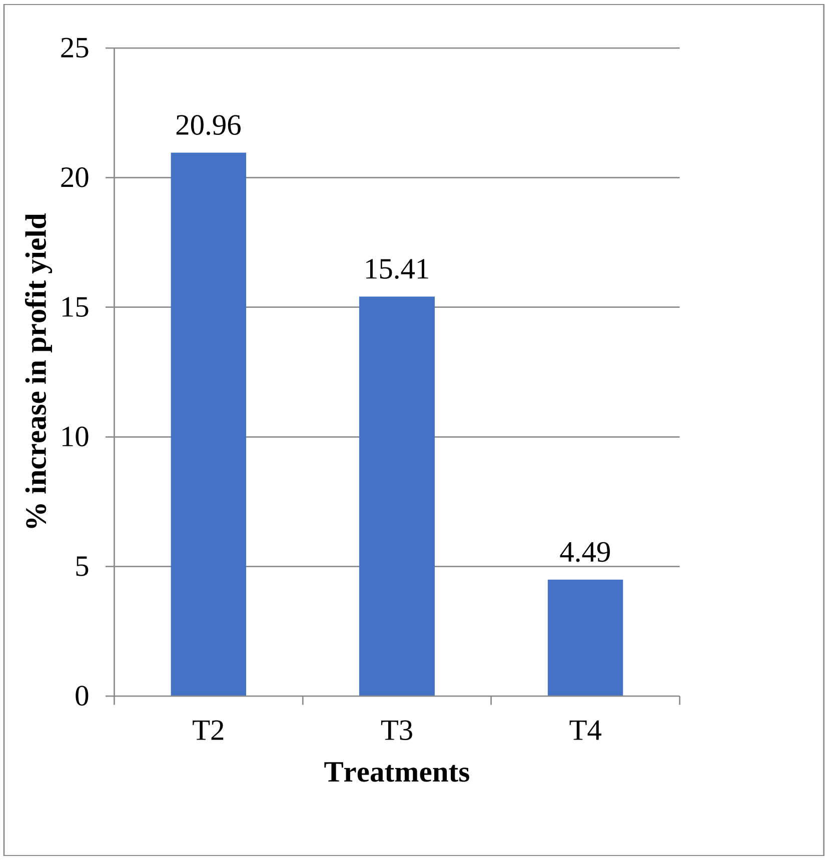

Fig. 2: Percentage increase in the profit yield due to SFA supplementation of layer diets

These results are different from those reported by Nwogu (2013) on the effects of plantain stalk and rootbase derived ashes on the percentage HDP of hens at their early stages of lay. Specifically, parameters such as age at first lay, weight of first egg, weekly number of eggs, % HDP, and egg weight were adversely affected by the plantain ash supplementation up to 3g/Kg body weight. The study therefore concluded that supplementation of the plantain ashes were generally detrimental to the laying performance of the birds. In the present study, the DEB values that supported the optimal improvements in the %HDP ranged from 389.13 – 401.08 mEq/100kg diet (Table 4.5), with the lower range being preferred. It is similar to the 360mEq/100kg diet recommended by Nobakht *et al*. (2007) for laying hens. The egg conversion ratio results followed a similar trend with the HDP results, with T2 recording the most superior results. Overall, the laying performance results show that the 0.1 and 0.15kg/100kg diet supplementation of SFA in partial replacement of common salt recorded the best results, followed by the 0.2kg/100kg diet supplementation level.

v. Cost benefit analysis of egg production

The SFA treated birds produced higher numbers of egg (67.00 – 72.00) than the control birds (64.00). This trend was also observed in both revenue, and profit results. Based on the feed consumption and feed cost results, the ash treated birds recorded significantly higher ($p<0.05$) revenues and profit margins with T2 and T3 values. Also being significantly higher than the T4 ($p<0.05$) suggesting that hens fed SFA supplemented diets yielded higher returns than the control birds. This higher return translated to 4.49 – 20.96% increase in the profit yield from the control birds as shown in Fig 2.

5.0 CONCLUSION

The supplementation of layer diet with SFA is recommended at the inclusion levels of 0.1 and 0.15kg /100kg diet, based on their ability to elicit superior feed intake, egg mass, hen day production.

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