International Journal of Food, Agriculture and Veterinary Sciences ISSN: 2277-209X (Online)
An Open Access, Online International Journal Available at http://www.cibtech.org/jfav.htm
2017 Vol.7 (1) January-April, pp.30-34/Nampoothiri

Review Article

DIETARY INTERVENTIONS FOR IMPROVING THE FUNCTIONAL VALUE OF BUFFALO MEAT

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ABSTRACT
India being home for the largest number of buffalo population in the world is the fifth largest producer and exporter of buffalo meat. Consumer is demanding high quality and healthier meat. Dietary interventions can be done for improving the quality of meat produced and also for functional meat production. This article discusses some of the nutritional manipulations that can be done in the diet of buffalo for producing good quality and healthier meat. Functional value of buffalo meat can be improved by adding conjugated linoleic acid (CLA), antioxidants and omega 3 fatty acids in the diet.

Keywords: *Buffalo, CLA, Vitamin E, Selenium*

INTRODUCTION
Buffaloes are of two types, riverine buffalo *(Bubalus bubalis*) and swamp buffalo *(B. bubalis*). Riverine buffaloes are distributed in India, Pakistan, Sri Lanka and some European countries such as Italy, Bulgaria, Greece and Yugoslavia. Swamp buffaloes are spread in far East Asia including China, Indo-China, Indonesia, Philippines and Thailand. India has largest livestock population in the world. It has about 98 million buffaloes, which is 57% of total population in the world. They contribute to 1.48 million metric tonnes of meat, amounting 24.54% of the total meat produced in the country (FAO, 2008). India is the fifth largest producer of meat. Per capita consumption of meat in India is 13.7g/day against world average of 106.85g/day. India is also the fifth largest exporter of buffalo meat (FAO, 2008). Despite vast resource of population and contribution of buffaloes to the total meat production in the country, their potential for utility in the processed meat sector is not completely exploited. Lesser importance is given to quality control. Now a day's consumer demand for healthier meat and meat products increased. So, improving the functional value of meat is important.

Inherent Qualities of Buffalo as a Meat Producer
Buffaloes have a unique ability in converting coarse feed, straw and crop residues to protein rich lean meat. Buffalo properly managed and fed as a meat producing animal and slaughtered at 16 to 20 months of age yields a highly satisfactory top quality meat at a much lower cost than the cattle (Ranjan and Pathak, 1979). Sub cutaneous fat layer in buffalo is low compared to that of cattle. Disease resistance power of buffaloes is high compared to cattle. Buffaloes have excellent body weight gain and feed efficiency compared to cattle. Buffalo meat is dark red in color, firm in consistency with white fat color. More pigmentation or less intra muscular fat (1-2% marbling compared with 3-4% in beef) content causes darker appearance of buffalo meat.

Table 1: Nutrient Content of Different Types of Meat

Species	Calories (Kcal/100g)	Protein %	Fat %	Cholesterol (mg/100g)
Buffalo	131	20.2-24.1	**0.9- 1.8**	**61**
Beef (USDA standard)	152	22.7	2.0	69
Pork	165	22.3	4.9	71
Goat	144	22	3.0	75
Chicken	135	23.6	0.7	62

(National nutrient database for standard reference, 2007)

Functional Food

Food having health promoting benefits and/or disease preventing properties over and above its usual nutritional value are called functional foods (Hardy, 2000; Stanson *et al.*, 2005). Functional foods should satisfy three requirements i.e. derived from naturally occurring ingredients, consume as a part of daily diet and also involve in regulating specific processes like preventing diseases and improving immunity. The term functional food was first mentioned in 1980s in Japan. Japan and USA are the most dynamic market for functional foods.

Improving Functional Value of Buffalo Meat

Functional value of buffalo meat can be improved by dietary modifications and processing methods. Conjugated linoleic acid, vitamin E, n3 fatty acids and selenium in animal diets can improve carcass composition and fresh meat quality.

