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Effects of feeding Cashew Apple Waste with or without Supplementation of Non-starch Polysaccharide Degrading Enzymes on Nutrient Digestibility and Growth Performance of broilers

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ABSTRACT

The current research was carried out to study the effect of different inclusion level of cashew apple waste (CAW) to improve the ileal digestibility of nutrients and performance of broilers supplemented with non-starch polysaccharides (NSP) degrading enzymes. Two hundred and ten day-old Vencobb broiler chicks divided into 7 groups with 3 replicates of 10 chicks in each. Birds of groups G_1, G_2, G_3 which received CAW at 0, 5 and 10 per cent, respectively. G_4 and G_5 birds fed with 5 per cent CAW, and were additionally fed NSP degrading enzyme at 500 g and 750 g/ton, respectively. Similarly, G_6 and G_7 birds received 10 per cent CAW, and NSP degrading enzyme at 500 and 750 g/ton, respectively. Ileal digestibility values of dry matter, crude protein and crude fibre were significantly (P<0.01) increased in enzyme supplemented group with CAW. Feed intake did not differ significantly (P<0.11) among the groups at 42nd day. Body weight Gain and feed conversion ratio recorded in experimental birds received 10 per cent CAW and NSP degrading enzyme at 750 g/ton was comparable to control group (G_1). However, better feed conversion efficiency (P<0.01) was recorded G_4 and G_5 group birds compared to control (G_1). Thus, CAW could be included in corn, soya bean meal based broiler ration at 10 % level with NSP enzyme at 75 0 g/ton.

Key words: Broilers, Body weight gain, Cashew apple waste, FCR, Ileal digestibility, NSP Enzyme

INTRODUCTION

In India, broiler industry had shown annual growth rate of 11.00 per cent during year 2018 (DAHD, 2018). However, high cost and scarcity of conventional feed ingredients especially for energy and protein sources has led to utilization of agricultural by products/ unconventional feedstuffs in poultry feed formulations to check the ever increasing feeding cost. The inclusion level of un-conventional feedstuffs is limited, because of lack of knowledge on nutritive value, digestibility, anti-nutritive factors, and safety (FAO, 2011).

The use of alternate feedstuffs to replace maize and soya bean meal in poultry feed is practiced by commercial feed formulators considering fiber and non-starch polysaccharides (NSP) content. The NSP's like galactosides (raffinose and stachyose) hemicelluloses, mannans and glucans will not be digested in small intestine of poultry because of lack of endogenous NSP's enzymes like glycosidase, mannase, protease and glucanase (Iirish *et al.,* 1995). Thus, broiler diets with high NSP content might result in gas accumulation and diarrhea and addition of exogenous NSP degrading enzymes are thus recommended to improve the nutritive value of poultry ration (Wu *et al.,* 2005).

Cashew apple (*Anacardium occidentale*) waste (CAW) is one of the by-product from the cashew apple processing industry which is seasonally available in India. About, 65 lakh metric tonnes of cashew apple were wasted in India and 4.97 lakh metric tonnes of cashew apple were wasted in Kerala (Murugan *et al.,* 2015). The CAW can be considered as energy source to replace maize in broiler diets without any adverse effect (Bhamare *et al.,* 2016). Different studies were conducted to study the effects of enzyme as single enzyme and combination of different NSP enzymes in broiler ration with unconventional feedstuffs (Moftakharzadeh *et al.,* 2017). The presence of soluble

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NSP in unconventional feed stuffs like CAW has anti nutritional effect and restricts the inclusion in poultry diet but no research had been conducted. Hence the present experiment was carried out to evaluate ileal digestibility of CAW based diet with NSP enzyme supplementation and their influence on growth performance in broiler diets.

