

Effect of Feeding Ammoniated Wheat Straw Treated with and without Hydrochloric Acid on Meat Quality and Various Sensory Attributes of Growing Male Buffalo (*Bubalus bubalis*) Calves

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ABSTRACT : An experiment was conducted to study the effect of feeding ammoniated wheat straw treated with and without HCl on meat quality and various sensory attributes of growing male buffalo (*Bubalus bubalis*) calves. Due to urea-ammoniation, the CP content of wheat straw increased from 2.90 to 6.96%. The addition of HCl along with urea during urea-ammoniation further increased the CP content to 10.09%. The proximate composition (% fresh basis) of psoas major, longissimus dorsi and semitendinosus were comparable among the groups. However, comparatively higher cumulative muscle mean protein and ash percentage and lower moisture percentage in groups II and III in comparison to group I indicated the desirable effect of feeding AWS and HCl-AWS. The cumulative muscle mean pH in group III (5.54) was comparatively lower than group I (5.65) and II (5.62). The cumulative group mean pH and water holding capacity (% water retained) in semitendinosus was comparatively lower than psoas major and longissimus dorsi. The cumulative muscle mean SSP (g%) was significantly ($p < 0.05$) lower in group III (41.78) than group I (42.45). The cumulative group mean cooking loss (%) was significantly ($p < 0.01$) lower in psoas major (31.61) and longissimus dorsi (29.78) than semitendinosus (35.10). The cumulative group mean SFV (kg/cm^2) of psoas major, longissimus dorsi and semitendinosus were 6.38, 6.32 and 6.56, respectively, being lowest in psoas major and highest in semitendinosus. However, the cumulative muscle mean SFV (kg/cm^2) in group I, II and III were 6.53, 6.56 and 6.17, respectively, being lowest in group III and highest in group II. The scores of the cooked (2% common salt) buffen for various sensory attributes viz. appearance, flavour, juiciness, texture, mouth coating and overall palatability were comparable among the groups. Results suggested that feeding of ammoniated wheat straw treated with and without HCl to growing male buffalo calves for 180 days had no adverse effect on the meat quality and various sensory attributes. (*Asian-Aust. J. Anim. Sci.* 2004, Vol 17, No. 4 : 485-490)

Key Words : Ammoniated Wheat Straw, HCl, Buffalo Calves, Meat Quality, Sensory Attributes

INTRODUCTION

The livestock population in India is the largest (470.86 million) in the world and is estimated to be around 204.58 million cattle, 84.21 million buffaloes, 50.78 million sheep, 115.28 million goats and 12.79 million pigs. (Annual Report, Govt. of India, 1999-2000). Also, with the present trend of growth, live stock population is estimated to grow at 0.5% in cattle and 1.9% in buffaloes. (Annual Report, Govt. of India 1999-2000), which indicates that the present trend is towards more buffalo production. In addition to this production potential, buffaloes have high contribution to Indian meat industry and out of the total meat production of 4.7 million tones in India, 1.5 million tones was from buffalo, contributing a major share (95%) to the meat export and is now exhibiting a tremendous growth (FAO, 2000). But, feeding these farm livestock accounts for 55-75% of the total cost of production in the livestock industry. Rearing of these animals on high levels of concentrate

mixture is very difficult, because of the cost and wide gap between availability and requirement of concentrate and green fodders (Mudgal et al., 1995). More over about 25% of Indian farmers are landless and 33% are marginal farmers, so feeding concentrate to their livestock is out of reach for them and hence, Indian livestock mainly depends upon poor quality crop-residues such as, wheat straw, which accounts nearly 75% of the total diet. But the major factors limiting the extensive utilization of these crop-residues are their poor palatability, poor digestibility and low nutritive value. Out of the several methods tried in India and abroad to increase the nutritive value of crop residues, urea ammoniation has been found to be the most promising, practicable and user's friendly (Mehra et al., 1989; Khan et al., 1999). But the loss of ammonia during urea ammoniation of straw is enormous and accounts to 60-66% (Sundstol et al., 1978; Mondal et al., 1995; Dass et al., 2000). Many workers used various types of acids to fix the excess ammonia with different degree of success (Borhami et al., 1982; Dass et al., 2000; Mehra et al., 2001). But, the study on the effect of feeding acid treated straw on the performance of buffaloes especially with respect of meat quality is limited. Therefore, an experiment was conducted to study the effect of feeding ammoniated wheat straw treated with hydrochloric acid on meat quality of growing male buffalo calves.

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MATERIALS AND METHODS

Preparation of concentrate mixture

To make the three diets iso-nitrogenous three types of concentrate mixtures namely CM₁, CM₂ and CM₃ were prepared. The CP content of CM₁, CM₂ and CM₃ were 22.07, 18.97 and 17.05% respectively. Vitablend was added at 25 g/100 kg concentrate mixtures to meet the vitamin A and D₃ requirements.

