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Effect of feeding graded levels of apple pomace on growth performance, haemato-biochemical parameters and rumen metabolites in crossbred calves

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ABSTRACT

To study effect of feeding graded levels of apple pomace on performance of crossbred calves,90 days growth trial followed by 6 days metabolic trail was conducted on 16 female Jersey crossbred calves divided into four equal groups with control (T_0) fed concentrate diet without apple pomace and experimental groups *viz*, T_1, T_2 and T_3, where maize was replaced by 25%, 50% and 75% of apple pomace, respectively. There was no significant difference in dry matter intake, growth performance, feed conversion ratio and digestibility coefficients of CF, NFE, ADF and HC with inclusion of apple pomace in calf ration; however digestibility of DM, OM, CP, EE and NDF reduced significantly at higher inclusion level (75%). There was also no significant difference in nutritive value of the experimental diets with respect to %DCP and %TDN, ME, DE and NR. There was no significant difference in the mean haemato-biochemical values, however significant ($P<0.05$) effect of feeding apple pomace was observed on total serum proteins with lower values in animals of T_3group as compared to control. Similarly non-significant differences were observed in ruminal pH, TVFA, total nitrogen, NH_3-N, TCA-ppt. N and NPN values.

Key words: Apple pomace, Calves, Daily gain, Economics, Haemato-biochemical, Maize, Nutrient utilization, Rumen metabolites.

INTRODUCTION

Maize is major ingredient which provides energy and occupies 30 to 70 per cent in any of the calf ration. Due to variable composition, reducing availability and increasing price of maize, alternative sources of energy have been considered, for inclusion in livestock rations (Elanchezhian *et al.*, 2014). Though India produces more than 20 million MT of maize per year, about 32 per cent deficiency in concentrate feed sources is a major threat to the animal industry which compete humans for grains. To meet the nutrient requirements of livestock and to sustain their productivity under these conditions seems rather impossible, unless and until available non-conventional alternate feed resources are utilized to bridge the gap between demand and supply of nutrients and to economize livestock farming. Apple pomace is a major agro industrial byproduct in state with availability of 1.02 lakh tons per year with these values ever increasing (NHB, 2014). It has been reported by Ganai *et al*. (2006) that apple pomace contains 7.92% crude protein, 20% crude fibre, 2.96% ether extract, 4.27% total ash, 47.7% NDF and 36.82% ADF, 0.19% calcium and 0.14% phosphorus. As per reports of Tiwari *et al.* (2008) apple pomace contains 2600-2750 K Cal/kg energy and 65% TDN respectively with potential digestibility of neutral detergent fiber (74.90%), acid detergent fiber (71.33%) and hemicellulose (85.42%) and contains higher level of fiber (20.50%) with substantial amount of fermentable carbohydrates, which increases its utility for the feeding of livestock. Owing to its feeding value, the present study was undertaken to see the effect of feeding apple pomace as maize replacer in diet of calves on growth performance, physiological healthy status and rumen fermentation parameters.

MATERIALS AND METHODS

A 90 days growth trial was conducted on sixteen female Jersey crossbred calves (6 months) divided in to four equal groups with control (T_0) fed concentrate diet with ingredients maize, wheat bran, mustard oil cake, rice polish, soyabean, molasses, salt, mineral mixture and urea. In experimental groups *viz*, T_1, T_2 and T_3, maize was replaced by25%, 50% and 75% of apple pomace, respectively. The animals were treated for ecto and endoparasites with proper doses of standard anthelminthic prior to start of experiment. Weighed quantities of the respective rations with maize silage 60% and concentrate 40%were offered to animals individually to meet nutrient requirements as per ICAR (2013). Feed intake and left over was quantified daily, whereas recording of body weight was done at fortnightly interval.To assess the digestibility of nutrients, a 7 day digestion trial was conducted in the last week of 90 days growth, during which feed offered, residue left and faeces voided by the animals was recorded and were analyzed for

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proximate composition(AOAC, 2000), fibre fractions (Van Soest *et al.,* 1991) and major minerals *viz.,* calcium and phosphorous (Talpatra *et al.,* 1948).The blood samples were drawn aseptically from the experimental animals for estimation of haemato-biochemicals- Hb, PCV, RBC's, WBC's, Lymphocytes, Granulocytesby automatic hematology analyzer (SB-21 Vet). Glucose was estimated by glucometer instantly after blood collection. Total protein, albumin, BUN and creatinine were estimated by using commercial diagnostic kits (Span diagnostics limited, Surat, Gujarat, India). Globulin was determined by subtracting albumin from total protein. The rumen liquor was collected from experimental calves using stomach tube for determination of pH (pH meter), TVFA (Barnett and Reid 1957), total nitrogen, TCA ppt.N and NH_3-N as perKjeldahl technique. The data is analyzed using statistical procedures as given by Snedecor and Cochran (1994) and significance of mean difference was tested by Duncan's New Multiple Range Test (DNMRT).