MATERIALS AND METHODS

The sun dried study material CAW was collected after juice extraction of cashew apple from M/S. Plantation Corporation of Kerala (Government of Kerala Undertaking, Kottayam). About 1000 g of sample was dried in a hot air oven at 60° C for 48 hours and ground to pass through 1mm sieve and preserved in air tight containers for chemical composition analysis. The samples were analyzed for proximate principles as per AOAC (2016) and acid insoluble ash content was analyzed as per BIS (IS: 14826; 2000).The calcium and phosphorus were estimated following procedure of Talapatra *et al.* (1940). Non Starch Polysaccharide (NSP) in terms of Neutral detergent fibre (NDF), Acid detergent fibre (ADF), Acid Detergent lignin (ADL) were analysed for CAW and experimental rations as per Van Soest *et al.* (1991). The difference between NDF and ADF was calculated as hemi-cellulose (HC) content and difference between ADF and ADL is noted as cellulose (C). The cell contents were calculated by 100 – NDF.

Two hundred and ten, day old commercial broiler (Vencobb-400) chicks were weighed individually; wing banded and randomly distributed to seven treatment groups *viz* G_1, G_2, G_3, G_4, G_5, G_6 and G_7 with three replicates of ten chicks in each group. The CAW were included at 0, 5 and 10 per cent in the experimental diets and multi-enzymes were supplemented at 0, 500 and 750 g/ton of feed. The details of experimental design are presented in Table 1. All the experimental diets were made iso-nitrogenous and iso-caloric, for pre-starter (0-14 days), starter (15-28 days) and finisher (29-42 days) phases as per ICAR (2013) nutrient recommendations. The true metabolizable value (TME) of 3676 kcal/kg Bhamrae, 2016 for CAW was considered and palm oil was added to prepare iso-caloric experimental diets. The ingredient composition of experimental diets is presented in Table 2.

All experimental chicks were reared in deep litter system in pens up to 6 week of age. The standard management practices were followed for rearing. The incandescent bulbs were provided at 1 watt per chick till 3rd week of age. Thereafter, light was provided only during night hours. The birds were provided with feed and clean drinking water *ad libitum* throughout the experimental period. On 42nd day of experiment, 42 birds (6 birds from each group) were randomly selected, fasted for 16 hours and anaesthetized and bled to death. The different segment of intestine was separated and ligated into duodenum, jejunum (from bile duct entrance to the Meckel's diverticulum), ileum (from the Meckel's diverticulum to 40 cm proximal to the ileocecal junction) and caecum (Ravindran *et al.,*2005). The undigested content in the ileum was squeezed gently without damage the ileal tissues and collected digesta in petri-dish was deep freezed at -20ºC for further

Table1: Details of experimental diets

Treatment Groups	Composition of experimental diets
G_1	Experimental diet without CAW + no enzymes
G_2	Experimental diet with 5 % CAW + no enzymes
G_3	Experimental diet with 10 % CAW + no enzymes
G_4	Experimental with 5 % CAW + multi enzymes @ 500 g/ton
G_5	Experimental diet with 5 % CAW + multi enzymes @ 750 g/ton
G_6	Experimental diet with 10 % CAW + multi enzymes @ 500 g/ton
G_7	Experimental diet with 10 % CAW + multi enzymes @ 750 g/ton

studies. Ileal digestibility of nutrients was calculated as per equation given by Zhang *et al.* (2014).

Ileal digestibility (%) =

$$100 - \frac{\text{Diet AIA \%}}{\text{Ileal digesta AIA \%}} \times \frac{\text{Ileal digesta nutrient \%}}{\text{Diet nutrient \%}} \times 100$$

Daily feed intake and weekly live body weight of all birds in each replicate were recorded. All the data obtained in this experiment were subjected to analysis of variance using SPSS software version 24.0.

RESULTS AND DISCUSSION

The chemical composition of CAW (on dry matter) used in the experimental diets are 87.10 ± 0.19 % dry matter (DM), 20.68 ± 0.27 % crude protein (CP), 2.90 ± 0.40 % ether extract (EE), 13.90 ± 0.11 % crude fibre (CF), 03.80 ±0.09 % total ash (TA), 58.72 ± 0.47 % nitrogen free extract (NFE), 96.20 ±0.12 % organic matter (OM), 0.76 ± 0.08 % calcium, and 0.40±0.11 % of phosphorus. Contents of NDF, ADF, ADL, cell contents, hemi-cellulose and cellulose (%, DM) in CAW were 60.00±0.31, 39.00±0.7, 14.80±0.17, 40.00±0.32, 21.00±0.51 and 24.20±0.30, respectively. The chemical composition of experimental diets is presented in Table 3.

