Asian-Aust. J. Anim. Sci.
Vol. 24, No. 11 : 1595 - 1600
November 2011

www.ajas.info
http://dx.doi.org/10.5713/ajas.2011.11054

Dried Sugarcane Press Residue as a Potential Feed Ingredient Source of Nutrients for Poultry

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ABSTRACT : Sugarcane press residue (SPR), a byproduct from the sugar industry was evaluated for it's nutrient and energetic quality in broilers and layers. The composition of SPR included (% DM): CP-11.76 (methionine-2.21, cystine-1.05, lysine-4.85, threonine-5.48% of CP), EE-7.87 (palmitic acid-30.3, stearic acid-4.1, oleic aicd-17.2, linoleic acid-38.0, linolenic acid-5.4% of EE), CF-10.08, TA-21.08 (Ca-3.87, P-1.10, Mg-0.95%, Fe-3500, Mn-284, Zn-113, Cu-61.5, Co-5.0 ppm and AIA-4.93%) and NFE-48.35% indicating that SPR is a valuable source of both organic and inorganic nutrients for poultry. The metabolic trials revealed the average ME of SPR as 749, 842 and 1,270 kcal/kg, respectively in broilers and 844, 936 and 1,031 kcal/kg in layers, at 10, 20 and 30% inclusion levels, respectively. Further, the fortification of SPR incorporated diets with biotechnological products viz., lipid utilizing agents (lipase and lecithin) or NSP degrading enzymes and their combination did not improve the ME content of such diets. (**Key Words :** Sugarcane Press Residue, Chemical Composition, Metabolizable Energy, Poultry)

INTRODUCTION

The poultry industry is one of the most profitable businesses of agriculture and provides nutritious meat and eggs for human consumption within the shortest possible time. However, the availability of feed ingredients at affordable cost is a key to successful poultry operations (Basak et al., 2002). There is a genuine need to economize poultry rations by utilizing the agro-industrial byproducts. Sugarcane press residue (SPR) (also referred to as sugarcane mud, sugarcane filter mud, filter press cake, fiber cake, clarification mud, filter mud and scum), a byproduct of sugar industry, is one such potential material available to the tune of 3.6 million tons annually in India. It is a soft, spongy, amorphous dark brown material containing sugars, fiber, coagulated colloids including wax, apart from containing albuminoids, organic salts, etc. and rich in organic carbon and N, P, Ca, Fe and Mn (Singh and Solomon, 1995). Currently, SPR is used as soil conditioner but the majority of it remains unrecycled due to lack of proper technology and thus poses environmental problems. Recent reports (Budeppa et al., 2008) indicated that young birds such as broilers tolerated low levels of SPR (up to 3%) while adults such as layers tolerated higher SPR (up to 15%) levels in their diets (Suma et al., 2007). According to them, SPR contains substantial amounts of lipids and crude fiber. Both the lipids and fiber fractions in SPR appear to find their way largely from the residual vegetative portion of cane. On one hand, absence of fiber degrading enzymes in the digestive tract of birds might necessitate their supplementation in feed. On the other hand, given the fact that higher level of lipids exist in SPR, addition of lipase and lecithin in diets may help to better the hydrolysis and emulsification of SPR's lipids and complement the action of *in situ* lipase and lecithin. Yet, the information available in both broilers and layers is not sufficient to include SPR in practical poultry diets. Therefore, an effort was made to determine nutrient constituents and metabolizable energy value of SPR for broilers and layers separately.

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Received February 26, 2011; Accepted May 23, 2011

MATERIALS AND METHODS

Procurement and analysis of sugarcane press residue

Sufficient quantum of fresh SPR was procured from a local sugar plant (M/s Mysore Sugar Ltd., Mandya, Karnataka) and was sun dried for five days until it became crispy, milled through a 1 mm sieve and stored in polythene bags until used for biological trials.

A sample of sun dried SPR was subjected to proximate analysis as per methods of AOAC (2005). The fiber

constituents were determined as per methods described by Van Soest et al. (1991) (Fibertec 2010 hot extractor, M/s. Foss Instruments). The sample was analyzed for the levels of calcium (Talapatra et al., 1971), total phosphorous (UV-visible Spectrophotometer, M/s Jenway; AOAC 2005), magnesium, copper, iron, zinc, manganese and cobalt (Atomic Absorption Spectrophotometer AA 300, M/s. Perkin Elmer). The gross energy (GE) of sun-dried SPR was estimated using adiabatic bomb calorimeter (AOAC, 2005).