RESULTS AND DISCUSSION

The chemical composition always depicts the potential feeding value of a feedstuff. The chemical composition of apple pomace in the present investigation is comparable to earlier observations of Sharma and Sharma (1984), Tiwari *et al.* (2008) and Abdollahzadeh *et al*. (2010). However, Ganai *et al.* (2006) and NRC (2001) reported higher CP content as compared to present investigation. The differences in chemical composition may be due to specific apple varieties (natural variation), husbandry practices, fruit maturity and post-harvest management (Table 1).

The results of feed intake, body weight, feed conversion ratio, nutrient digestibility and economics are depicted in Table 2. The intake of feed is one of the main parameters to ascertain the palatability of the experimental rations. The dry matter as well as organic matter intake recorded in the present studysuggested that inclusion of apple pomacein the ration of dairy calves has no adverse effect on feed intake as there was non-sigificant difference among experimental groups. The results obtained in this investigation were in line with the findings of Tiwari *et al.* (1995). The DM intake as % body weight was also as per requirement (ICAR, 2013). There was no significant difference in average daily gain in apple pomace supplemented groups (T_1, T_2 and T_3) as compared to control.Chandel *et al.* (2015) also reported non-significant difference in body weight changes and ADG in crossbred heifers fed apple pomace replacing concentrate mixture at 10% level. The Feed conversion ratio (FCR) values increased in level of apple pomace in ration. The results are in concurrence with findings of Ghoreishi *et al.* (2007).

Table 1: Chemical composition of experimental feeds and feed ingredients.

Attributes	DM	OM	CP	EE	CF	NFE	TA	AIA	NDF	ADF	HC	Cellu.	Ca	P
Feed Ingredients														
Apple Pomace	77.30	95.27	5.83	4.43	19.04	65.96	4.73	2.77	69.47	48.23	21.23	27.63	0.25	0.22
Corn Silage	31.93	89.68	6.42	1.97	11.00	70.30	10.30	3.84	69.87	49.2	20.67	23.53	0.38	0.23
M.O.C	91.4	93.19	26.83	8.31	6.52	51.53	6.80	3.53	64.35	44.11	20.24	10.60	0.10	0.12
Maize	89.96	96.57	11.08	4.47	6.78	74.24	3.43	1.32	32.73	21.4	11.33	10.90	0.16	0.39
Rice Polish	88.93	89.06	11.08	4.50	8.60	64.87	10.94	6.29	52.67	23.14	29.52	4.90	0.32	1.20
Soyabean	90.2	95.12	42.58	13.18	7.37	31.98	4.88	1.36	32.53	25.15	7.38	13.03	0.25	0.78
Wheat Bran	87.43	96.07	14.00	3.03	4.43	74.61	3.92	1.48	36.73	23.18	13.56	9.03	0.26	0.88
Mineral mix.	97.05	-	-	-	-	-	100.0	-	-	-	-		29.60	10.20
Salt	96.80	-	-	-	-	-	100.0	-	-	-	-		-	-
Experimental Feeds														
T_0	90.87	94.77	21.58	5.03	8.91	59.25	5.22	2.78	56.37	23.58	32.79	8.17	1.09	1.00
T_1	90.74	94.79	21.00	5.19	9.57	59.04	5.21	2.29	48.37	24.40	23.97	11.14	1.04	0.69
T_2	90.91	93.77	22.17	7.08	8.55	55.98	6.22	2.37	46.21	41.30	19.90	13.63	1.01	0.49
T_3	91.57	93.87	21.58	6.22	11.91	54.16	6.13	2.14	50.35	39.77	15.58	15.67	0.66	0.78

