

*Review Article***Role of Pastures in Value Addition of Animal Products: A Review****Shahid H. Mir<sup>1</sup>, H. A. Ahmed<sup>2</sup>, A. M. Ganai<sup>2</sup>, Shabir A. Lone<sup>3\*</sup>, Bilal A. Ganaie<sup>3</sup> and Tariq A. Malik<sup>1</sup>**<sup>1</sup>Division of Animal Nutrition, ICAR-National Dairy Research Institute (NDRI), Karnal-132001, Haryana, INDIA<sup>2</sup>Division of Animal Nutrition, FVSc & A.H, SKUAST-K, Shuhama, Alusteng, Srinagar-190006, Jammu & Kashmir, INDIA<sup>3</sup>Division of Animal Reproduction Gynaecology and Obstetrics, ICAR-National Dairy Research Institute (NDRI), Karnal-132001, Haryana, INDIA**\*Corresponding author:** [drloneshabir@gmail.com](mailto:drloneshabir@gmail.com)

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**Abstract**

*The emergence of many lifestyle diseases in humans has been related to the over-consumption of saturated fats generally through animal products. But the consumption of animal products by humans is as old as the human civilization itself. Yet the recent emergence of these diseases is baffling. So the shift of focus from “what we eat” to “what we eat, ate” occurs, thus bringing in froth the importance of animal feeding. Industrialization revolutionizes almost everything including the kind and type of feed offered to animals. Animals are most commonly offered factory made feed with grains as the main ingredient. These animals have evolved over millions of years for the feeding of grass, so feeding of grains although accelerated growth and production, inevitably brought some problems with them and one of them is absence of important nutrients which are thought to have protected our ancestors from the diseases which we are experiencing now. The most important of these diseases are cancer and those associated with cardiovascular system and brain. Grass-fed animals secrete some substances in their products having nutraceutical properties thereby making their products special and value-added. These substances are either present in grass or are produced by the animals from their precursors in the grass. They include CLA,  $\omega$ -3 fatty acids,  $\beta$ -carotene (vitamin A),  $\alpha$ -tocopherol (vitamin E) and antioxidant enzymes. However, a shift from the traditional established grain feeding system to the grass feeding system might not be easy in today’s highly competitive era and require greater motivation from consumers and producers. The present review enlightens the importance of these substances in humans via their incorporation in animal products along with its feasibility under the present feeding systems.*

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## Introduction

Pastures form the integral part of the society, serving man and livestock since antiquity. Man used to depend on pastures for its survival relishing grass-fed meat and milk, but for the past two hundred years or so, the dependency on pastures has decreased due to unprecedented growth of industries. Animals are fed concentrates in the form of manufactured feeds like compound feed, pelleted feed and complete feed, to achieve high production in less time. Even at present, approximately 60 percent of the world's pasture land is classified as grazing land, thus forming the enormous feed resources for ruminants (Haan *et al.*, 1997). Pastures are distributed throughout the temperate and tropical regions of the world. Many of the world's pasturelands are grazed by domestic livestock providing livelihood to thousands of pastoralists and are often central to their cultural heritage. In temperate regions, grass-based systems of milk production predominate as the naturally occurring pastures are abundantly available. For example, dairy production in New Zealand is solely based on pasture feeding with over 90 percent of the total nutrient requirements fulfilled by grazing and over 95 percent of milk production in the European Union is based on pastureland (Hodgson, 1990). Animal products have formed the important part of the human diet since the beginning of the human civilization. The curiosity of the researchers in the early part of the twentieth century for animal production was driven by food deficiency diseases like rickets and protein malnutrition, thus increasing the animal protein in the diet of the urban industrialized people. However, in the latter part of the twentieth century, it precipitated many diseases as the animal products become the carrier of fats especially saturated ones. These human health problems were mostly related to cardiovascular system thereby concerning individuals and officials equally. Many official advisories from the government in developed countries have asked people to reduce saturated fat intake and simultaneously increase the consumption of unsaturated fatty acids, especially the omega-3 polyunsaturated fatty acids (*n-3* PUFA). Considerable development in this regard was made by farmers who anticipated the drop in the demand of animal products with high fats. Several nutritional and breeding strategies to bring down the percentage of fat in the animal products mainly meat was adopted by farmers by roping in scientists and animal nutritionists. For example, in the 1960's, typical fat contents for beef and lamb as sold retail in Britain were 25 and 31 percent, respectively, while by 2000 the equivalent figures were 5 and 8 percent. After reducing the quantity of fat quality of fat i.e. fatty acid composition of ruminant products becomes the focus of considerable research attention as the link between saturated fat consumption and cardiovascular disease was established. The ratio of polyunsaturated to saturated fatty acids (P: S) in the human diet is recommended to be about 0.4 with relatively higher intake of *n-3* compared to *n-6* PUFA (Department of Health, 1994).

