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Effect of Feeding Calf Starter Diets Containing Shrimp Waste Meal on Nutrient Utilization in Murrah Buffalo Calves

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ABSTRACT

A 120-day growth trial was conducted using 20 Murrah buffalo calves (Avg. BW 71.0 ± 1.6 kg) by randomly allotting them to four groups of 5 animals each to study the effect of replacing the protein content of soybean meal with shrimp waste meal at 0, 10, 20 and 30 % levels on nutrient utilization. Chemical composition (% DMB) indicated that shrimp waste meal was rich source of crude protein. Amino acid composition revealed that shrimp waste meal used in the present study is a rich source of serine. Fatty acid composition indicated that shrimp waste meal is rich in saturated fatty acids and also possesses considerable quantities of mono- and poly-unsaturated fatty acids which accounts for 34.86 % of total fatty acids. The digestibility of DM, OM, CP, EE, CF, NFE, NDF, ADF, hemi-cellulose and cellulose increased (P<0.01) in Murrah buffalo calves irrespective of the level of inclusion of shrimp waste meal in the diet. However, higher (P<0.01) digestibilities were observed at 10 % replacement level (T_2) as compared to the other groups. The DM, DCP and TDN intakes of buffalo calves of all the groups were higher than the recommendations of ICAR (1998) indicating the adequacy and palatability of calf starter diets. The % DCP and TDN content were significantly higher (P<0.01) in T_2 as compared to other treatments. It is concluded that replacement of the protein content of soybean meal with shrimp waste meal at 10 % level in calf starter diets resulted in improved digestibility of gross nutrients in buffalo calves.

Key words: Buffalo calves, Calf starter, Nutrient utilization, Shrimp waste meal

INTRODUCTION

Livestock production in developing countries needs greater attention because of its role in food production, livelihood support and environmental change. In India dairy sector is growing at the rate of 4 % annually to meet the needs of human population (Singh, 2011). The growth in world's population and other factors have made our natural resources into scarce, limited commodities. It has become the responsibility of those who manage natural resources to maximize productivity while minimizing the demand on restricted resources. For this reason, search for other products that can substitute conventional feed ingredients has become the need of the hour.

By-products and recycling of nutrients have become common in areas associated with production in animal agriculture. In India, many of the organized farms use about 7 % animal protein like fish meal in the calf ration but due to high cost and variable quality of fish meals, alternatives need to be explored (Saijpaul *et al.,* 2008). One such by-products which could be more efficiently utilized in coastal areas is the waste generated from shrimp processing. The shrimp processing industry has been rapidly growing with the significant increase in cultured shrimp production in the South-East Asian region. A huge amount of bio-waste consisting of head shells and abdominal shells is produced from the industry because shrimps are normally sold as headless or peeled or both. One such waste by-products of shrimp industry is shrimp waste meal (SWM). It is a dried product consisting of heads, shells and appendages, a potential protein source that can replace conventional protein. Annual production of shrimp in India is about 2,92,810 tons during 2013 (Aqua culture Asia Pacific, 2014). There is a significant amount of waste generated by shrimp industry because of the large percentage of the shrimp heads, exoskeleton and soluble components lost during various processing operations. Shrimp heads comprise of approximately 44 % of the whole raw shrimp (Meyers

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and Rutledge, 1971). Shrimp processing waste generated in India is around 1.25 to 1.5 lakh tons per annum, channeling the waste as a protein alternative. Shrimp wastes constitute 48-56% of the weight of shrimp. The major components of the waste (DM basis) are protein (35-40%), chitin (10-15%), minerals (10-15%) and carotenoids (Ramya Devi *et al.,* 2012). These wastes, which are high in crude protein and extremely perishable, can be efficiently utilized by ruminant animals. Keeping in view the availability of this valuable animal protein source, the present study was undertaken to evaluate the optimum level of inclusion of shrimp waste meal in starter diets of buffalo calves.