CLA (Conjugated Linoleic Acid)

CLA is a mixture of positional and geometric isomers of linoleic acid (Eulitz *et al.*, 1999). Among isomers cis9, trans 11 and trans 10, cis 12 CLA are the most studied isomers. Ruminants are able to synthesize CLA through two processes i.e. exogenous and endogenous synthesis. Exogenous synthesis occurs in rumen with the help of *Butyrivibrio fibrisolvens*. Endogenous synthesis occurs in adipose tissue and mammary gland with the help of delta 9 desaturase enzyme. Methods to raise CLA content in meat includes Pasture feeding, including oil seeds in cattle rations, direct addition of oils in cattle feed, feeding encapsulated CLA, feeding algal meals and plant extracts.

(a) Pasture Feeding

Pasture feeding is the first and foremost strategy for improving CLA content in the buffalo meat. Forage based diets increase CLA production possibly through inhibitory effect of linolenic acid and other n-3 PUFA on biohydrogenation (Enser *et al*., 2000).

Realini *et al.,* (2004) found that total CLA content in intramuscular fat from Hereford steers fed with pasture was two times greater than that fed with concentrates.

Giuffrida *et al.,* (2005) compared the occurrence of CLA in longissimus muscle of cattle and buffalo raised in savannah and found that the total CLA formed is significantly higher in buffalo compared to cattle.

(b) Oil seeds in Diet

Oil seeds in the diet of buffalo found to have improved the CLA content of muscle. The order of effectiveness is safflower> sunflower> linseed> hempseed> heat treated soybeans> corn> rapeseed. Also usage of more oil seeds found to reduce the grassy taste of buffalo meat.

(c) Direct Addition of Oils in Feed

Addition of oleic fatty acids (5% DM basis in feed) results in raise of CLA (trans10, cis 12) in semimembranosus muscle (Hristov *et al*., 2005). But the main drawback is due to the excessive greasy or oily taste in consumer cuts. Addition of fish oil causes fishy taste to meat (Campo *et al*., 2006).

(d) Encapsulated CLA

Encapsulated CLA can bypass the rumen breakdown thus preventing the wastage. Gillis *et al.,* (2007) proved that encapsulated CLA in diet increased the CLA content in muscle meat.

(e) Algae as CLA Booster

Or-Rashid *et al*., (2008) found that algal meals change the microbial processes in rumen, favoring CLA conformers over others, particularly cis 9, trans 11.

(f) Plant Extracts

In vitro ruminal CLA production had increased by feeding 1mg/ml of *Acacia concinna* (Vaheideh, 2011). *Terminalia chebula* extract (1.06 & 3.18g/kg BW) increased CLA content of longissimus dorsi in kids (Rana *et al.,* 2012).

Antioxidants

Antioxidant is a molecule capable of slowing or preventing the oxidation of other molecules. Oxidation reaction produces free radicals which start chain reaction that damage cells. Vitamin E, Selenium and Vitamin C are the commonly used antioxidants.

(a) *Vitamin E*

Vitamin E is a generic form that includes all entities that exhibit the biological activity of α-tocopherol. Dietary supplementation with vitamin E increases the concentration of α–tocopherol in muscles and reduces the susceptibility of the muscle to the lipid oxidation.

Dass *et al.,* (2011) supplemented Vitamin E to male murrah buffalo calves at level of 0 (I), 300 IU (II) and 600 IU (III). The overall mean concentration of α–tocopherol was 1.61, 2.42 and 2.41 μg/g meat in group I, II and III, respectively. Significant differences were observed between control and vitamin E treated samples of longissimus dorsi ($P<0.05$), semimembranosus ($P<0.05$), semitendanosus ($P<0.05$) and overall attribute ($P<0.05$) for vitamin E content in muscles of buffalo calves. However, no significant difference was observed in group II and III, which indicated that supplementing the diet with high level of vitamin E (600 IU), did not further increase the concentration of α–tocopherol in the muscle tissues. The overall peroxide value (meq/1000 g) was significantly ($P<0.05$) lower in meat of vitamin E supplemented groups than control group. These results revealed that vitamin E supplementation was effective in reducing the lipid oxidation of the meat samples.

Similarly, Cascone *et al*., (2007) obtained significantly higher amount of Vitamin E concentration in the longissimus dorsi, triceps brachi and semimembranosus muscles of buffaloes supplemented with 600 IU/day and 1500 IU/day. Concerning lipid oxidation level, animals that received the dietary supplement with 600 IU of vitamin E demonstrated lower concentration of malondealdehyde (MDA) in the muscles. Results show that dietary supplementation with vitamin E influences the susceptibility of muscle lipid to undergo lipid oxidation reactions.