A representative SPR sample was sent to M/s Degussa Huls-AG, Hanau-Wolfgang, Germany for determination of amino acid profile. The ether extract component of the SPR was further subjected for assay of different fatty acid components by gas chromatography (M/s Bangalore Test House, Bangalore).

Metabolism assay in broilers

A practical type broiler starter diet was prepared using conventional energy and protein sources to serve as basal mixture (control). Similarly, 3 additional control diets were prepared by incorporating with either lipid utilizing agents (lipase 0.2 g and soy lecithin 2 g/kg) (T_5) or NSP degrading enzyme preparation (0.4 g/kg) (T_9) or with both (T_{13}). The test diets were prepared by incorporating sun dried SPR at 10, 20 and 30% level replacing the corresponding proportion of the afore said control basal mixtures (0% SPR level) as described by Sibbald and Slinger (1963). Thus there were a total of 16 diets, all in mash form. Each gram of NSP degrading enzyme preparation contained 2,500, 1,000, 500 and 250 units of xylanases, beta-glucanases, cellulases and pectinases, respectively and an experimental lipase contained mainly lipase at 500 units/g. The mineral sources and other additives were added over and above 100% to all the diets. The ingredient composition of each diet is given in Table 1.

Three hundred and twenty, one-day-old straight-run commercial broiler chicks (Hubbard strain) were distributed into 32 replicate groups of 10 chicks each. The birds were reared on raised wire floor battery brooders with *ad libitum*

Table 1. Ingredient and nutrient composition of experimental diets used in metabolism trial of broilers and layers

Ingredients (kg)	Broiler diets				Layer diets			
	T_1 to T_4	T_5 to T_8	T_9 to T_{12}	T_{13} to T_{16}	T_1 to T_4	T_5 to T_8	T_9 to T_{12}	T_{13} to T_{16}
Basal mix A[1]	100	90	80	70				
Basal mix B[2]					100	90	80	70
Sugarcane press residue	-	10	20	30	-	10	20	30
Total	100	100	100	100	100	100	100	100
Di-calcium phosphate	2.05	2.05	2.05	2.05				
Calcite powder	1.20	1.20	1.20	1.20				
Salt	0.35	0.35	0.35	0.35	0.39	0.39	0.39	0.39
Shell grit					8.96	8.96	8.96	8.96
Mineral mixture[3]					3.92	3.92	3.92	3.92
Vitamin premix[4]	0.50	0.50	0.50	0.50	0.30	0.30	0.30	0.30
Trace mineral premix[5]	0.10	0.10	0.10	0.10				
Other additives[6]	0.54	0.54	0.54	0.54	0.28	0.28	0.28	0.28
Chromic oxide	0.50	0.50	0.50	0.50	0.56	0.56	0.56	0.56
Nutrients (%)								
ME (Kcal/kg)	2,864	2,692	2,521	2,349	2,608	2,454	2,301	2,147
CP	21.62	20.69	19.75	18.82	17.53	16.92	16.32	15.71
EE	3.25	3.91	4.57	5.23	2.36	3.04	3.73	4.41
CF	3.93	5.43	6.94	8.44	5.41	6.64	7.88	9.11
Ca	1.02	1.25	1.48	1.71	3.30	3.51	3.71	0.92
TP	0.79	0.86	0.94	1.01	0.56	0.63	0.69	0.76
Pav	0.53	0.55	0.58	0.60	0.31	0.33	0.35	0.38

[1] Basal mix A consisted of 61% maize, 38% soybean meal and 1% soya oil.

[2] Basal mix B consisted of 65% maize, 10% soybean meal, 15% groundnut extractions and 10% sunflower extractions.

[3] Mineral mixture contained: Calcium -32, phosphorus - 6% and other trace elements.

[4] Each 500 g vitamin premix contained vit A-12.5 MIU, vit D_3-2.8 MIU, vit E-30 g, vit K-2 g, vit B_1-2 g, vit B_2-5 g, vit B_6-3 g, vit B_{12}-0.015 g, niacin-40 g, Cal-d-pantothenate-15 g, folic acid-1 g, biotin-0.08 g, organic nutritive carrier-q.s.

[5] Trace mineral premix contained Fe-90,000, I-2,000, Cu-15,000, Mn-90,000, Zn-80,000 and Se-300 ppm.

