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Partial replacement of maize with palm oil (*Elaeis guineensis*) Sludge in broiler chicken diet: Effect on the haemato-biochemical properties and carcass characteristics

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Abstract
A feeding trial was carried out to elucidate the effect of replacing maize with Palm Oil Sludge on blood profile and carcass characteristics of broiler chicken. A completely randomized design was used for 200 (day old) broiler chicks. Palm Oil Sludge was incorporated in the experimental diets (mash form) at 0% (Group-1, control), 10% (Group-2), 15% (Group-3) and 20% (Group-4) to replace maize as energy source for a period of 6 weeks. Blood collection was done at 2 different occasions i.e. on 21st and 42nd day. The blood biochemical and hematological parameters showed no significant (P>0.05) difference among the groups in both the collections. At the end of the experiment, 20 birds, one from each replicate were selected for evaluation of carcass traits. The result obtained showed no significant difference (P>0.05). The sensory parameters showed no significant difference (P>0.05) as well. However, Juiciness showed significant difference ($P\leq$0.05).

Keywords: Palm oil sludge, broiler chicken, haemato-biochemical, carcass characteristics

Introduction
Poultry meat is an important source of high quality proteins, minerals and vitamins to balance the human diet. To achieve optimum economic benefit within short time it is important to provide balanced diet to the commercial broilers. However, Maize, due to it high cost, it is becoming more expensive to use at high level in poultry feeds. Therefore, unconventional feed resources such as POS can be an alternative as total or partial replacement of maize in feeding of poultry birds as it is cheaper and locally available in abundance.
Palm oil, sometimes known as African Oil Palm or Macaw fat, belongs to the genus: *Elaeis*, Species: *E. Guineensis*, was first describe by Michel Adanson [1]. Palm Oil Sludge (POS) is the material that remains after decanting the palm oil mill effluent [2]. Palm oil sludge has a crude protein of 9.6% and metabolisable energy of 4245 kcal/kg [3]. This makes it relatively comparable to maize with protein content of 9% and metabolisable energy of 3434 kcal/kg. Studies [4] have shown that POME contain organic and essential nutrient which may be used to grow micro-algae as natural food for aquatic organism and it could be used as fertilizers and animal feeds [5]. This study was designed to assess the effect of replacing up to 20% energy from dietary maize with energy supplied by palm oil sludge on blood haemato-biochemical properties and carcass characteristics of broiler chicken.

Materials and Methods
The research work was carried out in the Instructional Livestock Farm and Department of Livestock Product Technology, College of Veterinary Sciences & Animal Husbandry, Selesih, Aizawl.

Experimental design and management:
A basal diet of 23% crude protein and 3000 kcal/kg ME for pre-starter, 22% crude protein and 3100 kcal/kg ME for starter and 20% crude protein and 3200 kcal/kg ME for finisher was formulated. The maize was then replaced with the palm oil sludge at the rates of 0%, 10%, 15% and 20% in diet-1, diet-2, diet-3 and diet-4, respectively. During the 42 days feeding trial, a total of 200 numbers of day old broiler chickens of either sex was randomly distributed into four groups of fifty (50) birds each.

In each group, there were 5 replicate with ten (10) birds each. Each group was randomly divided into four dietary treatment groups of five replicates to study the effect of Palm oil sludge on haemato-biochemical properties, carcass traits, dressing percentage and sensory evaluation of broiler. Birds were raised under deep litter system of management. They were subjected to standard management and health practices. Drinkers was washed daily and fresh feed and water was served daily *ad libitum*. After taking the body weight (day old), birds were randomly allocated to dietary treatment in which 0, 10%, 15%, 20% of Maize was replaced on a weight for weight basis with sludge in a mash form. The birds were fed twice daily at 6:00 am in the morning and 4:00 pm in the evening.