### **Pasture/Grass Fed and Grain Fed Animals**

USDA has defined grass/forage fed animal as those that don't feed on grain or grain-byproducts throughout their lifetime, except of the milk consumed prior to weaning, instead consume grasses and forage. Hay, haylage, baleage, silage, crop residue and daily mineral and vitamin supplementation are also included in the feeding regimen (AMS, 2007). In contrast, grain-fed animals are those animals which are deliberately fed grains during their lifetime.

### **Pasture/Grass-Fed versus Organic Food**

It is important to differentiate between organic and grass-fed food. Organic products are those that are produced from animals fed diets free of any pesticides, herbicide, hormones, antibiotic or any synthetic fertilizers. Organic products can come from animals that were fed organically grown grain. Hence organic does not mean grass-fed, similarly, grass-fed does not mean organic. Grass-fed animals often graze on land that has been treated with herbicides or synthetic fertilizers. Unless it is specifically mentioned that food is both grass-fed and organic it can be either.

### **How Pasture/Grass Feeding Helps in Value Addition of Animal Products?**

In addition to protein, carbohydrate and fat, pasture grasses are also rich in some important substances or nutraceuticals which can have protective action in human beings and prevent the occurrence of many diseases like cancer, diabetes and atherosclerosis. Through the consumption of pasture grass these nutrients are incorporated in the animal products thereby improving their quality. These value added or designer animal products can help us to lead healthier life with little or no occurrence of diseases. Some of these substances are present only in animal products like CLA, EPA, DHA, although their precursors (like ALA) might be present in plants. Hundreds of such nutraceuticals can be found in grass-fed animal products like  $\beta$ -Glucan, Ascorbic acid,  $\gamma$ -Tocotrienol, Quercetin, Luteolin, Lutein, Gallic acid, Perillyl alcohol, Indole-3-carbonol, Daidzein, Glutathione, Allicin,  $\delta$ -Limonene, Genestein, Geraniol and  $\beta$ -Ionone. However, the most important among them are ALA / conjugated linoleic acid (CLA),  $\omega$ -3 fatty acids,  $\beta$ -carotene (Vitamin A) and  $\alpha$ -tocopherol (Vitamin E). Apart from these nutrients, pasture grasses also increase the synthesis of the folic acid, Vitamin B<sub>12</sub> and antioxidants in animal body which are essential in the human diet.

Grasses and green forage are rich in  $\alpha$ -linolenic acid and recent researches have shown that the fatty acid composition of animal products from ruminants which have been fed on a grass diet differs from that fed concentrates. Comparison of grain-fed animal products with that of grass-fed showed lower amount of total fat especially saturated fats, higher concentration of beta-carotene, vitamin E (alpha-tocopherol), B-complex vitamins (thiamin and riboflavin), minerals (calcium, magnesium, and potassium), total omega-3s, CLA (cis-9 trans-11) and vaccenic acid (which can be transformed into CLA) in animal products from

grass-fed animals. Moreover, a healthier ratio of omega-6 to omega-3 fatty acids with consequent reduction in heart diseases in consumers eating animal products from grass-fed animals was observed (Duckett *et al.*, 2009).