MATERIALS AND METHODS

Shrimp shell waste was suspended (1:15 w/v) in 1 N NaOH solution at 100° C for 2 h. This treatment was repeated several times. This removed the chitin present in shrimp shell waste. These extracts were combined and the pH was adjusted to 4.0 using concentrated HCl to precipitate the protein. The precipitated protein was recovered by centrifugation at 2000 rpm for 15 min followed by removal of the supernatant by decantation. Protein cured was readjusted to pH 7 using 1 N NaOH (to neutralize sample) and then washed with distilled water several times. The precipitate was collected by centrifugation at 2000 rpm for 15 minutes and dried in a hot air oven at 40° C until dried; 3 g of precipitate was collected from 100 ml of the extract. The dried sample was ground and used for laboratory evaluation. In case of bulk preparation of the material, the sediment was collected by allowing the extracts to settle in sedimentation tanks for 2 days. Precipitated protein was sun dried and used in experimental rations.

A calf starter with 23% CP was prepared by using conventional feed ingredients and was used as control (T_1). In this, the protein supplied through soybean meal was replaced at 10 (T_2), 20 (T_3) and 30 (T_4) percent level by incorporating SWM. The ingredient composition of calf starters is furnished in Table 1. All the calf starters were made iso-nitrogenous.

In an experiment based on completely randomized design (CRD), 20 Murrah buffalo calves (BW 71.0 ± 1.60 kg; 3 m of age) were randomly divided into 4 equal groups with 5 caves in each group. The animals were housed in well ventilated conventional sheds. During the trial period, the buffalo calves were offered chopped green fodder (Super Napier) *ad libitum* and respective calf starter (T_1 to T_4) diets to meet the growth requirements (ICAR, 1998). The calves were fed on respective experimental diets for 120 days. During the middle of the trial period (after 90 d), a digestion trial was conducted by following 7 days collection period. Clean, fresh drinking water was made available throughout the trial period. During the digestion trial, the amount of feed offered and faces voided were recorded. Daily representative samples of feed and faeces were collected and pooled animal wise.

Table 1. Ingredient composition of calf starter

Ingredient	Dietary treatments			
	T_1	T_2	T_3	T_4
Maize	35.0	35.0	35.0	35.0
DORB	23.0	23.5	24.0	24.7
Soybean meal	32.5	29.3	26.0	22.7
Sunflower cake	5.00	5.00	5.00	5.00
Shrimp waste meal	0.00	2.70	5.50	8.10
Molasses	2.00	2.00	2.00	2.00
Mineral mixture	2.00	2.00	2.00	2.00
Salt	0.50	0.50	0.50	0.50
Total	100	100	100	100

The feed and faecal samples were analyzed for proximate constituents (AOAC, 2007) and fibre fractions (Van Soest *et al.,* 1991). Estimation of Ca and P in feed was also done (Talapatra *et al.,* 1940). Amino acid composition of shrimp waste meal was quantified using reverse phase HPLC while fatty acid composition was determined by Gas chromatography (AOAC 996.01).The data were analyzed statistically (Snedecor and Cochran, 1994) and tested for significance by Duncan's multiple range test (Duncan, 1955) using SPSS 17.0 version.

RESULTS AND DISCUSSION

The per cent DM, OM, CP, EE, CF, NFE, TA and AIA of SWM were 94.25, 81.05, 55.00, 6.41, 2.50, 17.14, 18.95 and 3.20, respectively. The per cent calcium and phosphorous content of SWM were 5.65 and 1.28, respectively. The CP content (55.0%) of SWM in the present study was in close agreement with the findings of Rosenfeld *et al.* (1997) and Gernat (2001) who reported the CP value of shrimp waste meal as 50.89 and 52.70 per cent, respectively. However, Cobos *et al.* (2007), Mahata *et al.* (2008) and Ingweye *et al.* (2008) reported lower CP content of 35.6, 24.03 and 48.3 %, respectively as compared to the CP content reported in the present study.

Amino acid composition of SWM is shown in Table 2. The amino acid composition revealed that SWM contains 12 amino acids, of which 7 are essential and 5 are non-essential amino acids. The present study indicated that SWM is a good source of serine. Similar findings were also reported by Lakshmi and Saravanan (2012). The lysine, threonine and methionine contents of SWM observed in the present study were lower compared to the values reported earlier (Khempaka *et al.,* 2006; Fanimo *et al.,* 2004).