Additionally T_2, T_6, T_{10} and T_{14} supplemented with lipid utilizing agents (lipase - 500 units/g+lecithin - 0.2 kg), T_3, T_7, T_{11} and T_{15} NSP degrading enzymes (xylanase-2,500, beta-glucanase-1,000, cellulose-500 and pectinase-250 units/g) and T_4, T_8, T_{12} and T_{16} with both.

[6] Includes DL-methionine and L-lysine.

access to feed and water. A corn-soya type starter diet was offered to all the chicks till 7th day and from 8th day onwards, the experimental diets were assigned randomly to two replicates of such groups. All other managemental conditions were uniform for all groups.

On 19th, 20th and 21st day of the experiment, feed consumed by each replicate group was accurately measured and the excreta voided by such replicate group were collected before the beginning of the subsequent day at 0900 h. The daily collections were dried in a hot air oven at 70°C to a constant weight and pooled replicate wise. Samples of the test diets and excreta from respective groups of chicks were assayed for calorific value directly with adiabatic bomb calorimeter (AOAC, 2005).

Following equation was used to estimate the AME value:

$$\text{AME diet (kcal/kg)} = \frac{(\text{Feed intake} \times \text{GE}_{\text{diet}}) - (\text{Excreta output} \times \text{GE}_{\text{excreta}})}{\text{Feed intake}}$$

Having derived the AME value for test diets, the AME value of the test material was calculated by using the following equation:

$$\text{AME of the test material (kcal/kg)} = \text{AME of the test diet} - \frac{(\text{AME of reference diet} \times \frac{\%\text{ of basal in test diet}}{\%\text{ of basal in the reference diet}}) \times 100}{\%\text{ of the test material in test diet}}$$

Metabolism assay in layers

Since differences exist among different types of birds in their ability to metabolize energy or digest other nutrients, a metabolism trial was also conducted with egg type chickens. The dietary experimental design employed was very much similar to that described under the metabolism assay in broilers wherein a conventional practical type layer diet comprising maize, soybean meal, groundnut extraction and sunflower extraction had served as basal mixture. The detailed ingredient composition of each diet is given in Table 1.

A total of one hundred and forty four BV-300 commercial layers of about 35 weeks age and uniform body weight were randomly divided into 48 groups of 3 birds each. Each of the 16 experimental diets was offered to three such replications of 3 birds each. Feed was offered replication wise and the drinking water was accessed through a running water channel. Additional light of 4 hours was provided in addition to day light. The remaining management conditions were uniform for all groups. After conditioning the laying hens with their corresponding experimental diets for 11 days, a metabolism trial for 3 days was carried out by the methods similar to metabolism assay in broilers to arrive at the AME content of test diets and test material in layers.

The data was analyzed as per the completely randomized design described by Snedecor and Cochran (1989) and the means were compared using Duncan's Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Chemical composition of SPR

From the proximate analysis data (Table 2), it was evident that the SPR resembles certain cereal by-products for protein and crude fiber contents. The mineral analysis (Table 2) indicates that the SPR contains substantial amount of inorganic nutrients and appears to be superior (except iron) to other conventional feed ingredients used in poultry rations. The nutrient profile of SPR was well within the range reported by Singh and Solomon (1995). However, the values appeared to be different from the values reported by Suresh et al. (2007) and Suma et al. (2008). Such a variation was mainly attributed to the differences in agro-climatic conditions, stage of harvesting (quality of the cane crushed), possible differences that occurred during the clarification of cane juice in the sugar factory and the variation in experimental procedures *per se*. Although SPR contains substantial amounts of ash, its higher GE content (4,068 kcal/kg) was essentially due to the higher amount of ether extract and crude fiber.

The amino acid profile of SPR (except tryptophan) was also very much comparable to that of the amino acid profile of de-oiled rice bran. The SPR carries a high amount of aspartic acid and glutamic acid. However, total sulfur amino acids (methoinine+cysteine) and lysine, the most limiting amino acids, were lower in SPR samples when compared to de-oiled rice bran. Among the fatty acids, the linoleic acid was in the highest concentration (4.54%) while the least being caprylic and capric acids (0.024% each). The quality assessment of the ether extract fraction of SPR revealed that its fat contained more unsaturated fatty acids, particularly linolenic acid, an important essential fatty acid in a way similar to that of oils of plant and marine origin. However, SPR also contained a good amount of saturated long chain fatty acid (palmitic acid).