### **Beneficial Effects of Pasture Nutrients on Human Health through Value Addition of Animal Products**

#### **Conjugated Linoleic Acid (CLA)**

CLA is a mixture of isomers of essential fatty acid, linoleic acid, having conjugated double bonds. The two bonds can either be in trans or cis position. The two most important isomers of CLA are c9, t11 CLA (rumenic acid) and t10, c12 CLA. It is formed in the rumen by the partial biohydrogenation of linoleic acid by *Butyrivibrio fibrisolvens* using enzyme linoleic acid isomerase (Kritchevsky, 2000) or in the mammary gland by the endogenous conversion of transvaccenic acid (trans-11, C18:1), another intermediate of linoleic or linolenic acid biohydrogenation, by  $\Delta^9$ -desaturase (Corl *et al.*, 2001).

Meat and milk from pasture-fed ruminants are a major source of conjugated linoleic acids (CLA) in the human diet, which have a number of health promoting benefits such as anti-carcinogenic activity, anti-atherosclerotic activity, the ability to decrease the catabolic effect of immune stimulation, enhanced growth and more importantly reduction in body fat (Banni *et al.*, 1998). There exists a positive relationship between the CLA concentration in milk and the fresh forage proportion in the diet of dairy cows (Ward *et al.*, 2003; Tyagi *et al.*, 2007). Products obtained from milk like ghee and butter tend to have higher CLA content than the milk probably because of high concentration of the fat in them. Moreover, milk products produced by the villages in India has higher CLA levels and the levels tended to be higher in buffalo than cow probably it is because they tend to graze more on pastures under the traditional rearing system (Aneja and Murthi, 1990). Many authors have also reported that meat and milk of pasture fed animals contain higher amount of CLA which is documented in the Table 1.

**Table 1:** Effect of feeding pasture grasses on the CLA content (% of total lipid) in meat

S. No.	Author, Year	Breed	Treatment	Vaccenic acid	Linoleic acid	Total CLA
1	Alfaia <i>et al.</i> , 2009	Cross-bred steers	Grass	1.35	12.55	5.14
			Grain	0.92	11.95	2.65
2	Leheska <i>et al.</i> , 2008	Mixed cattle	Grass	2.95	2.01	0.85
			Grain	0.51	2.38	0.48
3	Garcia <i>et al.</i> , 2008	Angus cattle	Grass	3.22	3.41	0.72
			Grain	2.25	3.93	0.58
4	Ponnampalam <i>et al.</i> , 2006	Angus cattle	Grass	Na	108.8	14.3
			Grain	Na	167.4	16.1
5	Nuernberg <i>et al.</i> , 2005	Simmental cattle	Grass	Na	6.56	0.87
			Grain	Na	5.22	0.72

## Beneficial Effects of CLA on Human Health

### Anti-carcinogenic Activity

The anticarcinogenic activity is one of the most studied properties of CLA since its discovery by Michael Pariza in 1987. CLA is thought to be one of the most potent nutraceutical against cancer as its anticarcinogenicity has been proven beyond any doubt through various experiments. Ha *et al.* (1989) in his experiment with mice found that the mice treated with CLA developed only 50% papillomas and presented a lower incidence of tumor when compared with the control mice. Similarly women who have higher levels of CLA in their diet tend to have lower risk of breast cancer than those with lower levels of CLA. Interestingly, women were placed in lower risk category when they switch their diets from grain-fed to grass-fed products (Aro *et al.*, 2000). In yet another study the breast tissues of 360 women were analyzed for CLA concentration and it was found that women with high CLA levels have 74 percent lower risk of breast cancer than women with lower CLA levels (Bougnoux *et al.*, 1999). The possible mechanism is that CLA up-regulates the estrogen-regulated cancer suppressor gene, protein tyrosine phosphatase gamma (PTP gamma) in human breast cells (Wang *et al.*, 2006). Thus, CLA might serve as a chemo-preventive and chemotherapeutic agent in human breast cancers. Moreover, t-10, c-12 CLA can induce cell death in human colon cancer cells through reactive oxygen species (ROS) mediated ER stress (Pierre *et al.*, 2013). In laboratory animals, a very small percentage of CLA (0.1 % total calories) greatly reduced tumor growth (Ip *et al.*, 1994). Dhiman *et al.* (1999) reported that a person may be able to lower the risk of cancer simply by having a one glass of whole milk, 30 grams of cheese and meat each day obtained from grass-fed animals. To get the same level of protection a person would have to eat five times that amount of grain fed meat and dairy products.