Fatty acid composition of shrimp waste meal is presented in Table 3. Fatty acid composition of SWM revealed more concentration of saturated fatty acids than unsaturated fatty acids. The SWM used in the present study was rich in saturated fatty acids and also possessed considerable quantities of mono and poly- unsaturated fatty acids which accounted for 34.86 % of total fatty acids, which is similar to the findings observed by Kandra *et al.* (2012). Major fatty acids observed in the present study were palmitic acid, palmitoleic acid, margaric acid, stearic acid, oleic acid and linoleic acid which were similar to the results obtained by Sachindra *et al.* (2005) in various species of shrimp available in India. In contrast, Bragagnolo and Rodriguez-Amaya (2001) reported that the fatty acid composition of penaeid shrimp from Brazilian water was found to be rich in unsaturated fatty acids, indicating that fatty acid composition varies with species of shrimp. Individual fatty acid composition (g/100g sample) of SWM indicated that the content of palmitic acid, palmitoleic acid, margaric acid, stearic acid, oleic acid and linoleic acid were 2.11, 0.16, 0.14, 1.01, 1.12 and 0.5 g, respectively while that of other fatty acids were at less than 0.1g/100g sample.

The chemical composition of calf starters containing SWM at varying levels is presented in

Table 2. Amino acid composition of shrimp waste meal

Amino acid	mg/100g of sample
Serine	332.36
Aspartic acid	192.37
Glutamic acid	55.01
Proline	43.76
Taurine	56.68
Threonine	35.9
Histidine	18.83
Phenyl alanine	32.9
Lysine	8.75
Valine	5.35
Methionine	14.08
Isoleucine	2.0

Table 3. Fatty acid composition of shrimp waste meal

Fatty acid	g/100 g sample
Saturated fatty acids	3.6
Monounsaturated fatty acids	1.32
Polyunsaturated fatty acids	0.66
Total trans-fatty acids	0.1

Table 4. All the calf starters were iso-nitrogenous.

Data pertaining to the effect of dietary inclusion of SWM at varying levels in calf starter diets on digestibility of proximate constituents and fibre fractions are presented in Table 5. The digestibility of DM, OM, CP, EE, CF, NFE NDF, ADF, hemi-cellulose and cellulose increased significantly (P<0.01) in calves fed diets containing SWM at 10 % level as compared to those fed SWM at 0, 20 and 30 % levels (Table 5). Further, the study indicated that digestibility of gross nutrients and fibre fractions decreased significantly (P<0.01) in calves when SWM was included at 20 and 30 % levels as compared to 10 % level. In contrast to the findings of the present study, Cobos *et al.* (2002) observed no effect (P>0.05) on digestibility of DM, CP and ADF in lambs by feeding shrimp shell waste at 15 % level as compared to the control, while DM, CP and EE digestibility decreased significantly (P<0.05) when fed shrimp shell waste at 25 % level in the diet. On the other hand, Cobos *et al.* (2002) reported that NDF digestibility decreased significantly (P<0.05) irrespective of the level of inclusion of shrimp shell waste as compared to the control. Similarly, Fanimo *et al.* (2006) observed decreased (P<0.05) digestibility of DM, CP and CF in growing pigs fed diets replacing fish meal with shrimp meal. Further, Ngoan *et al.* (2000) also reported that nutrient digestibility of diets based on shrimp by-product silages were lower than for similar diets based on fish meal which might be attributed to the high level of chitin in shrimp meal (Ngoan *et al.,* 2000).

A major concern with shrimp meal is the chemical nature of the exoskeleton of the shrimp, which is mainly composed of chitin and is considered to have low digestibility (Austin *et al.,* 1981). Due to this low digestibility, chitin physically blocks the access of digestive enzymes to lipids and proteins, thus affecting the utilization of these nutrients (Karasov, 1990). In the present study, SWM was obtained after extraction of chitin. This might had resulted in increased digestibility of gross nutrients in calves fed diets containing shrimp waste meal as compared to those in control group.