The detailed chemical analysis of different components of SPR revealed that SPR was a valuable source of both organic and inorganic nutrients. Its nutrient composition was comparable to that of cereal grains and their by-products and appeared to be a potential feed ingredient for poultry.

Metabolizability of DM and energy content of test diets

As expected, the contents of crude fiber, ether extract

Table 2. Chemical composition of SPR

Nutrient profile		Amino acid profile			Fatty acid profile		
Constituent	% DM basis	Constituent	% as is	% of CP	Constituent	% as is	% of EE
Dry matter	92.83	Crude protein	11.33	-	Crude fat	11.95	-
Organic matter	76.05	Methionine	0.23	2.03	Caproic acid	0.000	0.0
Total ash	23.95	Cystine	0.11	0.97	Caprylic acid	0.024	0.2
Crude protein	11.80	Meth+cyst.	0.34	3.00	Capric acid	0.024	0.2
Crude fiber	13.73	Lysine	0.44	3.88	Lauric acid	0.167	1.4
Ether extract	11.95	Threonine	0.59	5.21	Myristic acid	0.108	0.9
NFE	38.57	Arginine	0.37	3.27	Palmitic acid	3.621	30.3
AIA	4.93	Isoleucine	0.50	4.41	Stearic acid	0.490	4.1
GE (kcal/kg)	4,068	Leucine	0.90	7.94	Oleic acid	2.055	17.2
Neutral detergent fiber	55.80	Valine	0.65	5.74	Linoleic acid	4.541	38.0
Acid detergent fiber	29.42	Histidine	0.25	2.21	Linolenic acid	0.645	5.4
Acid detergent lignin	11.13	Phenylalanine	0.51	4.50			
Hemicellulose	26.38	Glycine	0.63	5.56			
Calcium	4.90	Serine	0.48	4.24			
Phosphorous	1.25	Proline	0.50	4.41			
Magnesium	1.35	Alanine	0.66	5.83			
Copper (ppm)	58.5	Aspartic acid	1.07	9.44			
Zinc (ppm)	86.5	Glutamic acid	1.33	11.74			
Iron (ppm)	4,300	Total (without NH_3)	9.22	81.38			
Manganese (ppm)	260.0	Ammonia	0.19	1.68			
Cobalt (ppm)	6.4	Total	9.41	83.05			

and total ash in the experimental diets (Table 1) tended to increase with the incremental level of SPR (0, 10, 20 and 30%) while the trend was declining for rest of the nutrients i.e. NFE and crude protein including gross energy. Such a pattern was obviously due to the chemical composition of SPR *per se*.

The metabolizability coefficient of DM and GE content of experimental diets varied significantly ($p<0.01$) among different treatments in both broilers and layers. A generalized decreased metabolizability coefficient with the incremental level of SPR was noticed. Similar observations were made by Suma et al. (2007). Higher levels of crude fiber and total ash in the SPR based diets, appeared to have affected the DM metabolizability. While more crude fiber increases the rate of passage in the gut and brings about physico-chemical changes in the ingesta leading to rapid escape and inaccessibility of nutrients (Southgate, 1973), the higher levels of inorganic matter are also known to affect the DM metabolizability by interference (Scott et al., 1982).

Interestingly, the ME content of the experimental diets was found to be statistically similar ($p>0.05$) and ranged between 2,680 and 3,303 kcal/kg in broilers and 2,680 and 3,303 kcal/kg in layers. There was a linear reduction in ME content of the diets with the incremental level of SPR. The lower ME values of SPR based diets were due to the higher amount of total ash in such diets as the SPR contained 23.95% total ash. There was no improvement in ME content of SPR with fortification by either lipid utilizing agents or NSP degrading enzymes or both together. This might be due to the fact that the SPR's lipids might be of non-glycerol based nature and that the NSP enzymes' action might have been inconsistent as evident from reported varying results under practical conditions (Al-marzooqui and Leeson, 2000; Meng et al., 2004).

The metabolizability of DM and GE in SPR based diets differed significantly ($p<0.01$) at 0, 10, 20 and 30% SPR inclusion with the lowest value in 30% SPR based diets. With the addition of biotechnological agents, the metabolizability of DM and GE remained similar among diets fortified with no supplement, lipid utilizing agent, NSP degrading enzymes or lipid utilizing agents and NSP degrading enzymes together. However, the metabolizability coefficient of GE was numerically higher in diets supplemented with lipid utilizing agent or NSP degrading enzymes or both in layer diets perhaps due to the well established gut conditions that could take care of higher fiber level as well as lipids in SPR.