The proximate composition of CAW as observed in this study was similar to that reported by Bhamare *et*

Table 2. Ingredient composition of experimental diets (%)

Group	Maize	SBM	CAW	Oil	DCP	Shell grit	*Additives	**Enzymes	Salt	Total
Pre-starter diet										
G_1	55.00	39.0	0	2.5	1	1.2	1.05	0	0.25	100
G_2	50.50	38.5	5	2.5	1	1.2	1.05	0	0.25	100
G_3	47.00	36.4	10	3.3	1	1	1.05	0	0.25	100
G_4	50.45	38.5	5	2.5	1	1.2	1.05	0.05	0.25	100
G_5	50.43	38.5	5	2.5	1	1.2	1.05	0.075	0.25	100
G_6	46.55	36.4	10	3.3	1	1	1.05	0.05	0.25	100
G_7	46.93	36.4	10	3.3	1	1	1.05	0.075	0.25	100
Starter diet										
G_1	58.00	35.5	0	3.15	1	1	1.05	0	0.25	100
G_2	53.50	34.9	5	3.25	1	1	1.05	0	0.25	100
G_3	50.65	32.5	10	3.5	1	1	1.05	0	0.25	100
G_4	53.45	34.9	5	3.25	1	1	1.05	0.05	0.25	100
G_5	53.43	34.9	5	3.25	1	1	1.05	0.075	0.25	100
G_6	50.60	32.5	10	3.5	1	1	1.05	0.05	0.25	100
G_7	50.58	32.5	10	3.5	1	1	1.05	0.075	0.25	100
Finisher diet										
G_1	62.00	30.7	0	3.95	1	1	1.05	0	0.25	100
G_2	56.45	30.7	5	4.5	1	1	1.05	0	0.25	100
G_3	52.65	29.5	10	4.5	1	1	1.05	0	0.25	100
G_4	56.40	30.7	5	4.5	1	1	1.05	0.05	0.25	100
G_5	56.40	30.7	5	4.5	1	1	1.05	0.075	0.25	100
G_6	52.60	29.5	10	4.5	1	1	1.05	0.05	0.25	100
G_7	52.58	29.5	10	4.5	1	1	1.05	0.075	0.25	100

*Feed additives in all experimental diets contains broiler trace mineral premix @ 0.15%, choline chloride 0.15 %, toxin binder 0.05 %, Liv-52 powder 0.15 %, DL- methionine 0.225 %, L- lysine 0.225 %, broiler vitamin premix 0.10 %; **Exogenous NSP degrading multi-enzymes with chemical composition (per kg) of amylase (24,00,000 Units), hemi-cellulase (54,00,000 Units), cellulase (1,20,00,000 Units), beta-glucanase (1,06,000 Units) and protease (24,00,000 Units).

Table 3 Chemical composition of experimental diets (%, Dry Matter Basis)

Group	DM	CP	CF	EE	Total Ash	NFE	AIA	Ca	Total P
Pre-Starter Diet									
G_1	88.50	22.98	5.21	3.70	5.35	62.76	1.49	1.14	0.42
G_2	88.00	22.68	5.41	2.80	5.30	63.81	1.70	1.19	0.46
G_3	87.80	22.58	5.58	3.20	5.40	63.24	1.70	1.21	0.42
G_4	87.90	22.71	5.32	3.15	5.26	63.56	1.60	1.17	0.48
G_5	88.10	22.79	5.26	3.14	5.31	63.50	1.75	1.65	0.41
G_6	88.00	22.61	5.49	2.98	5.32	63.60	1.76	1.68	0.42
G_7	87.90	22.66	5.71	3.10	5.39	63.14	1.72	1.18	0.38
Starter Diet									
G_1	88.00	21.90	4.80	3.43	5.34	64.53	1.64	1.14	0.43
G_2	87.90	21.59	5.30	3.45	5.59	64.07	1.69	1.21	0.44
G_3	87.80	21.61	5.70	3.92	5.8	62.97	1.68	1.16	0.45
G_4	88.10	21.60	5.29	3.49	5.62	64.00	1.71	1.26	0.48
G_5	88.20	21.64	5.32	3.51	5.68	63.85	1.61	1.19	0.41
G_6	87.90	21.69	5.71	3.94	5.74	62.92	1.71	1.18	0.45
G_7	88.00	21.68	5.69	3.89	5.76	62.98	1.66	1.21	0.47
Finisher Diet									
G_1	86.20	20.23	5.18	4.10	5.63	64.86	1.16	1.25	0.44
G_2	87.40	19.63	5.20	3.90	5.56	65.71	1.20	1.32	0.41
G_3	86.70	19.92	5.42	4.01	5.52	65.13	1.40	1.35	0.45
G_4	86.00	19.84	5.59	4.10	5.55	64.92	1.25	1.34	0.49
G_5	86.00	20.00	5.04	4.19	5.60	65.16	1.24	1.30	0.41
G_6	87.30	19.92	5.67	4.20	5.98	64.23	1.42	1.37	0.45
G_7	86.80	19.96	5.65	4.16	5.66	64.57	1.49	1.32	0.47