Ammoniation of wheat straw

Ammoniated wheat straw without HCl (type A) and with HCl (type B) was prepared. In type A, wheat straw was treated with 4% fertilizer grade urea at 50% moisture level and in type B, wheat straw was treated simultaneously with 4% fertilizer grade urea and 3.5 litres hydrochloric acid (specific gravity 1.18 and purity 35%) to trap 30% of the free ammonia evolved. In both the cases, treated wheat straw was covered with polythene sheet and was kept air tight at room temperature for 21 days, as described by Dass et al. (1984).

Animals management and feeding

Twenty four growing male buffalo (*Bubalus bubalis*) calves (one year age, 88.54±3.81 kg average body weight) were randomly divided into three groups on the basis of their body weight. During the experiment, the animals were kept in well ventilated shed with individual feeding and watering arrangement. The animals were offered concentrate mixtures (CM₁, CM₂ and CM₃) along with wheat straw, ammoniated wheat straw and HCl treated ammoniated wheat straw in groups I, II and III, respectively for a period of one hundred and eighty days as per Kearl (1982) for the nutrient requirement of 500 g gain/day. In all diets, the concentrate: roughage ratio was fixed at 50:50 and were made isonitrogenous. Roughage part was offered *ad libitum* to all the experimental animals, only after complete consumption of respective concentrate mixtures. Clean and fresh drinking water was provided *ad libitum* to all the experimental animals twice daily at about 10 am and 3.30 pm

Slaughtering of the animals

At the end of 180 days of the experimental feeding trial, three animals from each group were slaughtered for the study of meat quality. Feed was withdrawn 24 h prior to slaughter and only water was provided *ad libitum* twice, during the day. Next morning the animals were slaughtered by ritual halal method. Slaughter and dressing procedures were carried traditionally by experienced butchers and all the operations were done on the floor of the slaughter room.

Collection of muscle samples:

About one kg each of three muscles i.e. psoas major, longissimus dorsi and semitendinosus was collected immediately after slaughter of each animal. After removing the separable fat and connective tissues, the samples were finally minced for determination of proximate principles (moisture, ash, protein and fat) and physico-chemical parameters viz. pH, water holding capacity (WHC), extract release volume (ERV), protein fractions, water soluble protein (WSP) and salt soluble protein (SSP), cooking loss and shear force value (SFV).

Analytical techniques:

The proximate principles (moisture, ash, protein and fat) of the minced meat samples were determined as per AOAC (1980). The procedure described by Bouton et al. (1971) was used to measure the pH. The water holding capacity (WHC) was estimated by following the press technique used by Whittings and Jenkins (1981) which is a modified method of Winsor-Pedersen (1959). The extract release volume (ERV) of the minced meat sample was estimated according to the procedure described by Strange et al. (1977). Exactly 2 g of meat sample was homogenized in 100 ml of cold distilled water, which was then centrifuged at 5,000 rpm for 20 min. The solution was then filtered through Whatman filter paper No.1 and the supernatant and residues collected were then used for the estimation of WSP and SSP, respectively as per the procedure provided by Kang and Rice (1970). Cooking loss was determined (Anjaneyulu et al., 1989) by heating minced meat (25 g) in polypropylene bags at 80°C in a thermostatically controlled water bath for 20 minutes. After draining out the exudates, the cooked nods were cooled, weighed and weight loss was calculated as cooking loss percent. For the determination of shear force value, cores of 1 cm³ were taken from cooked samples after cooling at 4±1°C for over night and sheared using Warner and Bratzler shear press with the fibres parallel to the longitudinal axis. The force required to shear the samples was observed and recorded (kg/cm²). Five observations were recorded for each sample to get the average value.

Sensory evaluation

The gluteus muscles were collected for the sensory evaluation of the meat. It was made into small pieces and were cooked in a pressure cooker for 20 min with 2% common salt. These products were served to the semi-experienced panelists consisted of scientists and students of LPT Division, IVRI, Izatnagar. Samples were evaluated as per the procedure of Keeton (1983) for appearance/colour, flavour/texture, juiciness, mouth coating and over all palatability, using 8 point descriptive scale.