### Anti-atherosclerosis Activity

CLA can inhibit hyperlipidemia and prevent the formation of atherosclerosis by decreasing the concentration of lipids and cholesterol in plasma (Yi *et al.*, 2011). The hypolipidemic and hypocholesterolemic activities of conjugated linoleic acid isomers change the erythrocyte membrane fluidity thereby tend to increase their lifespan (Saha *et al.*, 2012). Hypercholesterolemia induced in male albino rats by feeding high fat diet was reversed by the supplementation of CLA nano-particles (Sengupta *et al.*, 2015). McCarthy *et al.* (2013) studied the anti atherosclerosis activity of CLA in great detail and found that CLA activates Macrophage PPAR gamma Co-activator-1 alpha which represses foam cell formation and thereby prevents atherosclerosis.

### Anti-diabetic Activity

CLA (c9, t11 CLA) shows anti-diabetic effect by improving the systemic insulin sensitivity, promoting anti-inflammatory effects in white adipose tissue and mediating the release of insulin from pancreas. CLA

also improves the coordination between carbohydrate and energy metabolism thereby influencing metabolic flexibility of the liver and muscle cells. CLA may ameliorate systemic insulin sensitivity in obesity induced diabetes by altering cellular stress and redox status, moreover, in key insulin sensitive tissues it may modulate nutrient handling through the complex biochemical reactions (Rungapamestry *et al.*, 2012). CLA up regulates insulin receptor substrate 1 and GLUT4 expression by inhibiting negative effect of TNF- $\alpha$  and promote insulin mediated glucose transport in 3T3-L1 adipocytes compared to linoleic acid (Moloney *et al.*, 2007). Trans-10, cis-12 CLA can improve liver carbohydrate and lipid metabolism in type I diabetic mice by stimulating fat accumulation in the absence of insulin in the liver (Jourdan *et al.*, 2009). Insulin release by islet's G protein-coupled receptor, FFA1/GPR40 is augmented by CLA (Schmid *et al.*, 2006).

### **Myocardial Infarction Prevention**

Cis-9, trans-11 CLA, which is present in meaningful amounts in the products of pasture-grazed animals, might alleviate the adverse effect of the saturated fats and decrease the risk of myocardial infarction in humans (Smit *et al.*, 2010).

### **Anti-allergic**

Dietary cis-9, trans-11 CLA can reduce allergic sensitization and bronchial inflammation via a PPAR related mechanism and decreases the concentration of the eicosanoid precursor, arachidonic acid, in tissue lipids (Jaudszus *et al.*, 2008). Thus, CLA's role in immunomodulation can be exploited in the prevention and treatment of allergic asthma through dietary manipulation.

### **Liver Protection**

Liver protective properties of CLA can be visualized by an experiment carried out by Carvalho *et al.* (2014) who showed that dietary supplementation of CLA markedly reduced the liver damage induced by carbon tetrachloride. The levels of enzymes catalase (CAT), glutathione reductase (GR) and reduced glutathione (GSH) were increased along with the increased expression of *CAT gene* in damaged liver after CLA feeding, suggesting its antioxidant potential. Thus, CLAs can be used as adjuncts to attenuate hepatic damage.

### **Aids in Calcium Absorption**

Effect of interaction between dietary CLA and calcium on body composition was studied by Park *et al.* (2006) who found that CLA supplementation increased body ash compared to control only when the calcium level was higher than 0.5%. This suggests possible beneficial effects of CLA along with calcium supplementation on bone mass. Trans-10, cis-12 CLA induce osteoblastogenesis by stimulating bone

marrow mesenchymal stem cells. It also aids in the bone formation by inhibiting adipogenesis through peroxisome proliferator activated receptor- $\gamma$  dependent mechanisms (Kim *et al.*, 2013).

### CLA Enhances Activity of Probiotics

Jedidi *et al.* (2014) studied the effect of the milk fortified with CLA on the viability of probiotic bacteria using TIM-1 digestion simulator. They reported that the considerable growth of probiotic bacteria like *Lactobacillus rhamnosus* R0011 and *Lactobacillus rhamnosus* LGG in digesta containing milk enriched with CLA and adjusted to 1.0% fat level. CLA enriched milk provides a suitable environment for the bacteria to proliferate and grow in the digesta, thereby enhancing the effect of probiotics in animals.