Note: Mineral mixture consisted ofVitamin A-7,00,000 I.U, Vitamin D_3-70, 000 I.U, Vitamin E-250mg, Nicotinamide-1000mg, Co-200mg, Cu - 2000mg, I - 325mg, Fe - 1500mg, Mg - 6000mg, Mn - 1500mg, K - 100mg, Na - 5.9mg, S - 0.72%, Zn - 15gm, Ca - 25% and P - 12.75%

Table 2: Effect of feeding graded levels of apple pomaceon feed intake, ADG, FCR and nutrient utilization in calves

Attribute	Treatment groups				
	T_0	T_1	T_2	T_3	SEM
Feed intake & growth rate (g/d)					
DMI	2233.84	2234.81	2236.59	2232.58	19.91
OMI	2041.29	2042.17	2036.42	2033.43	0.351
ADG	319.44	305.55	294.44	280.55	8.83
FCR	7.58	7.94	7.95	8.75	0.245
Digestibility (%) and balance of nutrients(g/d)					
DM	70.44^{ab}	70.53^{ab}	68.76^{ab}	67.93^{a}	0.467
OM	73.57^{ab}	73.65^{ab}	71.73^{ab}	71.10^{a}	0.453
CP	83.99^{c}	82.84^{bc}	81.46^{ab}	80.87^{a}	0.408
EE	81.37^{bc}	83.12^{c}	79.49^{b}	76.06^{a}	0.776
CF	65.57	64.33	64.78	61.41	1.100
NFE	71.26	71.62	69.90	70.78	0.439
NDF	71.47^{b}	68.42^{a}	66.64^{a}	66.88^{a}	0.662
ADF	62.58	63.01	63.38	61.94	0.564
HC	72.47	71.18	69.52	68.14	1.278
Nutritive value					
%DCP	8.48	8.15	8.15	7.88	0.070
%TDN	64.39	63.42	63.77	60.48	0.913
NR	6.59	6.77	6.82	6.67	0.081
DE (Kcal/g)	2.84	2.79	2.81	2.67	0.033
ME (Kcal/g)	2.33	2.29	2.30	2.19	0.040
Economics					
Cost/kg body wt. gain (Rs)	76.61	75.80	75.47	76.43	
Reduction in feed cost/ animal (%)	-	5.35	9.19	12.38	

Means superscripted with different letters in a row differ significantly ($P<0.05$)

Digestibility of CP, EE and NDF was significantly reduced due to supplementation of apple pomace at higher level (T_3), however there was non-significant difference in the digestibility coefficients of DM, OM and EE between treatment groups (T_1, T_2 and T_3) as compared to control (T_0) in ration of calves. Our results corroborate well with observations of Tiwari *et al.* (1995),Singhal *et al.* (1991)and Narang and Roshanlal (1985) reported non-significant decrease in digestibility of nutrients only at higher levels. The nutritive value of the diet with respect to % DCP was influenced significantly ($P\leq0.05$) by addition of apple pomace, however, energy value of feed with respect to % TDN, ME and DE was non-significantly reduced in apple pomace supplemented groups, likewise the nutritive ratio in all the groups was found to be statistically similar. The improvement in DCP content on dietary supplementation of apple pomace might be due to better utilization of microbial protein turnover. Similarly intake of digestible DM and digestible TDN were statistically non-significant between control and apple pomace supplemented groups. However, intake of digestible OM and DCP as g/d was statistically lower when maize was replaced with apple pomace at higher (75%) level in ration of dairy calves. Results of this experiment were in accordance with (Tiwari *et al.* 1995)

To ascertain the effect of feeding apple pomace based complete feed on physiological health status of experimental animals; various hemato-biochemical parameters were studied and are depicted in Table 3. All the blood parameters in the present study were found to be in the normal range (Radostits *et al.*, 2007). The mean hematological values (Hb, PCV, RBC, WBC, lymphocytes and granulocytes) showed increased trend with statistically non-significant difference between the groups. These results were in concurrence with reported observations of Chandel *et al.* (2015). The increased trend of hematological values in present study might be attributed to increased concentration of iron in apple pomace (Beigh *et al.* 2015). However, the results of present study showed significant variation in total serum proteins between different experimental groups, which corroborated with observations of Abdollahzadeh and Abdulkarimi (2012). The values of blood glucose, BUN, creatinine, albumin and globulin in all the groups did not differ significantly and were in the normal range (Radostits *et al.*, 2007) and in line with the observations of Abdollahzadeh and Abdulkarimi (2012) and Chandel *et al.* (2015).