Regression equations for prediction of energy values of diets

The following simple regression equations were derived for the prediction of energy values of SPR based diets:

Broiler diets:

Classical ME (kcal/kg) = (48.77×DMM %)-163.1

R^2 = 0.94 r = 0.97**

Layer diets:

Classical ME (kcal/kg) = (42.79×DMM %)-62.87

R^2 = 0.93 r = 0.96**

Where **Significant ($p<0.01$) and DMM = DM metabolizability coefficient.

The correlation between the metabolizability coefficient of DM to that of ME values was highly significant ($p<0.01$). From R^2 value it is clear that the dependent variable (ME) can sufficiently be predicted by the independent variable (DMM). The predicted values are in close association with the assayed values.

Metabolizability of DM and energy content of test ingredient (SPR)

The metabolizability coefficient of DM of SPR under different treatments ranged from 11.81 to 39.19 percent in broilers and 4.36 to 34.03 per cent in layers and that of GE from 35.53 to 56.68 percent in broilers and from 41.72 to 62.39 per cent in layers. The ME of SPR under different treatments varied from 683.1 to 1,627 Kcal/kg in broilers and from 780 to 1,133 kcal/kg in layers. The analysis of variance showed non-significant ($p>0.05$) differences in DM, GE metabolizability and ME values in both broilers and layers.

When SPR was considered as the main factor, the metabolizability of DM of SPR at 10, 20 and 30% inclusion levels was statistically similar to each other in both broilers and layers where as the GE metabolizability and ME

Table 3. Metabolizability coefficient of DM and GE (%) of experimental diets and SPR in broilers and layers