The alpha-tocopherol content in meat is positively correlated with the amount in enriched diet and negatively correlated with MDA values from lipid oxidation. It is concluded that diets enriched with 600 IU/buffalo die for about 100 days can be a successful strategy to inhibit the development of lipid oxidation and it is possible to suppose that vitamin E, preserving lipids, can influence positively organoleptic characteristics prolonging the shelf-life of meat and, therefore, allowing a major diffusion of buffalo meat consumption.

(b) *Selenium*

Selenium is a micro mineral which plays an important role in immune mechanism and growth. Selenium act as an effective anti oxidant, thus, prevents lipid oxidation of muscles. Selenium forms integral part of enzyme glutathione peroxidase which is an antioxidant enzyme.

Organic selenium found to have more bioavailability compared to inorganic selenium. Organic selenium supplementation improved meat color by 3.8% and tenderness by 17% compared to inorganic selenium in beef cattle.

Omega 3 Fatty Acids

Long chain ω3 polyunsaturated fatty acids (PUFA) are recognized as essential constituents for normal growth and development in animal. This group of fatty acids includes eicosapentaenoic acid (EPA, 20:5), docosapentaenoic acid (DPA, 22:5) and docosahexaenoic acid (DHA, 22:6). Dietary supplementation of fat and oils is an efficient method to increase content of ω3 PUFA in animal muscles (Lopez-Ferrer *et al.,* 2001). Dietary supplementation with vegetable oils including linseed oil and rapeseed oil increase ω3 fatty acid content in form of linolenic acid, which could be used to synthesize long chain ω3 PUFA (Lopez-Ferrer *et al*., 2001).

Improvement of Sensory Attributes

Sensory attributes of meat include appearance, flavor, juiciness, tenderness and overall palatability. According to the work done by Sehgal *et al.,* (1999a) it was found that high concentrate ratio of 80:20 causes less cooking loss in Indian murrah buffaloes at veal stage. There was a significant increase in flavor, juiciness, tenderness in longissimus dorsi muscle of male murrah buffalo calves supplemented with 300 IU of Vitamin E (Dass *et al*., 2011).

Sehgal *et al*., (1999b) also studied the effect of high (80:20) and medium (60:40) concentrate diet on the meat quality of murrah male calves found significantly higher cooking loss in high concentrate supplemented group compared to the medium concentrate group.

Table 2: Meat Qualities of Murrah Buffaloes at Beef Stage

Parameters	**High Concentrate (80:20)**	**Medium Concentrate (60:40)**
Cooking loss (%)	**35.2± 1.3***	31.7±0.7
WHC (%)	18.2± 0.2	17.8± 0.6
Colour	Pink to light red	Pink to light red

Source- Sehgal *et al*., (1999b)

Diet Nutritive Level on Buffalo Meat Quality

High concentrate feeding (80:20) in murrah male calves lead to significantly higher dressing percentage at beef stage (Sehgal *et al*., 1999b). High concentrate diet (80:20) also caused significantly higher dressing percentage and significantly lower fat percentage in meat of murrah calves at veal stage compared to the medium concentrate diet (60:40). Prakash *et al*., (1988) during his work on male murrah buffalo calves by feeding high energy (100% of ARC recommendations) and low energy (80% of ARC recommendations) diets noticed no significant effect on dressing percentage, meat, fat and bone ratio but had higher fat percentage in higher energy ration. Similar result on fat percentage was observed by Baruah *et al*., (1988) when male buffalo calves were kept on 90, 100 and 110% energy levels of NRC, 1976. Sharma *et al*., (1988) reported that dressing percentage in murrah calves ranged from 50.5 to 53.3 and that there was no difference due to levels of energy in the ration.

Conclusion

The innate potential of buffaloes, especially the value of male calves is increasing on a high note. Buffalo is the chief foreign exchange earner in meat sector. India, having the highest buffalo population in the world, is expected to provide leadership in buffalo husbandry.

In dairy industry buffaloes play a key role and this can well be repeated in meat industry, if only available knowledge and ideas are crystallized into action plans. Massive developmental programmes have to be launched to produce meat as the principal commodity from buffaloes for substantially increasing the livestock economy of the country.

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