### CLA and Vitamin A

Dietary intake of CLA has shown a significant increase in the retinol levels in the tissue along with retinol binding protein. The precise mechanism of this increase is yet to be elucidated. However, Carta *et al.* (2014) have speculated similar degradation pathway for both molecules results in competition for the pathway enzymes resulting in the increase in the half-life of vitamin A. More precisely competition for PPAR- $\alpha$  and RXR heterodimer is thought to occur which regulates the activity of the catabolic pathway of both the molecules. Moreover, CLA has shown to increase the activity of alpha-tocopherol which has sparing action on vitamin A.

### Omega ( $\omega$ )-3 Fatty Acids

Omega-3 fatty acids are considered as essential fatty acids for mammals as they lack the desaturase enzyme which induces double bond beyond carbon-9. Important sources of Omega-3 fatty acids are marine food especially fish or fish oil and products from grass-fed animals. The reason being these animals have more access to green herbage which contains high amount of omega-3 fatty acids in their leaves (chloroplasts). Most prevalent fatty acid in green herbage is a type of omega-3 fatty acid known as alpha-linolenic which constitutes about sixty percent of the total fatty acids of the plant. When animals are removed from pasture-based grazing and moved to a feedlot to be fattened on grain-based rations, the valuable store of LNA along with two other types of omega-3 fatty acids, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are lost at a constant rate. Each day that an animal spends on the grain-based ration, its supply of omega-3 fatty acids is diminished (Duckett *et al.*, 1993). Omega-3 fatty acids form the important part of the cellular membranes; however, structural function of the omega-3 fatty acid doesn't restrict its importance as it has been found to carry other vital function in every cell and system in our body. Omega-3 fatty acids are considered as most heart friendly as the persons having ample amount of omega-3 fatty acids in their diets are 50% less likely to suffer from heart diseases (Siscovick *et al.*, 1995) and are also less likely to suffer from brain disorders like depression, schizophrenia, or Alzheimer's

disease (Simopolous and Robinson, 1999). These essential fatty acids have shown to slow the growth of a wide array of cancers and prevent them from spreading (Rose *et al.*, 1995). Omega-3 fatty acids can hasten the recovery of patients suffering from advanced cancers by slowing or even reversing the extreme weight loss (Tisdale, 1999). Moreover, high concentration of these fatty acids in the blood of such patients would make them better responsive to chemotherapy (Bounoux *et al.*, 1999). Presence of omega-3 fatty acids in the diet is essential to lead a healthy and quality life.

### Ratio of Omega 3: Omega 6 Fatty Acids in diet

The comprehensive analysis of the disease pattern over the last 200 years reveal that modern chronic diseases were almost absent in our ancestors and there is consensus among the nutritionists that it is directly related to our dietary patterns. There is no report of any heart attack in ancient Greek. Our ancestors thrived on the diet having an omega-6: omega-3 ratio of 1:1, while our current diets are closer to 10-20:1 as most of their products come from grazing animals and ours come from grain-fed animals (Simopoulos, 1991). An inappropriate balance of the ratio between omega-6 and omega-3 invariably contributes to the development of disease while a healthy balance maintains and even improves health. A healthy diet should contain about one to four times more omega-6 fatty acids than omega-3 fatty acids. Grass-fed cattle produce higher percentages of omega-3 fatty acids within the lipid fraction than grain-fed animals thereby maintain a very healthy and balanced ratio (Table 2) (Rule *et al.*, 2002).