Table 1. Proximate composition (% fresh basis) of various muscles in buffalo calves

Group	Muscle			SEM	Muscle mean	SEM		Interaction
	Psoas major	Longissimus dorsi	Semi-tendinosus			Group	Muscle	
Proximate composition (% fresh basis)								
Moisture								
I	76.95	77.00	77.15	1.03	77.03	0.50	0.50	NS
II	76.04	76.10	76.99	0.55	76.38			
III	75.37	75.74	74.73	0.95	75.28			
SEM	0.94	0.86	0.80					
Group mean	76.12	76.28	76.29					
Protein								
I	19.30	18.89	18.47	0.20	18.88	0.25	0.25	NS
II	19.22	19.68	18.91	0.57	19.27			
III	18.80	19.90	19.25	0.45	19.32			
SEM	0.29	0.33	0.61					
Group mean	19.11	19.49	18.88					
Fat								
I	0.45	0.45	0.47	0.05	0.46	0.02	0.02	NS
II	0.47	0.51	0.48	0.03	0.49			
III	0.47	0.48	0.48	0.04	0.48			
SEM	0.08	0.12	0.14					
Group mean	0.46	0.48	0.48					
Ash								
I	1.13	1.13	1.12	0.05	1.13	0.03	0.03	NS
II	1.24	1.14	1.13	0.06	1.17			
III	1.30	1.20	1.15	0.06	1.22			
SEM	0.08	0.15	0.12					
Group mean	1.23	1.16	1.13					

Statistical analysis

The data were subjected to test of significant (Snedecor and Cochran, 1967) by using the statistical software package (SPSS).

RESULTS AND DISCUSSION

Results revealed that, due to urea-ammoniation, the CP content of wheat straw increased from 2.90 to 6.96%. This might be due to the binding of ammonia released from the hydrolysis of urea inside the intermolecular spaces of wheat straw (Dass et al., 1984; Reddy et al., 1989). However, addition of HCl along with urea during urea-ammoniation further increased the CP content to 10.09%. This might be due to the trapping of the excess ammonia by forming ammonium chloride (Dass et al., 2001; Nair et al., 2002).

The proximate composition (% fresh basis) and physico-chemical properties of various muscles viz., psoas major, longissimus dorsi and semitendinosus in buffalo calves are presented in Table 1. It is evident from the Table 1 that, the proximate composition (% fresh basis) of psoas major, longissimus dorsi, semitendinosus and the cumulative muscle mean values in terms of moisture, protein, fat and ash are comparable among the groups. It indicated that there was no adverse effect of feeding AWS and HCl-AWS on proximate composition of these muscles. The cumulative muscle mean moisture percentage was

77.03, 76.38 and 75.28 in three groups, respectively. The cumulative muscle mean protein percentage was comparatively higher in groups II (19.27) and III (19.32) in composition to group I (18.88). Similarly, the cumulative muscle mean ash percentage was comparatively higher in groups II (1.17) and III (1.22) than group I (1.13). These comparatively higher cumulative muscle mean protein and ash percentage and lower moisture percentage in group II and III in comparison to group I indicated the desirable effect of feeding AWS and HCl-AWS. The mean values of moisture (75.28 to 77.15) and ash (1.12 to 1.30) found in this study were very close to the findings of the earlier workers (Rao, 1978; Anjaneyulu et al., 1985). Also, similar to this study, protein percentage, in buffalo meat have been reported earlier (Rao, 1978; Baruah et al., 1983). Contrary, the mean values of protein (18.47 to 19.90) and fat (0.45 to 0.51) in this study were marginally lower than the findings of Anjaneyulu et al. (1985) and Tiwari (1995), which may be attributed to the difference in age and slaughter weight of the experimental animals, as the percentage of fat normally increased with age (Maynard et al., 1979).

Various physico-chemical properties of different muscles in buffalo calves are presented in Table 2. Although the cumulative muscle mean pH in group III (5.54) was lower than group I (5.65) and II (5.62), but the difference did not turn out to be significant. The cumulative group mean pH in semitendinosus (5.59) was comparatively lower