Treatment description		No	Broiler diets			SPR in broiler diets			Layer diets			SPR in layer diets		
SPR %	Biotechnological agent		DM	GE	ME kcal/kg	DM	GE	ME kcal/kg	DM	GE	ME kcal/kg	DM	GE	ME kcal/kg
0	No supplement	T_1	69.88^{ab}	77.63^{a}	3,297^{a}	-	-	-	66.97^{abc}	74.68^{a}	2,846^{ab}	-	-	-
	Lipase+lecithin	T_2	71.29^{a}	77.25^{a}	3,277^{ab}	-	-	-	69.79^{a}	75.07^{a}	2,838^{ab}	-	-	-
	NSPases	T_3	70.83^{ab}	78.11^{a}	3,295^{a}	-	-	-	67.12^{abc}	75.00^{a}	2,827^{abc}	-	-	-
	Lipase+lecithin+NSPases	T_4	70.34^{ab}	77.70^{a}	3,303^{a}	-	-	-	67.92^{ab}	74.04^{a}	2,883^{a}	-	-	-
10	No supplement	T_5	66.27^{bcde}	75.54^{abc}	3,098^{c}	33.71	56.68	1,308	63.68^{bcde}	71.28^{abc}	2,646^{cd}	34.03	40.68	845
	Lipase+lecithin	T_6	66.41^{abcd}	74.08^{abc}	3,042^{bc}	22.48	45.59	924.1	63.25^{bcde}	71.73^{ab}	2,634^{de}	4.36	41.67	803
	NSPases	T_7	65.80^{abcd}	75.92^{ab}	3,077^{abc}	20.46	56.16	1,123	62.22^{cdef}	70.92^{abc}	2,622^{de}	18.10	34.23	780
	Lipase+lecithin+NSPases	T_8	66.58^{abc}	75.30^{ab}	3,051^{bc}	32.71	53.69	788.2	64.14^{bcd}	72.14^{ab}	2,689^{bcd}	30.18	55.12	950
20	No supplement	T_9	60.99^{cdef}	70.13^{bc}	2,860^{cd}	25.43	40.13	112.8	58.37^{efg}	66.43^{cdef}	2,449^{efg}	23.97	33.47	859
	Lipase+lecithin	T_{10}	59.40^{def}	68.90^{c}	2,779^{d}	11.81	35.53	783.1	57.46^{fg}	67.73^{bcde}	2,455^{efg}	8.12	38.38	925
	NSPases	T_{11}	60.22^{cdef}	70.24^{bc}	2,794^{d}	17.77	38.76	790.3	59.62^{defg}	68.27^{bcde}	2,454^{efg}	29.64	41.97	953
	Lipase+lecithin+NSPases	T_{12}	62.33^{cdef}	70.63^{bc}	2,779^{d}	30.28	42.34	683.1	56.76^{g}	68.82^{bcd}	2,506^{def}	12.12	47.97	1,000
30	No supplement	T_{13}	60.20^{cdef}	71.00^{bc}	2,796^{d}	37.60	55.51	1,627	57.07^{fg}	63.19^{ef}	2,307^{gh}	33.97	36.39	1,058
	Lipase+lecithin	T_{14}	58.67^{ef}	68.93^{c}	2,723^{d}	29.22	49.49	1,428	55.52^{g}	62.40^{f}	2,243^{h}	22.21	32.84	855
	NSPases	T_{15}	61.34^{cdef}	70.31^{bc}	2,682^{d}	39.19	52.12	1,252	56.32^{g}	64.84^{def}	2,304^{gh}	31.13	41.16	1,086
	Lipase+lecithin+NSPases	T_{16}	59.01^{f}	70.85^{c}	2,745^{d}	32.56	54.86	1,445	56.90^{fg}	65.42^{def}	2,358^{efg}	31.19	45.31	1,133
	Mean					27.77	48.40	1,105				23.25	40.72	937
	SEM		1.540	1.742	70.53	13.15	8.52	342.7	2.07	1.989	73.23	12.03	16.36	412.7
	p-value[1]		<0.001	<0.001	<0.001	0.642	0.218	0.200	<0.001	<0.001	<0.001	0.02	0.956	1.00
Effect of SPR														
	0%		70.59^{a}	77.67^{a}	3,293^{a}	-	-	-	67.95^{a}	74.69^{c}	2,848^{a}	-	-	-
	10%		66.26^{b}	75.21^{b}	3,067^{b}	27.34	53.03^{a}	1,036^{ab}	63.32^{b}	77.67^{b}	2,648^{b}	21.67	42.92	845
	20%		60.73^{c}	69.98^{c}	2,803^{c}	21.32	39.19^{b}	842.3^{b}	58.05^{c}	80.97^{a}	2,466^{c}	18.46	40.30	937
	30%		59.80^{c}	70.27^{c}	2,736^{d}	34.64	53.00^{a}	1,438^{a}	56.45^{c}	72.58^{c}	2,303^{d}	29.63	38.93	1,031
	SEM		0.770	0.871	35.26	6.577	4.262	171.3	1.03	0.995	36.62	6.01	8.196	206.3
	p-value[1]		<0.001	<0.001	<0.001	0.171	0.010	0.014	<0.001	<0.001	<0.001	0.18	0.797	0.67
Effect of Biotechnological supplements														
	No supplement		64.34	73.58	3,013	32.24	50.77	1,349	61.52	68.89	2,562	30.66	36.85	918
	Lipase+lecithin		63.94	72.29	2,955	21.17	43.54	1,045	61.50	78.43	2,542	11.56	37.63	861
	NSPases		64.55	73.65	2,962	25.81	49.01	1,055	61.32	78.33	2,552	26.29	38.92	943
	Lipase+lecithin+NSPases		64.46	73.62	2,969	31.85	50.29	972.0	61.43	81.72	2,609	24.50	49.47	1,028
	SEM		0.770	0.871	0.341	7.594	4.921	197.8	1.03	0.995	36.62	6.95	9.464	238.3
	p-value[1]		0.838	0.355	0.379	0.438	0.462	0.285	1.00	0.628	0.29	0.06	0.756	0.92

[1] An effect with a probability of less than 0.05 is considered significant.

[a-e] Means with different superscripts in a column differ significantly.

content of SPR were significantly ($p<0.01$) lower at 20% SPR inclusion in broiler diets, but not in layer diets. The maximum metabolizability coefficient values for DM and GE of SPR was apparent when SPR was included at 30% level. The observation was in conformity with that of Bhatia (1969) who found that the ME value of most of the ingredients at lower levels of inclusion was lower and indicated that incorporation at a higher level of test ingredient would give a correct appraisal of the ME value of the feedstuff. Similar conclusion was made by Podder and Biswas (1991) while evaluating metabolizability of rice bran at 20 and 40% level of inclusion.

Pertaining to biotechnological supplements, no significant improvement in metabolizability of DM and GE of SPR was evident with supplementation of biotechnological agents in both broilers and layers. The ME content of SPR was also statistically ($p>0.05$) unaffected by biotechnological agents and no definitive trend could be observed. This might be due to experimental variation.