Blood collection was done from 2 birds per replicate on 21st and 42nd day of the feeding trial from the wing vein. Blood samples were collected from the wing vein on inner side of the elbow joint of the birds. A 2 ml Tuberculin syringe fitted with a sterile needle was carefully inserted into the vein after manual ligation and about 2 ml of blood were withdrawn and quickly added to Vacutainer containing Ethylene Diamine Tetraacetic Acid (EDTA). The sample bottle was shaken gently to mix up the blood with the EDTA to prevent clotting. For estimation of blood biochemical parameter, another 2 ml of blood was taken in a vacutainer having clot activator and the serum was separated by centrifugation at 4000 rpm for 5 minutes and stored at -20 ^{o}C until further analysis. At the end of the trial 1 birds per replicate was sacrificed to obtain the relative organ weight, carcass characteristics and muscle development as described [6]. Carcass weight was recorded after removing head, feathers, lungs, shank and the viscera. Dressing percentage was calculated by the formula:

$$\text{Dressing percentage} = \frac{\text{Carcass weight}}{\text{Live weight}} \times 100$$

Sensory Evaluation

Cuts obtained from the breast region from different carcasses were cooked for 25 minutes under the same temperature and pressure and were subjected to sensory evaluation on an 8-point hedonic scale for various sensory attributes of appearance, flavour, juiciness, texture and overall palatability.

Statistical analysis

The data were analyzed using general linear model procedure [7] for discussion, interpretation and result.

Results and discussion

Effect of replacing maize partially by palm oil sludge on blood biochemical and hematological parameters:

Effect of replacing maize partially by palm oil sludge on hematological parameters:

The hematological parameters like hemoglobin, White blood cells, total erythrocyte count and differential leukocyte count are shown in Table 1.

Table 1: Effect of replacing maize partially by palm oil sludge on hematological parameters:

WBC (m/mm^3)	G 1	G 2	G 3	G 4	P value
1st collection	18.50±1.29	17.84±2.45	17.06±1.95	17.83±2.25	0.968
2nd collection	18.42±2.31	17.86±1.25	17.44±0.76	16.83±1.79	0.916
RBC (m/mm^3)					
1st collection	2.22±0.15	2.18±0.15	2.31±0.15	2.20±0.28	0.961
2nd collection	2.56±0.38	2.28±0.34	2.53±0.34	2.41±0.18	0.906
HCT %					
1st collection	23.63±1.31	19.64±0.82	26.15±3.008	25.1±2.92	0.223
2nd collection	24.44±1.93	23.13±2.71	28.25±2.35	25.7±2.26	0.475
MCV (μm^3)					
1st collection	106.11±1.17^a	105.21±1.99^a	115.5±2.31^b	114.78±2.81^b	0.006*
2nd collection	110.07±2.16	113.13±9.97	111.61±3.07	106.4±0.62	0.831
Hb (g/dl)					
1st collection	7.85±0.49	7.97±0.46	7.76±0.72	8.23±0.71	0.952
2nd collection	7.83±0.89	7.4±0.66	7.98±0.53	8.08±0.77	0.915
THR (m/mm^3)					
1st collection	255.7±21.19	263.3±50.37	248.6±12.47	243.8±13.40	0.966
2nd collection	263.1±19.97	258.36±32.34	244.2±15.25	229.1±24.33	0.745
Differential leukocyte count (%)					
Lymphocyte					
1st collection	45.41±2.10	46.83±4.22	46.82±4.77	50.94±2.37	0.721
2nd collection	47.7±2.96	48.42±2.48	48.37±1.46	46.3±1.92	0.903
Monocyte					
1st collection	11.88±1.7	11.42±0.57	11.43±0.63	11.3±0.85	0.956
2nd collection	10.91±0.46	11.69±0.46	11.53±0.94	12.79±0.76	0.356
Granulocyte					
1st collection	44.63±3.52	40.83±4.35	42.92±4.32	43.74±2.98	0.909
2nd collection	45.59±5.22	45.06±4.54	42.93±2.87	41.51±2.84	0.878

Values with different superscript in same row differ significantly ($P \leq 0.05$)