al. (2016) and Sreekutty (2017). However, lower CP (11.5%) and CF (8.5 %) content were reported by Swain *et al.* (2007). As compared to our result, higher value of 6.67 % of AIA was reported by Bhamare *et al.* (2016). The contents of NDF, ADF, ADL, cellulose and hemi-cellulose as estimated in this study was higher than

Table 4 Effect of feeding CAW on nutrient digestibility during finisher phase

Treatments	Digestibility (%)		
	Dry matter	Crude Protein	Crude Fibre
G_1	$75.93^{b}\pm0.35$	$73.42^{b}\pm0.44$	$63.43^{b}\pm0.23$
G_2	$67.10^{d}\pm0.15$	$66.40^{e}\pm0.40$	$52.06^{e}\pm0.23$
G_3	$65.10^{d}\pm0.21$	$64.76^{f}\pm0.15$	$51.16^{e}\pm0.60$
G_4	$75.60^{b}\pm0.31$	$74.00^{b}\pm0.12$	$64.20^{b}\pm0.15$
G_5	$79.00^{a}\pm0.06$	$77.76^{a}\pm0.15$	$68.60^{a}\pm0.31$
G_6	$67.23^{d}\pm0.15$	$67.90^{d}\pm0.06$	$54.90^{d}\pm0.49$
G_7	$71.30^{c}\pm0.21$	$69.26^{c}\pm0.32$	$57.30^{c}\pm0.28$
P-value	<0.001	<0.001	<0.001

[a,b,c,d and e] Mean values with different superscripts within a row differ significantly

Table 5. Effect of incorporation of CAW with NSP degrading enzymes on feed intake

Age (week)	G_1	G_2	G_3	G_4	G_5	G_6	G_7	p-value
Weekly Feed Intake (g/bird)								
I	$140.91^{b}\pm$	$133.72^{c}\pm$	$151.57^{a}\pm$	$144.35^{b}\pm$	$145.67^{b}\pm$	$155.66^{a}\pm$	$141.23^{b}\pm$	$<0.001^{**}$
	0.49	1.46	2.22	0.59	3.93	0.89	1.49	$<0.001^{**}$
II	$387.65^{c}\pm$	$285.73^{d}\pm$	$435.06^{abc}\pm$	$480.53^{ab}\pm$	$411.58^{bc}\pm$	$486.71^{a}\pm$	$427.70^{abc}\pm$	$<0.001^{**}$
	8.19	43.02	17.38	3.09	31.08	14.35	3.12	$<0.001^{**}$
III	$561.29^{ab}\pm$	$497.67^{b}\pm$	$553.78^{ab}\pm$	$408.24^{c}\pm$	$559.29^{ab}\pm$	$594.64^{a}\pm$	$586.11^{a}\pm$	$<0.001^{**}$
	30.13	0.40	31.67	3.85	22.75	22.13	18.77	$<0.001^{**}$
IV	992.00±	1014.47±	1135.62±	1231.51±	979.59±	1138.59±	1090.75±	0.23^{ns}
	68.39	0.57	72.01	0.85	61.76	50.58	149.63	0.23^{ns}
V	1084.57±	1120.12±	1258.33±	1111.34±	1177.91±	1181.24±	1198.89±	0.88^{ns}
	35.89	16.31	117.44	49.41	16.82	40.024	220.81	0.88^{ns}
VI	$1123.35^{bc}\pm$	$1160.00^{b}\pm$	$1333.33^{a}\pm$	$996.16^{bcd}\pm$	$943.33^{d}\pm$	$1141.89^{bc}\pm$	$976.27^{cd}\pm$	$<0.001^{**}$
	1.43	92.38	20.88	1.19	60.38	78.09	35.73	$<0.001^{**}$
Overall	4293.11±	4211.72±	4867.71±	4372.13±	4217.45±	4698.74±	4421.02±	0.11^{ns}
	69.92	113.84	238.62	47.96	85.40	34.58	352.61	0.11^{ns}