The mean DM and GE metabolizability of SPR irrespective of its inclusion level, biotechnological supplements and type of birds were 25.56 and 45.56 per cent, respectively. The average ME content of SPR was 1,021 kcal/kg. The poor ME and DMM of SPR may be attributed to its chemical composition i.e., exceptionally high total ash content and moderate crude fiber content. The higher amount of ash and fiber in the SPR based diets appears to have adversely affected the digestibility of SPR lowering its ME value. That apart, the ash component does not contribute to any energy. The ME value of SPR was lower than the ME values reported for coarse rice bran which was 1,933 kcal/kg (Zablan et al., 1963), the coarse rice bran was somewhat higher in NFE and lower in ash content. That apart, the ash component does not contribute to any energy.

The ME values of SPR obtained for layers (973 kcal/kg) and broilers (1,105 kcal/kg) were thus lower than that of the conventional agro-industrial by-products such as rice bran and wheat bran. Further, supplementation of lipase and lecithin or fiber degrading enzymes has no beneficial effect on improving the nutritive value of SPR. Hence, it was concluded that SPR is a low energy feedstuff.

REFERENCES

Al-marzooqui, W. and S. Leeson. 2000. Effect of dietary lipase enzyme on gut morphology, gastric motility, and long term performance of broiler chicks. Poult. Sci. 79:956-960.

AOAC. 2005. Official methods of analysis. Association of Official Analytical Chemists. 18th Ed., Washington, DC.

Bhatia, I. S. 1969. Evaluation of feedstuffs available in India for protein quality and energy value. Final report (1964-1969), PAU, Ludhiana.

Budeppa, H. B., B. S. V. Reddy, K. C. Singh and R. G. Doss. 2008. Influence of sugarcane press mud on serum and plasma inorganic phosphorus in broilers. Indian J. Anim. Nutr. 25(1): 93-96.

Duncan, D. B. 1955. Multiple range and multiple f test. Biometrics 11:1-42.

Meng, X., B. A. Slominski and W. Guenter. 2004. The effect of fat type, carbohydrase, and lipase addition on growth performance and nutrient utilization of young broilers fed wheat-based diets. Poult. Sci. 83:1718-1727.

Poddar, K. and S. Biswas. 1991. Metabolizable energy value of two rice bran samples differing in proximate composition. Indian J. Poult. Sci. 26(2):84-88.

Singh, B. G. and S. Solomon. 1995. Alternative products form sugarcane: industrial and agricultural uses. In: sugarcane agro-industrial alternatives (Ed. B. G. Singh and S. Solomon). Vijay Pimlani for Oxford and IBH Pub. Co. Pvt. Ltd., New Delhi.

Sibbald, I. R. and S. J. Slinger. 1963. A biological assay for ME in poultry feed ingredients together findings which demonstrate some of the problems associated with the evaluation of fats. Poult. Sci. 42:313-325.

Snedecor, G. W. and W. G. Cochran. 1989. Statistical Methods. 9th edn., The Iowa State University Press, Ames, Iowa.

Southgate, D. A. T. 1973. Fiber and other unavailable carbohydrates and their effects on the energy value of the diet. Proc. Nutr. Soc. 32:131.

Suma, N., B. S. V. Reddy, R. G. Gloridoss, N. R. Rao, K. C. Singh, M. T. Rekha and A. R. Gomes. 2007. Egg quality traits of layers influenced by supplementation of different levels of sugarcane press residue. Int. J. Poult. Sci. 6(2):102-106.

Suresh, B. N., B. S. V. Reddy, T. M. Prabhu, R. G. Gloridoss and B. Jagadish. 2006. Nutritional evaluation of sugarcane pressmud in lambs. Indian J. Anim. Nutr. 23(1):47-49.

Van Soest, P. J., J. B. Robertson and B. A. Lewis. 1991. Methods for dietary fiber, neutral detergent fiber and non-starch polysaccharides in relation to animal nutrition. Symposium on carbohydrate methodology, metabolism and nutritional implications in dairy cattle. J. Dairy Sci. 74:3563-3597.

Zablan, T. A., M. Giffith, M. C. Neshein, R. J. Young and M. L. Scott. 1963. ME of some oil meals and some unusual feedstuffs. Poult. Sci. 43(3):619-625.