All data obtained during analysis on both the occasions was not significant ($P>0.05$) except for MCV (μm^3) at 21st day collection, which showed significant ($P \leq 0.05$) difference among the groups. This, probably, was due to stress and poor nutrition, as slight fall in MCV level in blood is usually attributed to malnutrition or low iron or high mineral intake (table 1). However, on 42nd day collection the data recorded for MCV (μm^3) showed no significant ($P>0.05$) difference among the groups that may be due to absence of stress towards the end of the experiment as well as with increase in the age the birds could probably maintain proper nutrition. It is [8] reported that the hematological variables of the broiler chickens were not significantly (*P*>0.05) influenced by dietary treatments, which supports the present study. It is also [9] reported that decreased RBC is usually associated with low quality feed and protein deficiency. The hematological values of the present study were comparable to those quoted for domestic and commercial chickens [10, 11].

Effect of replacing maize partially by palm oil sludge on blood biochemical parameters:

Blood biochemical parameters like blood glucose, protein, uric acid, SGOT and SGPT are given in Table 2. Blood glucose, protein, uric, Blood SGPT and Blood SGOT Mean ± S.E estimated values showed no significant difference (*P*>0.05) among the groups.

Table 2: Effect of replacing maize partially by palm oil sludge on blood biochemical parameters

Glucose(mg/dl)	G 1	G 2	G 3	G 4	P value
1st collection	246.07±16.73	244.75±21.075	244.07±18.78	246.09±14.68	1.00
2nd collection	249.33±20.50	245.98±18.33	245.95±17.49	246.82±17.85	0.999
Protein (mg/dl)					
1st collection	4.15±0.36	4.06±0.38	4.35±0.55	4.71±0.4	0.730
2nd collection	4.22±0.41	4.22±0.370	4.07±0.35	4.13±0.15	0.988
Uric acid (mg/dl)					
1st collection	5.45±0.42	5.2±1.19	4.34±0.88	5.7±0.53	0.670
2nd collection	5.45±0.4	5.35±0.54	5.22±0.43	4.96±0.42	0.883
SGPT (U/ml)					
1st collection	24.65±0.99	26.3±0.73	26.06±1.21	26.4±1.07	0.606
2nd collection	25.56±0.4	28.03±2.18	26.92±0.68	28.95±1.66	0.398
SGOT (U/ml)					
1st collection	182.8±24.04	154.4±14.32	163.6±6.24	209.7±20.78	0.170
2nd collection	165±18.11	131.1±11.79	162.9±12.98	212.7±28.15	0.053

A similar finding [12] was observed in an experiment conducted with unconventional feed (Indomie waste-based diets) in broiler chicken both in hematological as well as biochemical blood profile. In the present study the hematological and blood biochemical values obtained were within the normal range which is indicative of the facts that palm oil sludge based diets were adequately utilized thus indicating the normal functioning of the internal organs, absence of anemia and stress related problems of the experimental birds.

Carcass characteristics of broilers

There was no significant difference (*P*>0.05) in the live weight of experimental birds among the four groups. The inclusion of palm oil sludge at 0%, 10%, 15% and 20% levels by replacing maize in the diet of the broiler had no significant effect (*P*>0.05) on dressed carcass, head, shank, drumette, thigh, drumstick, wing, wingtip, neck, back, breast, heart, liver, gizzard, spleen, abdominal fat and oil gland as shown in Table 3.

Table 3: Effect of replacing maize partially by palm oil sludge on dressing percentage and other carcass traits of experimental birds