**Table 2:** Comparison EFAs (as % of total fatty acids) by the grass-fed and grain-fed

S. No.	EFAs by diet (as % of Total Fatty Acids)	Grass-fed (%)	Grain-fed (%)
1.	n-6 fatty acids	5.66	3.92
2.	n-3 fatty acids	2.9	0.64
3.	n-6: n-3 ratio	1.95	6.38

### Beta ( $\beta$ ) Carotene

Grasses and green herbage are rich in  $\beta$ -Carotene. Therefore, the animal products from grass-fed animals are a rich source of this pro-vitamin. Naturally yellow-colored, beta-carotene gives a yellow hue to the fat of grass-fed animals, which is quite different from the pasty white color fat in vitamin-deficient grain-fed animals. Pasture-fed animals have significantly higher concentration of beta-carotene into muscle tissues when compared to grain-fed animals (Table 3). A 7 fold increase in  $\beta$ -carotene levels, from 0.06 to 0.45  $\mu\text{g/g}$  was observed in grain-fed and grass-fed beef cattle, respectively (Descalzo *et al.*, 2005).

**Table 3:** Comparison of mean  $\beta$ -carotene content in fresh beef from grass-fed and grain-fed cattle

S. No.	Author, Year	Animal Class	Grass-fed ( $\mu\text{g/g}$ tissue)	Grain-fed ( $\mu\text{g/g}$ tissue)
1.	Insani <i>et al.</i> , 2007	Crossbred steers	0.74	0.17
2.	Descalzo <i>et al.</i> , 2005	Crossbred	0.45	0.06
3.	Yang <i>et al.</i> , 2002	Crossbred steers	0.16	0.01

### Vitamin E ( $\alpha$ -tocopherol)

Animal products obtained from grass-fed animals are higher in vitamin E. Pasture can provide vitamin E to animals better than supplementation through synthetic sources. An experiment conducted by Smith *et al.* (1996) found that grass-fed beef animals contain almost four times higher vitamin E than grain-fed animals and almost two times higher than beef from the grain-fed cattle given vitamin E supplements. Comparison of mean  $\alpha$ -tocopherol content in fresh beef from grass-fed and grain-fed cattle is given in Table 4. Vitamin E has the potential of lowering the risk of heart disease and cancer. It is potent antioxidant with proven anti-aging properties.

**Table 4:** Comparison of mean  $\alpha$ -tocopherol content in fresh beef from grass fed and grain fed cattle

S. No.	Author, Year	Animal type	Grass-fed ( $\mu\text{g } \alpha$ -tocopherol /g tissue)	Grain-fed ( $\mu\text{g } \alpha$ -tocopherol /g tissue)
1.	De la Fuente <i>et al.</i> , 2009	Cattle	4.07	0.75
2.	Descalzo <i>et al.</i> , 2008	Crossbred steers	3.08	1.50
3.	Insani <i>et al.</i> , 2007	Crossbred steers	2.1	0.8
4.	Descalzo, <i>et al.</i> , 2005	Crossbred steers	4.6	2.2
5.	Realini <i>et al.</i> , 2004	Hereford steers	3.91	2.92
6.	Yang <i>et al.</i> , 2002	Crossbred steers	4.5	1.8

### Antioxidant Enzyme Activity

Grass-fed products have higher superoxide dismutase, Glutathione and Catalase activity than products from grain-fed animals. A significant increase in Glutathione concentrations in grass-fed beef was observed by Descalzo *et al.* (2008). Antioxidants have the capability of quenching the free radicals arising out of various immune reactions in the body, thus protecting the cell from oxidative damage to DNA, lipids or proteins. Enzymes like superoxide dismutase, Glutathione and Catalase and other antioxidants like Vitamin E work in together to neutralize the antioxidants. CLA too has antioxidant properties which together with alpha-tocopherol markedly reduces the lipid peroxidation in rats (Dhar *et al.*, 2006; Saha *et al.*, 2012).

### Pasture Fed Poultry and Eggs

Chicken raised under free-range system have 21% less fat and 30% less saturated fat than their conventionally raised grain-fed counterparts. Similarly eggs obtained from poultry raised on pasture have

10% less fat, 40% more vitamin A, 30% more vitamin E and 400% more omega-3 fatty acids (SARE, 1999). Vitamin B<sub>12</sub> and folic acid content of eggs obtained from free-range poultry is appreciably higher than those obtained from confined poultry (Tolan *et al.*, 1974). Chicken housed and raised indoors are deprived of greens resulting in the decreased concentration of omega-3 fatty acids in their products (meat and egg) (Dolecek and Grandits, 1991). Switching to grain-fed to grass-fed production system might not be possible; however, occasional feeding of green (especially to layer) might fortify and add value to their products.