$^{a,b,c,d,and\ e}$Mean values with different superscripts within a row differ significantly; **Significance at p<0.01; ^{ns}non- significant

those reported by Dele *et al.* (2013), however, the values observed are quite similar to those reported by Sreekutty (2017).This variation in chemical composition among different studies may be due to the difference in variety of cashew apple processed from different location.

Ileal digestibility values of DM, CP and CF were significantly (P<0.01) higher in enzyme supplemented

Table 6. Effect of incorporation of CAW with NSP degrading enzymes on body weight gain in broilers

Age (week)	G_1	G_2	G_3	G_4	G_5	G_6	G_7	p-value
Initial B. wt	42.36±	44.72±	44.24±	44.03±	45.48±	43.99±	46.14±	0.27^{ns}
	0.47	2.10	0.68	0.46	1.03	0.64	0.68	0.27^{ns}
I	$150.58^{b}\pm$	$143.39^{c}\pm$	$161.24^{a}\pm$	$154.01^{b}\pm$	$155.34^{b}\pm$	$165.33^{a}\pm$	$150.89^{b}\pm$	$<0.001^{**}$
	0.59	0.66	1.71	0.30	3.37	1.63	2.11	$<0.001^{**}$
II	$391.82^{a}\pm$	$319.56^{b}\pm$	$407.14^{a}\pm$	$440.00^{a}\pm$	$417.20^{a}\pm$	$421.66^{a}\pm$	$417.31^{a}\pm$	$<0.001^{**}$
	6.33	36.44	15.45	1.69	1.11	6.55	7.46	$<0.001^{**}$
III	$742.52^{ab}\pm$	$671.02^{c}\pm$	$731.73^{ab}\pm$	$698.02^{bc}\pm$	$715.99^{abc}\pm$	$759.50^{a}\pm$	$764.40^{a}\pm$	$<0.001^{**}$
	6.91	8.28	24.58	3.67	8.97	27.45	2.85	$<0.001^{**}$
IV	$1312.58^{ab}\pm$	$1268.14^{b}\pm$	$1322.00^{ab}\pm$	$1414.37^{a}\pm$	$1262.52^{b}\pm$	$1437.75^{a}\pm$	$1369.88^{ab}\pm$	$<0.05^{*}$
	54.78	1.78	41.01	35.17	35.91	59.45	26.48	$<0.05^{*}$
V	$1894.26^{b}\pm$	$1833.26^{b}\pm$	$1877.33^{b}\pm$	$2061.90^{a}\pm$	$1937.65^{b}\pm$	$1910.89^{b}\pm$	$1929.72^{b}\pm$	$<0.001^{**}$
	4.68	10.63	38.69	4.47	27.32	47.62	56.59	$<0.001^{**}$
VI	$2290.87^{abc}\pm$	$2194.99^{bc}\pm$	$2264.33^{bc}\pm$	$2395.08^{a}\pm$	$2365.93^{a}\pm$	$2268.33^{bc}\pm$	$2288.89^{abc}\pm$	$<0.02^{*}$
	35.68	56.79	35.57	5.99	9.61	53.22	20.96	$<0.02^{*}$
Overall	$2248.51^{abc}\pm$	$2150.27^{c}\pm$	$2220.09^{bc}\pm$	$2351.06^{a}\pm$	$2320.46^{ab}\pm$	$2224.35^{bc}\pm$	$2242.75^{abc}\pm$	$<0.02^{*}$
	36.15	56.59	35.96	6.26	9.95	53.27	20.35	$<0.02^{*}$