Data pertaining to plane of nutrition of buffalo calves (Table 5) revealed that the DMI (g/kg $W^{0.75}$) was not significantly different (P>0.05) among different treatments. The average DMI of buffalo calves fed diets containing SWM was higher than the values recommended by ICAR (1998). This indicated that

Table 4. Chemical composition of calf starters containing varying levels of SWM

Nutrient	CM-1	CM-2	CM-3	CM-4
Dry matter	91.84	91.69	91.95	92.20
Organic matter	89.02	88.82	88.03	87.68
Total ash	10.98	11.18	11.97	12.32
Crude protein	23.01	23.10	23.05	23.21
Ether extract	0.98	1.23	1.49	1.58
Crude fibre	10.75	10.15	9.75	9.68
Nitrogen free extract	54.28	54.34	53.74	53.21
Neutral detergent fibre	32.87	32.22	31.45	30.35
Acid detergent fibre	15.10	14.33	13.98	13.55
Hemi-cellulose	17.77	17.89	17.47	16.80
Cellulose	7.62	7.53	7.41	7.32
Acid detergent lignin	6.92	6.07	6.04	6.04
Silica	2.31	2.20	1.75	1.73
Calcium (%)	0.32	0.42	0.55	0.70
Phosphorus (%)	0.22	0.38	0.45	0.50

Table 5. Effect of inclusion of Shrimp waste meal in the calf starter on intake and digestibility of nutrients in buffalo calves

Particulars	Dietary treatments†				SEM
	T_1	T_2	T_3	T_4	
Dry matter**	71.83^{a}	76.39^{c}	73.56^{b}	72.25^{ab}	0.44
Organic matter**	55.40^{a}	63.16^{d}	59.29^{c}	57.45^{b}	0.66
Crude protein**	62.64^{a}	70.90^{c}	66.08^{b}	64.4^{b}	0.73
Ether extract**	67.93^{a}	72.92^{c}	70.80^{b}	68.79^{a}	0.45
Crude fibre**	62.72^{a}	71.30^{d}	66.13^{c}	64.62^{b}	0.74
Nitrogen free extract**	65.60^{a}	70.38^{c}	67.25^{b}	66.27^{a}	0.43
Neutral detergent fibre**	64.49^{a}	70.55^{d}	68.12^{c}	66.49^{b}	0.52
Acid detergent fibre**	59.67^{a}	64.49^{c}	63.30^{b}	60.20^{a}	0.47
Hemi cellulose**	55.77^{a}	61.36^{d}	59.30^{c}	57.59^{b}	0.48
Cellulose**	46.70^{a}	50.77^{c}	48.43^{b}	47.72^{b}	0.35
Nutrient Intake (g/kg BW$^{0.75}$)					
Dry matter	89.53	81.91	86.41	89.83	2.39
Digestible crude protein	8.28	8.39	8.26	8.37	0.39
Total digestible nutrients	54.88	54.75	54.30	54.83	1.88
Plane of Nutrition					
Digestible crude protein (%)	9.05^{a}	10.25^{b}	9.55^{a}	9.32^{a}	0.17
Total digestible nutrients* (%)	61.30^{a}	67.24^{b}	63.60^{a}	62.40^{a}	0.93
Digestible energy* (M Cal)	7.18^{a}	8.02^{b}	7.19^{a}	7.23^{a}	0.11
Metabolizable energy* (M Cal)	5.89^{b}	6.58^{b}	5.89^{a}	5.93^{a}	0.09

[a,b,c,d]Values in the rows bearing different superscripts differ significantly (*P<0.05) (**P<0.01); †Calves of the control (T_1) group were fed a standard calf starter, the protein supplied through soybean meal of T_1 was replaced at 10 (T_2), 20 (T_3) and 30 (T_4) percent level by incorporating SWM.

inclusion of SWM in calf starter diets had not affected the palatability. The content of DCP (%) was significantly higher (P<0.01) in T_2 as compared to other treatments. This may be attributed to higher CP digestibility in T_2 as compared to other treatments (Table 5). Similarly, the % DCP was significantly higher (P<0.01) in T_2 as compared to other treatments. The numerically higher nutrient digestibility recorded in buffalo calves fed calf starter diets containing SWM at 10 % level as compared to those in other groups (Table 5) might have resulted in higher TDN content in that group.

CONCLUSION

Thus, it is concluded that shrimp waste meal obtained from shrimp shell processing industry can replace 10 % protein supplied through soybean meal in calf starter diets of Murrah buffalo calves without any adverse effect.

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Aquaculture Asia Pacific, 2014 10(2) https://www.shrimpnews.com

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