### Acceptability of Grass Fed Animal Products

Grass-fed animal product generates unique yet distinct grassy flavor and have unique cooking qualities. In addition, the fat and dairy products (cheese) from grass-fed animals may have a yellowish appearance. These effects are due to the presence of specific molecules introduced directly from the feed (carotenes, terpenes) or produced by the animals (plasmin, fatty acids) as a result of grass/pasture feeding (Martin *et al.*, 2005). These qualities can decrease the acceptability of the grass-fed animal products. Moreover, meat from grass-fed animals have lower fat content, hence possess different sensory properties which might not be accepted to the consumers who have long been habituated to the taste and eating experience of grain-fed products. However, Tyagi *et al.* (2007) found that CLA content of milk and milk products can be increased without affecting the sensory quality of the product by feeding berseem to the animals reared under intensive system.

Carcasses from grass-fed animals are lighter in weight and coarser in lean texture than grain-fed heifer carcasses. Yet the streaks of the meat from grain-fed animals are similar to grain-fed animals in tenderness, juiciness and flavor, but are darker in color during retail display (Crouse *et al.*, 1984). However, Brewer and Calkins (2003) found that grass-fed beef is lower in tenderness (both from shear force and by taste panel), flavor and overall acceptability and desirability ratings. Grass-fed production system can turn out to be more expensive, especially in parts of the country with less quality forage as grass-fed animals take longer time to attain market weight hence decreasing the profit and become uncompetitive with grain-fed animals (Mathews and Johnson, 2010). Increasing the awareness among consumers about the health benefits of grass-fed products can help to build a customer base that are willing to pay a high enough price for the product. Studies have shown that prior-knowledge about the health benefits of grass-fed products motivates consumers to pay high price which can cover the high cost of the product and include some profit (Gwin and Thiboumery, 2012).

Now-a-days consumers are becoming increasingly aware of issues such as food safety. A survey conducted on Irish consumers depicted that 64 percent of consumers were concerned about the animal products which include the freshness of food, antibiotic residues, hygiene standards and bacteria (Riordan

*et al.*, 2002). A very high count of *E. coli* bacteria are found in grain-fed cows as a result conditions created by grains in the rumen environment, which warrants use of antibiotics, hence become double whammy for consumers (Diez-Gonzalez *et al.*, 1998). On the other hand, grass-fed cattle remain healthier hence use of antibiotics is greatly reduced, moreover, in pasture conditions animals are separated by a very healthy distance which prevents the transfer of communicable diseases unlike in confinement (Pastures, 2006).

A considerable amount of energy and resources could be saved in the long run by raising the animals in pasture systems. Moreover, the impact on the environment is least when the animals are on pastures, in fact, it might prove beneficial as it decreases soil erosion, increases soil fertility, improves water quality and human health (Pastures, 2006).

### Conclusion

Pasture/Grass-fed animal products possess innumerable advantages over grain fed even though some limitations are there. Grass-fed products are healthier, heart friendly and possess properties like being anticarcinogenic, antidiabetic, antiatherosclerosis etc. Research of four decades supports the argument that there is considerable value addition of animal products obtained from grass-fed animals as they have more desirable saturated fatty acid lipid profile, higher total CLA (C18:2) isomers, TVA (C18:1 t11), n-3 FAs, beta carotene and alpha-tocopherol, antioxidants activity (such as GT and SOD) and have preferred n-6: n-3 ratio as compared to grain-fed animal products.

Grass-fed products tend to have peculiar taste and flavor that might reduce its acceptability. However, the more important challenge is to reduce the cost of the product, increasing the efficiency of nutrient utilization in grass-fed animals making it competitive with the grain-fed animal products and motivate the producers and consumers to shift towards grass-fed animal products. Consumer interests can be generated in grass-fed animal products by spreading awareness about its health benefits like it contains healthier fats, reduces risk of heart and brain disorders, improve the quality of life, reduce environmental impacts, has no animal welfare problems as the animals are grown in their natural habitat, which can substantially increase the consumer base and motivate the producers to shift towards pasture-based system. It can thereby prove a boon for the local economy.

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