Table 2. Physico-chemical properties of various muscles in buffalo calves

Group	Muscle			SEM	Muscle mean	SEM		Interaction
	Psoas major	Longissimus dorsi	Semi-tendinosus			Group	Muscle	
Physicochemical properties								
pH								
I	5.66	5.68	5.61	0.05	5.65	0.04	0.04	NS
II	5.64	5.60	5.62	0.10	5.62			
III	5.54	5.54	5.54	0.06	5.54			
SEM	0.10	0.08	0.05					
Group mean	5.61	5.61	5.59					
WHC (% water retained)								
I	50.35	47.22	48.06	2.42	48.54	1.46	1.46	NS
II	51.31	50.88	49.23	2.42	50.47			
III	45.23	49.73	47.84	2.72	47.60			
SEM	2.90	2.39	2.24					
Group mean	48.96	49.28	48.38					
ERV								
I	47.73	46.06	46.20	1.48	46.66	0.80	0.80	NS
II	45.54	44.79	46.53	1.49	45.62			
III	48.77	47.14	49.49	1.13	48.47			
SEM	1.54	1.08	1.47					
Group mean	47.35	45.99	47.40					
WSP (g %)								
I	13.89	13.44	13.16	0.60	13.49	0.36	0.36	NS
II	13.17	13.63	13.79	0.74	13.53			
III	13.14	12.32	12.84	0.48	12.77			
SEM	0.76	0.42	0.62					
Group mean	13.40	13.13	13.26					
SSP (g %)								
I	42.44	42.64	42.28	0.55	42.54 ^x	0.28	0.28	NS
II	43.24	43.04	42.15	0.59	42.81 ^{xy}			
III	41.79	41.69	41.86	0.17	41.78 ^y			
SEM	0.40	0.64	0.33					
Group mean	42.49	42.46	42.10					
Cooking loss (%)								
I	32.72	30.47	35.75	2.42	48.54	0.10	0.10	NS
II	29.68	28.45	33.37	2.42	50.47			
III	32.42	30.41	36.19	2.72	47.60			
SEM	1.93	1.70	2.08					
Group mean**	31.61 ^b	29.78 ^b	35.10 ^a					
SFV (kg/cm ²)								
I	6.47	6.49	6.65	0.44	6.53	0.23	0.23	NS
II	6.57	6.34	6.76	0.38	6.56			
III	6.09	6.12	6.28	0.38	6.17			
SEM	0.35	0.45	0.40					
Group mean	6.38	6.32	6.56					

NS: non significant ($p < 0.05$). * $p < 0.05$. ** $p < 0.01$. ^{a,b} Means with different superscripts in a row differ significantly.

^{xy} Means with different superscripts in a column differ significantly.

than psoas major (5.61) and longissimus dorsi (5.61). Similarly, the cumulative group mean water holding capacity (% water retained) in semitendinosus (48.38) was also comparatively lower than psoas major (48.96) and longissimus dorsi (49.28). The mean values of salt soluble proteins (g%) of psoas major (41.79 to 43.29) longissimus dorsi (41.69 to 43.04) and semitendinosus (41.86 to 42.28) were comparable among the groups. However, the cumulative muscle mean salt soluble proteins was significantly ($p < 0.05$) lower in group attributed to the

comparatively lower cumulative muscle mean pH in group III (5.54) than group I (5.65). Arganosa and Marriott (1989) also reported that acid treatment decreased the myofibrillar protein extractability and caused coagulation of myofibrillar protein and decreased myofibrillar (salt soluble) protein extractability. The cumulative group mean cooking loss (%) was significantly ($p < 0.01$) lower in psoas major (31.61) and longissimus dorsi (29.78) than semitendinosus (35.10). This is due to the comparatively lower cumulative group mean pH and water holding capacity of semitendinosus than

Table 3. Various sensory attributes of cooked (2% common salt) buffen

Attributes	Group			SEM
	I	II	III	
Appearance/colour	6.37	6.43	6.43	0.20
Flavour	6.17	6.53	6.30	0.18
Juiciness	6.33	6.35	6.38	0.18
Texture	6.67	6.67	6.50	0.17
Mouth-coating	7.03	6.93	7.00	0.27
Overall palatability	6.70	6.80	6.77	0.20

psoas major and longissimus dorsi. The mean values of pH and cooking loss (%) found in this study were similar to the findings of Anjaneyulu et al. (1985). Mendiratta and Panda (1992) also reported decrease in cooking yield with decrease in pH and water holding capacity. The cumulative group mean shear force value (kg/cm^2) in psoas major, longissimus dorsi and semitendinosus were 6.38, 6.32 and 6.56, respectively, being lowest in psoas major and highest in semitendinosus. This indicated that psoas major was the tender most and semitendinosus was less tender one among the three muscles studied. Koohmaraie et al. (1988) also reported similar observations in muscles of beef cattle. The cumulative muscle mean shear force value (kg/cm^2) in group I, II and III were 6.53, 6.56 and 6.17, respectively, being lowest in group III and highest in group II. The decrease in tenderness in group II could be due to the higher growth rate in group II (605.56 g/d) than group I (504.86 g/d) and III (463.89 g/d). Tenderising effect in muscles of group III animals might be due to the tenderising effect of chloride ions of HCl (Palladino et al., 1979).

Data regarding the sensory attributes of cooked (2% common salt) buffen are presented in Table 3. The scores of various sensory attributes viz. appearance/colour (6.37 to 6.43), texture (6.50 to 6.67), mouth coating (6.93 to 7.03) and overall palatability (6.70 to 6.80) were comparable among the groups. It indicated that feeding of ammoniated wheat straw treated with and without HCl had no ill effect on these sensory attributes. Contrary, Pande and Shukla (1979) reported higher tenderness and lower juiciness in buffalo meat due to urea feeding.

CONCLUSION

Results of the present study suggested that feeding of ammoniated wheat straw treated with and without HCl to growing male buffalo calves for 180 days had no adverse effect on the meat quality and various sensory attributes.

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