The rumen parameters were studied to know the effect of feeding apple pomace based ration on rumen

Table 3: Effect of feeding apple pomace on feed intake, body weight gain and haemato-biochemical parameters in crossbred calves

Attribute	Treatment groups				
	T_0	T_1	T_2	T_3	SEM
Haemato-biochemical parameters					
Hb (g %)	12.77	12.99	13.16	13.03	0.173
PCV (%)	31.87	31.51	32.57	33.11	0.381
RBC (X x 10^{12} / l)	8.19	8.12	8.35	8.47	0.012
WBC's (X x 10^9/ l)	7.25	7.27	7.58	7.32	0.150
Lymphocytes (X x 10^9/ l)	4.21	4.20	4.35	4.10	0.156
Granulocytes (X x 10^9 / l)	2.73	2.76	2.93	2.91	0.069
Total serum protein (g/dl)	6.67^b	6.63^b	6.52^{ab}	6.37^a	0.037
Serum albumin (g/dl)	3.62	3.59	3.55	3.47	0.030
Serum globulin (g/dl)	3.05	3.04	3.03	2.82	0.038
Blood glucose (mg/dl)	54.68	55.19	54.26	53.92	0.493
BUN (mg/dl)	14.18	14.47	14.06	14.57	0.219
Serum creatinine (mg/dl)	1.50	1.48	1.51	1.52	0.215

Means superscripted with different letters in a row differ significantly (P<0.05)

Table 4: Effect of feeding apple pomace on rumen metabolites in crossbred calves.

Attribute	Treatment groups				
	T_0	T_1	T_2	T_3	SEM
pH	6.69	6.61	6.58	6.56	0.017
TVFA (mEq/l)	79.37	79.14	80.40	80.48	0.410
Total N (mg/dl)	87.50	86.05	85.33	82.93	1.311
NH_3-N (mg/dl)	22.14	21.73	21.54	20.98	0.330
TCA- ppt.N (mg/dl)	47.87	47.13	46.76	45.59	0.654
NPN (mg/dl)	31.34	29.90	29.84	28.89	0.657

Means superscripted with different letters in a row differ significantly (P<0.05)

environment in dairy calves (Table 4). Different rumen parameters *viz.* pH, TVFA, total nitrogen, NH_3-N, TCA-ppt. N and NPN were studied at the end of 90 days experimental feeding at different time periods after feeding, in both control and treatment groups. In all treatment groups (T_0, T_1, T_2 and T_3), non-significant differences were observed in pH, TVFA, total nitrogen, NH_3-N, TCA-ppt. N and NPN values. The pH values were quite stable at 6.56 to 6.69, which was within the normal range (6.0-7.0) considered optimal for microbial digestion of fiber and protein (Wanapat and Cherdthong, 2009). The results of the present investigation also find support from earlier reports of Ahn *et al.* (2002), Rumsey (1978) reported non-significant effect of apple pomace on ruminal NH_3 and TVFA concentration in steers. Further, while observing the effect of apple pomace in calf ration, it was noticed that mean values of total nitrogen, TCA-ppt-N, ammonia nitrogen and NPN were statistically similar with control (T_0) and were within range considered optimal for rumen fermentation functioning. The optimal level of total nitrogen may be attributed to a significantly better proteolytic activity of the rumen in treatment groups. Such proteolytic activity in rumen has been reported by Yoon and Stem (1996) and Moloney and Drennan (1994). It is concluded that feeding of apple pomace up to 75% level has no adverse on physiological health status and rumen functioning of dairy calves. Economics of feeding revealed decrease in the cost per 100 kg of feed with increased inclusion of apple pomace and cost of feed per animal but the cost of feed per kg body wt. gain remained almost same in all the experimental groups. Our results also find support from work of Tiwari *et al.* (1995) where appreciable reduction was noticed in ration of dairy calves where apple pomace replaced maize grain at graded levels.

CONCLUSION

Looking at the results of feed intake, nutrient utilization efficiency, physiological health status and rumen functioning of calves; it appears that feeding of apple pomace to calves in concentrate ration could be a practical and viable proposition that can be adopted for feeding of calves and other ruminants for sustainable production in the state and to alleviate the feed deficit.

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