^{a,b,c} Mean values with different superscripts within a row differ significantly; **Significance at p<0.01 *Significance at p<0.05; ^{ns}Non-significant

Table 7. Effect of incorporation of CAW with NSP degrading enzymes on cumulative feed conversion ratio in broilers

Age (week)	G_1	G_2	G_3	G_4	G_5	G_6	G_7	p-value
I	1.30±0.01	1.36±0.03	1.29±0.00	1.31±0.00	1.33±0.02	1.28±0.01	1.35±0.02	0.09^{ns}
II	1.52±0.04	1.54±0.04	1.62±0.03	1.58±0.01	1.50±0.08	1.70±0.03	1.54±0.03	0.06^{ns}
III	1.56^{bc}±0.04	1.46^{c}±0.05	1.66^{ab}±0.03	1.58^{bc}±0.01	1.67^{ab}±0.05	1.73^{a}±0.06	1.61^{ab}±0.02	$<0.001^{**}$
IV	1.65±0.06	1.58±0.02	1.78±0.04	1.66±0.04	1.72±0.04	1.71±0.048	1.69±0.10	0.29^{ns}
V	1.71±0.04	1.71±0.00	1.92±0.10	1.67±0.03	1.73±0.02	1.91±0.03	1.82±0.15	0.12^{ns}
VI	1.91^{bc}±0.05	1.96^{abc}±0.02	2.19^{a}±0.08	1.86^{c}±0.02	1.82^{c}±0.04	2.11^{ab}±0.04	1.97^{abc}±0.16	$<0.03^{*}$

^{a,b,c} Mean values with different superscripts within a row differ significantly; **Significance at p<0.01 *Significance at p<0.05; ^{ns}Non-significant

group with CAW (Table 4). These findings are in agreement with findings of Olukosi *et al.* (2015) who reported ileal digestibility of CP values increased by 4.2 per cent and 2.1 per cent in due to supplementation of multi-enzyme XAP-5000 and XAP-10,000, respectively. Ileal digestibility of DM, CP and CF were significantly (P<0.01) higher in birds fed G_5 (5% CAW + 750 g/ton enzymes) compared to control group and lower values were observed in birds fed 10 % CAW without any enzyme supplementation. Similarly, supplementation with either single or combined exogenous NSP enzymes improved apparent ileal digestibility of starch, CP,CF, EE, GE and phosphorus in broilers fed rations containing unconventional feed stuffs (Romero *et al.,*2014).

Data pertaining to feed intake, body weight gain and Feed conversion ratio under different dietary treatments are presented in table 5, 6 and 7. An increase in feed intake in pre-starter (1 -7 days) and starter period (8-21days) were recorded in experimental fed CAW supplemented with multi enzymes, however, overall DMI during the entire period (0-42 days) did not differ significantly. Abdel Hafez *et al.* (2018) and Alam *et al.* (2003) also observed similar trend in increased feed Intake in potato peel fed birds with multi enzymes supplementation. However, Bhamare *et al.* (2016) reported that addition of CAW at 10 and 20 % without enzymes supplementation resulted in decreased feed intake. Overall BWG in G_4 (5 % CAW with 500 g/ton) was significantly (P<0.05) higher as compared to other group of birds. The results reported by Jozefiak *et al.* (2006) was in agreement with the present study, where inclusion of 400 U/g beta-glucanase, 300 U/g xylanase and 800 U/g protease as cocktail enzyme at 1g/1 kg of diet in oat based broiler diet resulted in better body weight gain. Feed conversion ratio (FCR) was significantly (P<0.01) better in G_4 and G_5 groups birds compared to control. Similar results were recorded in broilers by Bhamare *et al.* (2016) who reported that inclusion of CAW at more than 5% without NSP enzymes shown poor FCR compared to control. Poorer FCR (P<0.01) was recorded in birds fed 10 % CAW with NSP enzymes supplemented group (G_6 and G_7) compared to G_4 and G_5.

CONCLUSION

It is concluded that CAW could be included in corn, soya bean meal based broiler ration at 10 % level with NSP enzyme at 75 0 g/ton with similar FI, BWG and FCR compared to control group.

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