Features	G1	G2	G3	G4	P value
Live weight (g)	2096.2±73.65	2107.2±48.77	2276.4±53.40	2192.2±111.83	0.335
Dressedcarcass (g)	1558.88±64.59	1575.64±31.44	1710.24±43.91	1587.28±69.32	0.227
Head (g)	53.8±3.85	52.24±3.68	56.72±1.54	56.72±1.95	0.641
Shank (g)	76.86±4.35	82.24±1.25	89.44±4.57	85.04±3.65	0.151
Drumette (g)	78.52±0.65	80.36±1.59	87.16±7.58	82.4±1.86	0.480
Thigh (g)	242.32±13.86	234.96±7.95	251.88±8.33	249.68±15.30	0.740
Drumstick (g)	171.16±8.25	184.84±6.3	208.6±13.13	183.48±5.12	0.056
Wing (g)	56.96±1.61	55.24±1.4	60±1.67	58.72±1.86	0.203
Wingtip (g)	19.44±0.67	18.28±0.5	19.56±0.82	19.12±0.51	0.506
Neck (g)	73±4.84	82.04±3.451	86.64±5.80	80.72±2.50	0.206
Back (g)	286.2±9.11	290.04±12.12	324.04±9.63	285.84±12.69	0.073
Breast (g)	512.88±26.64	508.24±5.96	542.2±22.19	506.16±31.32	0.682
Heart (g)	15.12±0.74	12.64±0.50	14.84±1.13	12.76±0.37	0.055
Liver (g)	46.12±1.53	50.96±2.25	48±1.30	45.52±2.53	0.244
Gizzard (g)	38.84±2.19	41.44±2.19	46.88±2.51	44.64±4.091	0.279
Spleen (g)	3.04±0.43	2.88±0.18	2.84±0.39	3.2±0.17	0.852
Abdominal fat (g)	11.28±4.93	18.84±3.33	11±1.82	10.56±4.29	0.380
Oil gland (g)	16.92±0.93	16.16±2.19	17.52±1.67	17±1.61	0.951
Dressing %	74.30±0.75	74.8±0.61	75.13±0.84	72.52±0.96	0.143

Dressing Percentage

The dressing percentage was observed as 74.30±0.75, 74.8±0.61, 75.13±0.84 and 72.52±0.96 for group-1, group-2, group-3 and group-4, respectively. Statistical analysis showed that there were no significant differences (*P*>0.05) among the groups in respect to dressing percentage. A similar study [13] also showed result relevant to the present study.

Sensory Evaluation

Average values of the sensory evaluation (Table 4) done on various sensory attributes of appearance & colour, flavour, texture, juiciness and overall acceptability.

Table 4: Effect of replacing maize partially by palm oil sludge on sensory evaluation of carcass of broilers

Attributes	G1	G2	G3	G4	P value
Appearance and colour	7.14±0.14	7.12±0.11	7.2±0.12	7.14±0.12	0.974
Flavour	7.03±0.11	7.21±0.11	7.23±0.11	7.09±0.13	0.557
Texture	7.09±0.13	7.12±0.13	7.34±0.12	7.25±0.11	0.484
Juiciness	6.96±0.11^{a}	6.98±0.13^{a}	7.37±0.114^{b}	7.42±0.10^{b}	0.007*
Overall acceptability	7.21±0.11	7.14±0.10	7.39±0.0.86	7.43±0.09	0.119

Values with different superscript in same row differ significantly ($P \leq 0.05$)

Statistical analysis showed no significant difference for parameters like appearance & colour, flavour, texture and overall acceptability ($P > 0.05$) among the groups. But juiciness showed significant difference ($P \leq 0.05$). Group 1 and group 2 showed comparable results but differed significantly ($P \leq 0.05$) from group-3 and group-4, whereas group-3 and group-4 were comparable to each other. Juiciness as observed showed increasing trend with increasing level of palm oil sludge in the diet. With increasing level of palm oil sludge in the diet rice bran oil was added in an increasing order as well to balance ME content of the diet. Juiciness in meat is attributed to water retention capacity and marbling effect which is dependent on dietary fats (high energy). Lipids are the key ingredient for marbling [14], thereby increasing the juiciness of meat.

Conclusion

From the above study, it may be concluded that:

1. Palm oil sludge can be used in broiler ration by partially replacing maize grain without causing adverse effect on the haemato-biochemical properties of the birds. Palm oil sludge was not found to have any deleterious effect on broilers even at 20% level of inclusion as a substitute of maize.
2. It is revealed that broilers fed palm oil sludge based diets had demonstrated no detrimental effect on the carcass traits.

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